

**FORMULATION OF FUNCTIONAL SNACKS  
AND ITS EFFECT ON BLOOD SUGAR AND  
LIPID PROFILE**

**BY**

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M.Sc. Home Science

**DISSERTATION**

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I also certify that the dissertation or part thereof has not been previously submitted by her for any degree, diploma or distinction to any other University /Institution. The assistance and help rendered during the course of investigation and sources of literature have been duly acknowledged.

**Place : PARBHANI**

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## **CERTIFICATE-II**

This is to certify that the dissertation entitled, “**Formulation of Functional Snacks and its Effect on Blood Sugar and Lipid Profile**” submitted by **Miss. Shinde Rupali Shyam** to the Vasantao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of **Doctor of Philosophy** (Home Science) in the subject of **Foods and Nutrition** has been approved by the Student's Advisory Committee after oral examination in collaboration with the External Member.

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degree or diploma

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**Date:**



***DEDICATED TO MY BELOVED  
PARENTS,  
MY LOVELY HUSBAND AND MY SON  
& MY RESEARCH GUIDE***

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## **Formulation of Functional Snacks and its Effect on Blood Sugar and Lipid Profile**

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### **Abstract**

An investigation entitled “Formulation of Functional Snacks and its Effect on Blood Sugar and Lipid Profile” was undertaken. For development of functional snack forty two variations were tried by changing the composition of ingredients to finalize one composition of functional snack. The impact of developed functional snack on blood glucose level of diabetic and lipid profile of hyperlipidemic subjects was assessed by conducting a clinical study. All the subjects of experimental group i.e. diabetic (15) and hyperlipidemic (15) were given 60 gm *Heartdiabocare snack* daily for 60 days. Variation 40 i.e. cardamom flavoured functional snack recorded highest scores in case of all sensory characters. The functional snack prepared by using in percent wheat flour 20, flax seed powder 5, niger seed powder 5, wheat bran 10, skim milk powder 20, soya chunk powder 5, oat flour 5, jowar flour 4, sugar powder 5, baking powder 3, fat 5, salt 1 and cardamom powder 2 per cent received an overall acceptability score of 8.97 and was liked by the sensory panel members. The cardamom flavoured functional snack recorded highest scores in case of all sensory characters viz. and overall acceptability (8.97). Hence, it was selected for further study. The developed functional snack was named as *Heartdibocare snack*. The functional properties of the flour were studied. It was evidenced from the data that the water absorption capacity and oil absorption capacity were recorded as 2.26 and 1.98 ml/g respectively and least gelation concentration was 4 per cent. Physical properties of developed functional snack indicated that the baking temperature was maintained while preparing functional snack was 150<sup>0</sup>C and the baking time was about 20 minutes. Number of pieces (*Heartdibocare snack*) obtained from 100g were seven. The weight of each piece was 15g. The length and width of the snack was 11cm and 3 cm respectively. The thickness of the sample was 0.6 cm. Volume of the snack was 30 ml. Bulk density was 1.23 g/ml and the hardness (texture) of the snack was 3.08 N. The colour of

functional snack was recorded as values of L, a and b as 48.28, 6.94 and 22.85 respectively. The developed *Heartdiabocare* functional snack was rich in protein (17.11%), dietary fibre (22.28 %), iron (7.5 mg/100g) and calcium (298.56 mg/100g). The developed functional snack was fit for consumption on 90<sup>th</sup> day of storage. Glycemic index of developed *Heartdiabocare* functional snack was 26.77 which was categorized as low glycemic index. Gender wise anthropometric measurements of selected diabetic subjects showed that there was no significant difference in recorded anthropometric measurements of experimental and control group men and women before and after supplementation of *Heartdiabocare Snack*. All the selected subjects were categorized as obese as they had more than 25 BMI. The protein, energy, iron and fiber intake of the selected subjects was lower than the RDAs of ICMR, while fat consumption exceeded significantly than RDAs in both groups of subjects. Supplementation of *Heartdiabocare Snack* to the diabetic and hyperlipidemic subjects for 60 days found to be helpful in reducing fasting (45.4 mg/dl) and post prandial blood glucose level (50.14 mg/dl) and total cholesterol (68.9 mg/dl), triglyceride (38.6 mg/dl) and LDL cholesterol level (37.54 mg/dl) respectively in both groups. Supplementation of *Heartdiabocare Snack* to the diabetic and hyperlipidemic subjects is helpful to control blood sugar and lipid profile in respectively both the groups. Cost of ingredients used for development of functional snack was 155 Rs./Kg.



# Introduction

## CHAPTER-I

### INTRODUCTION

*अन्नपते त्रस्यनोदेहि अनमीवस्य शुष्मिणः ।*

- यजुर्वेद

***(Oh, God Give us food which does not cause any disease  
and also gives us strength)***

- ***Yajurveda***

***“Let food be thy medicine and medicine be thy food”***

- ***Hippocrates***

The relationship between food and health is well known for centuries. Food is being used for prevention and treatment of diseases since ancient times. ‘Ayurveda’ is a classical example of this fact. Where in many foods are used as medicines. Even Hippocrates had proclaimed it almost 2500 years ago, stating the importance of food as a medicine. Recently, this food as a medicine concept is regaining the importance. It is receiving renewed public interest. Now consumers believe that foods contribute directly to their health. Rather there has been an explosion of consumer’s interest in the health promoting role of specific foods or physiological active food components called function foods.

The term ‘Functional Foods’ was first used in Japan, in 1980s, for product fortified with the special constituents that possessed advantageous physiological effect, decreased the risk of some diseases and could even be used for curing some illness. The concept of functional foods was first promoted in 1984 by Japanese scientist who studied the relationship and modulation of physiological role for approval of a specific health related food category called FOSHU (Food for specified health use) which included the establishment of specific health claims for this type of food (Burdok *et al.*, 2000b).

The International Food Information Council (Washington, USA) defines functional foods as “Foods that provide health benefits beyond basic nutrition”

(IFIC, 2000). The International Life Sciences Institute (ILSI) of North America has defined functional foods as “Foods by virtue of physiologically active food components provide health benefit beyond basic nutrition”. Health Canada (1999) defines functional foods as ‘Similar in appearance to a convenient food, consumed as a part of the usual diet with demonstrated physiological benefits, and/or to reduce the risk of chronic disease beyond basic nutritional functions.

According to the World Health Organization & the Food and Agriculture Organization, several dietary patterns along with lifestyle habits constitute major modifiable risk factors in relation to the development of coronary heart diseases, cancer, type 2 diabetes, obesity, osteoporosis and periodontal disease (WHO, 2003). In this regard, functional foods play an outstanding role. Hence, functional foods are considered to be useful in disease prevention and the maintenance of good health.

Today foods are not intended to only satisfy hunger and to provide necessary nutrients for humans but, also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers. The increasing demand for such foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy and the desire of older people for improved quality of their later years (Roberfroid, 2000b).

A variety of bioactive substances from plant or animal origins have been investigated for their potential functional and physiological properties (Shahidi, 2009). There are foods which can be categorized as functional foods based on their functional components viz., flaxseed, nigerseed, oats, cereal bran, soyabean etc.

The prospective health benefits of flaxseed, especially in relation to cancer and cardiovascular disease has got more consideration by the nutrition workers and food scientists. Many researchers are conducting studies on its role in the cure and prevention of several diseases. Due to health promoting properties and excellent nutrient profile of flaxseed; it can become a popular ingredient for incorporation in human diet, and can be used for the

development of functional foods. The components of flaxseed, identified to exhibit the health benefits are fiber, lignans and linolenic acid. Moreover, flaxseed is a good source of high quality protein, soluble fibers and phenolic compounds (Oomah, 2001). The people with more intake of lignans are least prone to prostate, breast and endometrial cancers (Sotchell *et al.*, 1981). The flaxseed is also an excellent source (about 28%) of dietary fiber. About two third of the total fiber in flaxseed is insoluble which increase the bulk in human digestive system, thus aids in digestion and prevent constipation. Whereas, remaining fiber portion of the flaxseed is soluble having the ability to lower cholesterol levels in the body. The soluble fibers also optimize the blood sugar concentrations (Institute of Medicine, 1994). The flaxseed is also a rich source of polyunsaturated fatty acids consisting about 80 per cent of total oil with a high ratio of omega-3 to omega-6, both of which are essential and to be eaten as a part of diet since the body does not manufacture them. Flaxseed oil contains one of the essential fatty acids i.e alpha linolenic acid which is one of the three omega-3 fatty acids; Omega-3 fatty acids play important role in reducing the risk of cardiovascular diseases regulate the cholesterol, triglycerides and blood pressure (Morris, 2003).

Niger seed is very good source of nutrients. It can supply 23.9 g protein, 39 g fat, 17.1 g carbohydrate, 300 mg calcium, 515 kcal energy and 56.7 mg iron per 100 gm (Gopalan, 2011). Among the commonly consumed various oilseeds, niger seeds are richest source of iron and good source of protein and energy. Hence, it has a vital role to play in human nutrition.

Oats contribute both starch and dietary fiber to the diet. Whole oat grain contains high amounts of valuable nutrients such as soluble fibers, proteins, unsaturated fatty acids, vitamins, minerals and phytochemicals.  $\beta$  glucan is a major component of soluble dietary fiber of oats (Wu and Doehlert, 2002). A diet containing whole oats can improve blood pressure control, reduce the need for antihypertensive medications and can be useful product to lower serum cholesterol level when used in conjunction with other appropriate health

measured, including a low fat diet, exercise and appropriate drug therapy etc.

Cereal brans have their roles in the battle against obesity, vascular complications and diabetes. Whole grain cereals and dietary fibre in particular, promote satiety, prolong gastric emptying time and slow down nutrient absorption (Slavin, 2013). Synergistic effect of fibre, resistant starch and antioxidants are deemed responsible for moderating the rate of glucose absorption, delaying insulin release, the consequence of which might influence weight management. Lowered risk of cardiovascular diseases, type 2 diabetes and obesity with high intakes of cereal fibre or mixtures of whole grains and bran have been reported (Cho, Qi, Fahey, & Klurfeld, 2013).

Soybean is significantly known not only for its nutrient content but also for its health related benefits. Hence, it is usually identified as a 'Miracle golden bean'. Based on protein digestibility corrected amino acid score (PDCAAS), purified soy protein has a score very close to 1.0, the highest rating possible as in the case of animal protein such as egg white and casein (Waggle and Potter, 2000). Thus soy protein is very useful in enhancing growth and development in human beings. The ratio of poly unsaturated fatty acid to saturated fatty acid is 82:18 which is highly conducive to lower the blood cholesterol. Further, the other poly unsaturated fatty acid such as linoleic acid has antioxidant property; therefore the soybean is very helpful in reducing risk of heart disease (Tripathi and Mishra, 2005).

Such functional ingredients can be utilized for designing various food products specially functional snacks. A snack is a type of food not meant to be eaten as a main meal of the day – breakfast, lunch or dinner but rather to assuage a person's hunger between meals, providing a brief supply of energy for the body (James, 2005).

Snacks are foods consumed between meals. In today's hectic lifestyle, meals are often taken on the run, between classes, in the car and on the work desk. Snack foods have become part of everybody's life, and often consumed in place of regular meals. Snacks and light meals, are popular forms of catering

at any time of the day or night and there is a wide variety of foods to be offered e.g. Chips, sweets, fried foods, chips, sandwiches, popcorn etc. (Foskett *et al.*, 2004).

However, with increasing rate of literacy and awareness people are paying more attention to what they are eating. The choice of snack foods is becoming more sophisticated and traditional potato chips or corn chips are not enough anymore. Consumers look for snacks with more protein, more vitamins, more fiber and less saturated fat.

Busy lifestyles and the increasing demand from consumers for meals and snacks that are quick sources of good nutrition have prompted the food industry to develop foods like ready-to-eat snacks that combine convenience and nutrition. Consumers demand nutritious, convenient, tasty snacks that satisfy their hunger momentarily until the next meal. Four in ten consumers are looking for snacks that provide health benefits beyond basic nutrition and similarly, due to the increase in the incidence of multi-tasking while eating, there has been upsurge in demand for “on-the-go” handheld snacks (Sloan, 2011). Functional snacks, if developed, will be beneficial for prevention, maintenance and treatment of life style diseases.

Lifestyle diseases also known as non communicable diseases are associated with the way people live and behave. Life style diseases are also becoming evident in the growing population. According to WHO factsheets, lifestyle diseases like CVD, diabetes, obesity, cancer, osteoporosis, respiratory diseases and gastrointestinal diseases accounts for 59 per cent of the 56.5 million deaths annually and 45.9 per cent of the global burden of diseases (WHO, 2010).

Diabetes is one of the most challenging noncommunicable health problems in the twenty first century (Rahman *et al.*, 2004). Diabetes currently afflicts 171 million people worldwide (Boden and Taggart, 2009). Unlike in the West, where older persons are most affected, diabetes in Asian countries is disproportionately high in young to middle-aged adults. This could have long-

lasting adverse effects on a nation's health and economy, especially for developing countries. According to the International Diabetes Federation (IDF), the number of people with diabetes in India is 40.9 million and is expected to rise to 69.9 million by 2025 (Ajay *et al.*, 2008). Shocking statistics on diabetes revealed that twenty per cent of the World's diabetics are Indians. Thirty per cent of diabetes in India are below the age of forty and that by 2025, WHO, has estimated that India would have highest number of diabetics followed by China and can be called as 'Diabetic Capital' of the world (WHO, 2003).

The global increase in the prevalence of diabetes is due to population growth, aging, urbanisation and an increase of obesity and physical inactivity. The primary determinants of the epidemic are the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity. Normal non-diabetic patients maintain plasma glucose <100 mg/dl in the fasting and <135 mg/dl in the post prandial period (Rossetti *et al.*, 2008).

Hypercholesterolemia or hyperlipidemia or dyslipidaemia, an another noncommunicable health problem is the most common factor in causing coronary heart disease. Lipid metabolism can be disturbed in different ways. It leads to changes in plasma lipoprotein function and /or levels. This by itself and through interaction with other cardiovascular risk factors may affect the development of atherosclerosis. Dyslipidaemias cover a broad spectrum of lipid abnormalities, some of which are of great importance in coronary heart disease prevention. Dyslipidaemias may be related to other diseases (secondary dyslipidaemias) or to the interaction between genetic predisposition and environmental factors, since overweight, obesity and central obesity often contribute to dyslipidaemia. Elevation of total cholesterol and low-density lipoprotein-cholesterol has received most attention, particularly because it can be modified by lifestyle changes and drug therapies (Sevket *et al.*, 2012).

In view of increased prevalence of non communicable diseases interests in the health benefits of food have been sparked. Consumer acceptance of the

functional snacks and better understanding of its determinants are widely recognized as key success factor for designer food development. Hence, the formulation of functional snack suitable for various age groups, which can exhibit the health benefits and beneficial for people with non communicable diseases is essential by utilizing functional ingredients.

All age group people prefer bakery products than other snack items as they are ready to eat, palatable and long lasting. Bakery products are the important staple foods in many countries. Bakery food market is continuously flourishing throughout the globe. Specifically crispy snack and bakery products are contributing as a major chunk in processed food.

Hence, a baked functional snack suitable for individuals with non communicable diseases (Diabetes and Hyperlipidemia) was formulated. The study was conducted with following objectives:

- To design and standardize the functional snack
- To assess the organoleptic quality of standardized snack
- To assess the nutritional quality of developed functional snack
- To study the shelf life of formulated functional snack
- To determine the therapeutic effect of supplementation of formulated functional snack on lipid profile and blood sugar content of selected subjects.



# **Review of Literature**

## **CHAPTER-II**

### **REVIEW OF LITERATURE**

Review of literature is of great help to get a vivid, comprehensive picture of the previous research conducted in similar lines, which provides a sound base for scientific investigation. The reviews also generate novel ideas and approaches for evaluating the research efforts in comparison with similar efforts done by others.

The documented literature pertaining to functional ingredients, development of functional food and their health benefits is presented below.

#### **2.1 Studies on Functional Ingredients**

#### **2.2 Development, physico-chemical Properties and Storage of Functional Foods**

#### **2.3 Non-Communicable Diseases: Diabetes Mellitus and Hyperlipidemia**

##### **2.3.1 Prevalence and Epidemiological Factors of Diabetes Mellitus**

##### **2.3.2 Prevalence and Epidemiological Factors of Hyperlipidemia**

#### **2.4 Effect of Supplementation of Functional Ingredients/ foods on Blood Glucose & Lipid Profile**

#### **2.1 Studies on Functional Ingredients**

Functional food components are potentially beneficial components found naturally in foods or added to them as functional ingredients which include carotenoids, dietary fibre, fatty acids, flavonoids, isothiocyanates, phenolic acids, plant sterols and sterols, polyols, prebiotics and probiotics, phytoestrogens, soy protein, vitamins and minerals.

At present, professionals are recognizing that some functional components of foods have a major role in health enhancement. In fact, the big importance of these “bioactives” present in many foods, either naturally or added, has lead many scientists of different fields to conduct studies aimed for establishing the scientific basis that supports and validates the benefits of particular food or component for the human health. Such particular foods

mostly discussed as functional food ingredients by various Researchers are reviewed below.

### **Flax seed**

Gutiérrez *et al.*, 2010 studied the flaxseed and flaxseed cake as a source of compounds for food industry and mentioned that flax (*Linum usitatissimum*) has been used for centuries as a source for oil extraction. In recent years it is attributed for its potential health benefits, including the prevention of chronic non-communicable diseases. Among the compounds presenting biological activity, alphanolenic acid, lignans and soluble fibre are of special interest. The composition of the flaxseed oil and flaxseed cake was estimated. From the results, it was observed that the oil extracted from flaxseed contained 51.86 per cent of linolenic, 16.34 per cent of linoleic and 20.98 per cent of oleic acid. Fractioning of defatted flaxseed cake produced polyphenol content of 0.73 mg GAE g<sup>-1</sup> extract and a protein isolate of considerable purity, 53.15 per cent yield with 0.78 g of albumin equivalent g<sup>-1</sup> protein isolate.

In a review article on flaxseed: a potential source of food, feed and fibre Singh *et al.* (2011) it is mentioned that flaxseed is one of the most important oilseed crops for industrial as well as food purposes. The seed provides oil rich in omega-3, digestible proteins and lignans. In addition to being one of the richest sources of  $\alpha$ -linolenic acid, oil and lignans, flaxseed is an essential source of high quality protein and soluble fiber and has considerable potential as a source of phenolic compounds. Flaxseed is emerging as an important functional food ingredient because of its rich contents of  $\alpha$ -linolenic acid (ALA), lignans and fiber. Lignans appear to be anti-carcinogenic compounds. The omega-3 fatty acids and lignan phytoestrogens of flaxseed are in focus for their benefits for a wide range of health conditions and may possess chemo-protective properties in animals and humans.

Hussain *et al.* (2012) stated that use of flaxseed as a functional food has gained in popularity in recent years. It has been grown since ancient times for food and other uses. Flaxseed is an excellent source of nutrients including protein, soluble and insoluble dietary fibre as well as omega-3 fatty acids. The

flaxseed can be used as a whole or it can be incorporated in other foods including bakery products. The flaxseed proteins can enhance the biological parameters of bread and unleavened flat bread (chapattis). The addition of flaxseed to wheat flour can also contribute towards several health benefits and can serve as a low-cost treatment for many diseases, e.g. diabetes, hypercholesterolemia and cardiovascular complications.

Amin and Thakur (2014) while reviewing about *Linum usitatissimum* L. (Flaxseed) as a multifarious functional food mentioned that flaxseed is a premium food delivering high performance and is one of the richest sources of  $\omega$ -3 fatty acids ( $\alpha$ -linolenic acid) known to man. Whole flaxseed, flaxseed oil, lignan precursors and its mucilage have many potential uses in the prevention or treatment of various diseases. Flaxseeds have been classified as functional food because it provides numerous health benefits in addition to serving as a source of nutrients. They have also been considered as a good mood food.

### **Wheat Bran**

Wheat bran is an important source of dietary fibre. It is rich in insoluble fibre but also contains some soluble fibre (Saunders, 1978). Wheat bran is an effective treatment of constipation and haemorrhoids (Gray, 1995). A study on biochemical and sensory evaluation of wheat bran supplemented sorghum bread was carried out by Mallasy *et al.*, (2002). Wheat bran was added to decorticated sorghum flour at the ratio of 64:35g and 64: 30g. The findings indicated that panel members preferred wheat bran sorghum bread compared to traditional sorghum bread. There was significant reduction in reducing sugars, invitro protein digestibility due to addition of wheat bran in sorghum bread.

Functional properties and anti-nutritional factors in cereal bran were studied by Kaur *et al.* (2011). It is reported that bran is the outer layer of most cereal grains. It is nutrient dense as it contains proteins, omega 3 and omega 6 fatty acids and antioxidants. Cereal bran is an excellent source of dietary fibre. It offers all the nutritional and nutraceutical benefits of whole grain. Brans are composed mainly of insoluble cellulose and hemicelluloses, with only about 5 per cent soluble fibre and have little hypercholesterolemia effect. Proximate

composition and functional characteristics of various cereal brans (wheat, rice, barley and oat) were investigated and the results showed that the crude protein content ranged from 9.6-15.03 per cent, fat 4.07-19.31 per cent, dietary fibre 14.0-38.95 per cent, bulk density 0.39-0.59 per cent, water absorption 115.20-383.70 g/100g, fat absorption 138.3-302.9 g/100g and free fatty acids 5.20-13.73 per cent. Cereal brans had total polyphenols in the range of 0.54-6.53 mg/g. Hence, it can be used as alternative source of nutrients (proteins, B-vitamins and minerals) in food products.

Kumar *et al.* (2011) reviewed about nutritional contents and medicinal properties of wheat. It is mentioned that wheat bran can be used as a supplemental source of dietary fiber for preventing colon cancer, treating Irritable Bowel Syndrome (IBS), reducing the risk of haemorrhoids & hiatal hernia, hypercholesterolemia, hypertension, reducing the risk of breast cancer, gallbladder disease and type 2 diabetes. Wheat bran helps constipation by speeding up the colon and increasing stool output and bowel frequency. The outer layer of the bran provides fiber that gives bulk and regulates the absorption and excretion of nutrients from the body.

### **Oats**

The effect of oat  $\beta$ -glucan on total and LDL-cholesterol was expressed by Sylvia *et al.* (2001). The effect of  $\beta$ -glucan derived from oat preparation on plasma lipid concentrations of fourteen human subjects was examined. The  $\beta$ -glucan supplemented diets were given for 3 weeks. Then  $\beta$ -glucan was incorporated into 3 foods cereals, muffins & bread. It was noticed that plasma cholesterol & LDL concentrations were declined significantly with the administration of 7 g  $\beta$  glucan/ day through cereals, muffins and bread.

Daou and Zhang (2012) reviewed excellently about the recent advances into the health promoting potentials of oat polysaccharide  $\beta$ -glucan. This soluble oat fiber is able to attenuate blood postprandial glycemic and insulinemic responses to lower total blood cholesterol and low-density lipoprotein cholesterol. It is also able to improve high-density lipoprotein cholesterol and blood lipid profile as well as helps to maintain body weight.

Thus, oat  $\beta$ -glucan intake is beneficial in the prevention, treatment, and control of diabetes and cardiovascular diseases. In addition, oat  $\beta$ -glucan can stimulate immune functions by activating monocytes/macrophages and increasing the amounts of immunoglobulin, natural killer cells, killer tumor cells and also improve resistance to cancer, infectious and parasitic diseases, as well as increase biological therapies and their prevention.

Oats provide more protein, fiber, iron and zinc than other whole grains. They have high nutritive value for people because of good taste and an activity of stimulating metabolic changes in the body. Oats are said to be unique among cereals as they are therapeutically active against diabetes, dyslipidemia, hypertension, inflammatory state and vascular injury than other grains which are predominantly insoluble, such as wheat or rice (Sangwan *et al.*, 2014).

Nutritional advantages of oats and opportunities for its processing as value added foods were reviewed by Rasane *et al.* (2015). It was stated that oat (*Avenasativa L.*) has received considerable attention for their high content of dietary fibers, phytochemicals and nutritional value. It is believed that consumption of oats results in various health benefits such as hypocholesterolemic and anticancerous properties. Oats have also recently been considered suitable in the diet of celiac patients. Owing to their high nutritional value, oat-based food products like breads, biscuits, cookies, probiotic drinks, breakfast cereals, flakes and infant food are gaining increasing consideration. Research and development on oat and its products may be helpful in combating various diseases known to mankind.

### **Niger seed**

Niger seed is most important oilseed crop of tropical and subtropical areas of the world. Mostly it is cultivated in Ethiopia and India. India is the largest producer of niger seed in the world. In India annual production of niger seed is over 0.6 lakh metric tonnes. In India niger seed is mainly grown in the states of Orissa, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Bihar. It is very rich source of nutrients. It contains 315 Kcal, oil 39 per cent, fiber 10.9 g, calcium 300 mg and iron 56.7mg /100g. The niger seed oil

contains 63 per cent linoleic acid, 17 per cent palmitic acid, 11 per cent oleic acid. It is rich source of vitamin K. The niger seed has unique health promoting characteristics (Goplan 2011; Jain *et. al* 2015).

Bhatnagar and Gopalakrishna (2015) studied the bioactives concentrate from commercial Indian niger (*Guizotia Abyssinica* (L. F.) cass.) seed and its antioxidant and antiradical activity. It is reported that niger seed oil contains high amount of omega 6 PUFA (63-75 %). The defatted niger seed and its extracts can serve as a natural source of antioxidants. The Indian niger seed is rich source of bioactive molecule namely phytochemicals vitamin K1 phospholipids. The findings of the study indicated that the incorporation of niger seed bioactives into commercial refined sunflower oil helped to the antioxidants and anti radical activity.

Deme *et al.*, in 2017 studied about mineral and anti-nutritional content of niger seed [(*Guizotia abyssinica* (L.f.) Cass.), varieties grown in Ethiopia. The findings indicated that the iron content of niger seed varied from 5.56-13.6mg/100g. The antinutritional factors analyzed were tannin 134.6mg/100g and phytates 352.58 mg/100g.

### **Skimmed milk powder (SMP)**

Skimmed milk powder (SMP) has low moisture and fat contents and, when stored in dry, cool conditions, has a shelf life in excess of two years. Specifically, when stored at 15°C and a relative humidity of 75 per cent, skimmed milk powder has a minimum shelf life of two year, an average shelf life of three years and a maximum shelf life of four years. Milk powders are hygroscopic: they tend to attract water readily from humid atmospheres. When moisture levels are excessive, milk powders may become sticky, caked or lumpy, and exhibit reduced flowability and solubility. These changes affect the ease of use of the product, requiring grinding for example and may affect the flavour, but do not represent a health or safety problem. If the powder's moisture content exceeds 15 per cent, it then becomes susceptible to microbiological growth and should not be used. Skimmed milk powder should have a mild flavour and aroma. After extended storage, it may develop slight

off flavour. These changes may be noticed in rehydrated or “recombined” milk products. However, milk powders for use as ingredients in manufactured foods and dry blends generally do not need to meet as high standards of palatability and redispersibility. Dried skimmed milk products stored in optimal conditions in proper packaging show essentially no change in colour, even during two years of storage at 35°C. In commercial situations, most dried milk products are susceptible to reactions that can result in small changes in the physical properties of the product, its palatability and nutritive value. These changes, however, do not significantly impact the nutritional benefits of milk powders. Vitamin and protein quality losses during storage of milk powders, when stored in good conditions, are negligible (US dairy export council, 2011).

Milk powder is prepared by drying fluid milk. It is a non fat dry milk. Due to drying skimmed milk powder has shelf life up to 3 years if stored properly. It is a very good source of protein (38%), fat (0.1 %), total minerals (6.8%), CHO (51 %), energy (357 Kcal) and calcium (1370 mg)/ 100g (Gopalan, 2011).

Functionality of milk powders and milk based powders for end use applications was reviewed by Sharma *et al.* (2012). It was mentioned that SMP is widely used as an ingredient in many formulated foods. Soups, sauces, confectionery and bakery products all benefit from the functional properties provided by SMP. Dairy powders include conventional powders like SMP, WMP, and partial SMP.

### **Gum acacia**

Physico-chemical properties of the gum acacia were studied by Jahan *et al.* (2008). It is stated that gum acacia is a potent drug having diverse pharmacological effects and wide therapeutic potential. It is used in diarrhoea, dysentery, irritations and ulcers of the stomach and intestine. It is also used in haemodialysis, bleeding piles, menorrhagia, leucorrhoea and spermatorrhoea.

Glover *et al.*, 2009 studied about the potential health benefits of acacia supergum in human subjects. It is mentioned that gum acacia retards glucose absorption, increases stool mass, traps bile acids and has a potential to

beneficially modify the physiological status of human subjects. Gum acacia can reach the large intestine without digestion in the small intestine, it can be categorised as a non-digestible carbohydrate or dietary fibre. It is fermented by intestinal bacteria to short chain fatty acids in large intestine. Gum acacia is a bifidogenic dietary fibre. It is able to selectively raise the proportion of lactic acid bacteria and bifidobacteria in healthy subjects. Gum acacia also increases stool output by augmenting the water content of stools. Its intestinal tolerance is excellent and high daily doses can be consumed without any adverse intestinal events. The study indicated that acacia gum acts as a prebiotic at a dose of 10g/day.

### **Soy protein**

In the review article on functional and edible uses of soy protein products by Singh *et al.* (2008) described that soybeans provide an alternative source of protein for people who are allergic to milk protein. Soy protein is highly digestible (92 to 100 %) and contains all essential amino acids. Although relatively low in methionine, it is a good source of lysine. The beneficial effects of soy protein include lowering of plasma cholesterol and prevention of cancer, diabetes, and obesity, as well as protection against bowel and kidney diseases. The cholesterol lowering effect of soy is because of the presence of isoflavones, a class of phytochemicals found in soybeans. Soy-protein products contain a high concentration of isoflavones, up to 1g/kg. Soy protein drinks that contain naturally occurring high levels of isoflavones reduced total cholesterol and LDL cholesterol, in patients who had high cholesterol levels despite consuming a low-fat, heart-healthy diet.

Joyandeh in 2011 reviewed about “Soy products as healthy and functional foods”. It is stated that the protein content of soybean has rich amino acids with a good balance. The high lysine content of soy protein makes it a good complement to cereal proteins, which are low in lysine. Soy foods can provide the body with beneficial agents including vitamins, minerals, fiber and flavonoids. Consumption of soy protein has been associated with reducing arterial stiffness, decreasing the susceptibility of LDL cholesterol to oxidation,

lowering total and LDL cholesterol and increasing HDL cholesterol, possibly reducing the risk of coronary artery disease. Soybeans have a very low glycemic index and are valuable foods to include in a diabetic diet. Regular consumption of soy protein help to reduce symptoms associated with Type 2 diabetes. Soy has shown decreased postprandial hyperglycemia, improved glucose tolerance and decreased amounts of glycosylated haemoglobin.

The documented literature on functional ingredients indicated that flaxseed, wheat bran, oats, niger seed, skimmed milk powder (SMP), gum acasia and soy protein are having bioactive principles which give functionality to the food ingredients. It is noticed that the bioactive principles present in these foods are carotenoids, dietary fibre, fatty acids, flavonoids, isothiocynates, phenolic acids respectively. Therefore, these foods do exert positive physiological effects such as improving the health of the heart, reduction in total cholesterol, prevention of constipation, prevention of various types of cancers, weight management.

## **2.2 Development, Physicochemical Properties and Storage of Functional Food Product**

In view of obtaining the benefits of functional ingredients, essential efforts were taken by some investigators and the studies were conducted for development of functional food products. Such few studies are reviewed here under.

Experiment on development of ready-to-eat (RTE) breakfast bars was carried out by Kanjana *et al.*, (2003). Two categories of breakfast bars were formulated - cocoa-based for flavor and the cereal-based for cereal millet fruit combinations. The RTE breakfast bars developed were compared with brand X's basmathi flakes, corn flakes and wheat flakes and brand Y oats. Nutritional content was evaluated by standard method. Energy value of the breakfast bars surpassed that of all the breakfast cereals with which they were compared. Protein value of the cocoa bars was comparable with that of the basmathi flakes. Sugar content was lower and fibre content was close to that of corn flakes and basmathi flakes. The iron content was more than that in the oats and

almost equal to that in the other breakfast cereals. Thiamine, niacin and riboflavin were relatively lower in the breakfast bars. The bars packed in 12-micron/150 gauge polythene laminate were stored under accelerated storage (relative humidity 90% and temperature 30 °C) because of the time restraint. Observations showed a gradual increase in both moisture and fat acidity per cent as days passed by. Deterioration resulted once the moisture and acidity increased to the level of 3 and 0.6 per cent, respectively. Cocoa-based and cereal-based bars exhibited the shelf life of 28 days under accelerated condition which was equivalent to 84 days under normal condition (relative humidity 60 % and temperature 27 °C).

Effect of flax addition on the flavor profile of muffins and snack bars was studied by Aliani *et al.* (2011). Three snack bar formulations and two muffin formulations with and without flaxseed were developed and evaluated. Panels consisted of one male and the rest female between 22 and 45 years of age with ten assessors for snack bars and eleven for muffins. Results revealed that the intensity of seven aroma and eight flavor attributes for snack bars, and nine aroma and ten flavor attributes for muffins were measured on 15-cm line scales. Both the orange cranberry and apple spice muffin formulations with flaxseed had significantly lower sweetness and vanilla aroma and flavor intensities, and significantly higher grain/flax aroma and flavor, and bitter taste compared to the non-flax muffin. Of the two flavourings apple spice appeared to have the best potential, since the apple aroma and flavor were significantly higher for the flax muffin compared to the non-flax muffin. The orange cranberry, gingerbread raisin and cappuccino chocolate chip snack bar formulations with and without flaxseed showed no significant differences in intensities for the grain/flax aroma and flavor. The gingerbread raisin snack bar formulations showed no significant differences for any other attributes except for higher spice aroma in the flax sample, which makes it a promising flavoring option.

Development and evaluation of flour mixes and their biscuits for suitability in diabetic diet was carried out. Wheat flour, soy flour and pearl

millet flour were mixed thoroughly and biscuits were prepared by using ISI standard (1980) by using mix 1 (WSP), mix 2 (SPW) and mix 3 (PSW). Mixes were analysed for nutrient evaluation. Data indicated that the moisture content of three flour mixes ranged from 10.61 to 11.05 per cent. The mix 2 (SWP) showed higher crude fibre (2.41 %), crude protein (24.34 %), crude fat (9.77 %) and energy (376 Kcal/100g) but was low in carbohydrate content (49.91 %) as compared to mix 1 and mix 3 flours. The higher values of protein and fat in mix 2 flours were due to higher incorporation of soyabean flour. The total dietary fibre content was also highest in mix 2 SWP flour (5.57 %) among three flours (Choudhary *et al.*, 2011).

Nadife *et al.* (2011) evaluated the nutritional and sensory quality of functional bread produced from whole wheat and soya bean flour blends. The flour blends of whole wheat and soybean were composites at replacement levels of 10, 20, 30 and 40 per cent while the whole wheat flour bread (sample A) served as control. The proximate composition of the various flour blends used for the preparation of breads were determined using standard methods. The bread loaves were produced using the straight-dough procedure and were subsequently evaluated for their nutritional composition and sensory attributes. The physico- chemical analysis results showed an increase in the range of 11.0 per cent for moisture, 4.37 per cent for protein, 2.40 per cent for fat, 2.35 per cent for crude fibre, 0.85 per cent for ash and a decrease in carbohydrate and energy contents by 20.92 and 44.60 per cent respectively. There was also a decrease in bread volume and dough expansion by 64.50 and 13.0 per cent respectively, with progressive inclusion of the soybean flour. The sensory analysis showed that there was no significant difference observed between the whole wheat bread and the soy bread samples in the sensory attributes of crust colour and crumb appearance. While significant difference ( $p < 0.05$ ) was observed in texture, flavour and overall preference respectively. It was concluded that a substitution of 10 per cent soy flour into wheat flour gave the bread with the best overall quality acceptability.

Aleem *et al.*, in 2012 studied about the effects of defatted soy flour incorporation on physical, sensorial and nutritional properties of biscuits. The defatted soy flour (DSF) was incorporated in the traditional recipe to replace wheat flour at levels by 0, 10, 20 and 30 per cent in preparation of biscuits. The data revealed that increase in level of DSF incorporation resulted in linear decrease of total weight, diameter, spread ratio and hardness. Thickness of biscuits increased with increase in concentration of DSF. The biscuits with 20 per cent DSF were not accepted. The DSF incorporated biscuits had lower hardness when compared to control biscuit. The nutritional value of biscuits with 20 per cent soy flour incorporation as determined through nutrient analysis were moisture (2.7%), protein (13.53 %), fat (17.74 %), ash (1.75 %), and total energy (462.30 Kcal). The biscuits with 20 per cent of defatted soy flour were comparable to control (wheat flour) biscuits.

Development of functional chapatti from texturized deoiled cake of sunflower, soybean and flaxseed was undertaken by Bhise and Kaur (2013). Texturized defatted meal of sunflower, soybean and flaxseed was blended at 10 per cent, 20 per cent, 30 per cent and 40 per cent levels with wheat flour (atta) for chapatti making. Chapattis were evaluated for physical, textural, sensory and functional properties. Proximate analysis of defatted sunflower meal had 2.56 per cent moisture, 2.53 per cent fat, 43.38 per cent protein, 13.07 per cent fiber and 32.54 per cent protein digestibility. The defatted soybean meal had 2.70 per cent moisture, 2.26 per cent fat, 52.86 per cent protein, 3.29 per cent fiber and 56.33 per cent protein digestibility. The defatted flaxseed meal had 2.61 per cent moisture, 2.71 per cent fat, 38.24 per cent protein, 12.24 per cent fiber and 43.77 per cent protein digestibility. The cutting force for chapattis increased with increased level of texturized defatted meal of sunflower, soybean and flaxseed. Sensory, colour and overall acceptability of chapattis were negatively affected when level of texturized flour increased as compared with the control. Overall acceptability scores were maximum for control and chapattis with 10 per cent texturized defatted meal of sunflower, soybean and flaxseed. Functional properties such as water absorption index, foaming

capacity and protein digestibility were increased while water solubility index and fat absorption capacity decreased with increased levels of texturized defatted meal. There was a decrease in L values for texturized defatted sunflower chapattis from 37.62 to 34.81. Similarly L value was decreased for texturized defatted soybean and flaxseed chapattis from 43.56 to 31.87 and 56.17 to 47.13. The a and b value increased with increasing levels of incorporation of texturized defatted sunflower, soybean and flaxseed cake. Decline in L values signified that with increase in percentage incorporation the lightness decreased while a and b values showed an increase in redness and yellowness in chapattis. The cutting force for sunflower, soybean and flaxseed chapattis were ranging from 4.69 to 6.60 N, 4.76 to 6.54 N and 4.22 to 6.47 N. this showed that incorporation of texturized defatted sunflower, soybean and flaxseed flour had negative results on textural properties. All functional properties except fat absorption capacity and water solubility index increased significantly with increase in level of texturized defatted flour of sunflower, soybean and flaxseed. Water absorption index, foaming capacity and protein digestibility were increased with increased level of incorporation of texturized defatted flour of sunflower, soybean and flaxseed in wheat flour for chapatti making. The result showed that texturized defatted meal served as good substitute to wheat flour with increased protein content in chapatti production and utilization.

Development of cereal bar using roasted rice bran was undertaken by Garcia *et al.* (2013). Cereal bars were developed using roasted rice bran, rice flakes, corn flakes, banana and baru nuts with syrup mixture. Results depicted that an increase in the roasted rice bran level in the formulation reduced the force of rupture and water activity, resulted in intermediate density and caused darkening of the bars. Color of developed cereal bars and commercial cereal bar was studied. Lightness ( $L^*$ ) ranged from 31.20 to 37.10, darker than the commercial bars ( $L^*$  between 40.70 and 42.20). The bars had reddish-yellow hue ( $h^*$  between 54.20 and 66.20) and were less yellow than the commercial

products (from 76.70 to 80.70). The higher the roasted rice bran content, the darker and the more reddish was the product (lower h\*).

Hassan *et al.*, (2012) examined the effect of addition of some plant sources (e.g. barley, mustard, defatted mustard, flaxseed meal and flaxseed oil) as a source of active healthy components to prepare functional prebiotic biscuits for lowering blood lipids. Functional biscuits were formulated by replacing wheat flour in biscuit formula by different plant meals at 5, 10, 15, 20, 25 and 30 per cent levels or shortening by flaxseed oil at 25, 50, 75 and 100 per cent levels. Data of sensory evaluation revealed that biscuit samples with 10 per cent defatted mustard meal (DMM), 15 per cent mustard and flaxseed meals (MM and FM), 30 per cent barley meal (BM) and 100 per cent flaxseed oil (FO) were significantly acceptable as control. Biscuits made with 10 per cent DMM and 15 per cent MM contained 1.37 and 1.25 times more protein than the control. Biscuits supplemented with 30 per cent BM and 15 per cent FM contained 2.84 and 3.31 times more of total dietary fibers, respectively than the control.  $\beta$ -glucan content of BM-biscuits was 1.82 per cent. Flaxseed oil-biscuits were particularly rich in alpha linolenic acid (42.76%) and it contained a less amount of linoleic acid (13.52 %). The biological evaluation of hypercholesterolemic rats fed on diets supplemented with different functional prebiotic biscuits for 8 weeks significantly reduced serum total cholesterol, triglycerides, low density lipoproteins, very low density lipoproteins and ratios of total cholesterol/high density lipoproteins cholesterol, low density lipoproteins/high density lipoproteins cholesterol, atherogenic index and increased high density lipoproteins. Histopathological examination revealed that feeding of diets containing flaxseed oil, flaxseed and barley meals to the hypercholesterolemic rats lowered the degree of lesions of heart and liver tissues. Thus, it could be concluded that flaxseed oil, flaxseed meal or barley meal based bakery products could be developed as a useful therapy for hyperlipidemia in developing countries like Egypt.

Formulation of nutri bar for lactating women was attempted by Jan *et al.* (2012). Traditional ingredients, such as fenugreek, dry ginger, gum acacia,

were incorporated into Nutri bar to increase milk production of mothers along with some other ingredients like almonds, cashews, coconut, honey, makhana as nutrition supplement. Semolina (92.5g) when fortified with makhana (7.5g), coconut (6g), cashew (5g), almonds (5g), fenugreek (0.1g), ginger (0.1g), gum acacia (5g) and honey (42g) attained a good consistency, nutritional value and better organoleptic properties. Proximate composition of nutri bar samples resulted in gradual increase in protein, ash, carbohydrate and dietary fiber content, while fat content was decreased as compared to control. Microbiological studies during 30 days of storage under ambient temperature conditions were carried out. At the last day of storage salmonella and yeast/mold count was  $1.00 \times 10^{-1}$ ,  $<1.00 \times 10^{-1}$  respectively, which was within safe level.

Functional biscuits from soy flour and rice bran were developed by Mishra and Chandra (2012). The research intended to explore the possibility of fortifying the soy flour and rice bran to formulate the functional biscuit with the ability to improve the quality of food products due to various functional properties. Supplementation of wheat flour with soya and rice bran was tried at 10, 15, 20 and 25 per cent level each respectively. Prepared biscuit was subjected to physical, sensory and nutritional analysis to evaluate the suitability of biscuit for consumption. The width of biscuit decreased from 44 to 36.2 with increase in the level of substitution of composite flour of rice bran and soya. Similar trend was observed with spread ratio. However, biscuit thickness increased from 9.2 to 10.6 with increasing level of substitution. Nine-Point Hedonic Scale was used for sensory evaluation of prepared biscuit. From overall acceptability rating, 15 per cent soy flour +15 per cent rice bran incorporated biscuit obtained the highest rating compared to other treatments. There were no significant difference between the control treatment and best rated supplemented biscuit (70:15:15) in general preference of sensory rating. Nutritional evaluation of best rated supplemented biscuit indicated that protein content was 15.7 per cent, fat was 19.5 per cent, fiber was 2.2 per cent, moisture 3.6 was per cent. Thus, it can be concluded that supplementation of

soy flour and rice bran at 15 per cent level each, would improve the nutritional quality without adversely affecting the sensory parameters

In an experiment Ananthan *et al.*, (2012) developed cereal bar using oat, flax seed and wheat as major ingredients and their shelf life was assessed in polypropylene (75 $\mu$ ), paper (42  $\mu$ ) aluminum foil (20 $\mu$ ) polyethylene (37.5 $\mu$ ), metallized polyester (12 $\mu$ ) and low density (150 $\mu$ ) (with and without vacuum) films and stored under ambient temperature conditions of 37°C for 12 months. It was found that bar remained acceptable during entire storage period irrespective of package material at ambient temperature. At the end of the storage month, overall acceptability of cereal bar stored at ambient temperature and packed in metalized polyester with vacuum scored highest (7.30) followed by metallized polyester without vacuum (7.17), polyethylene (7.13) and polypropylene (6.48). At 37 °C, the bar packed in polypropylene film remained acceptable up to 6 months only, while rest of the bar packed in polyethylene, metallized polyester with vacuum and metallized polyester without vacuum remained stable and acceptable during the total storage period of 12 months.

Annahas *et al.*, (2013) incorporated omega-3 in an extruded snack with golden flaxseed. Snacks were formulated with incorporation of golden flaxseed with and without seasoning. Results showed that there were six different fatty acids found in the snacks such as 16:0, 18:0, 18:1n-9, 18:1n-7, 18:2n-6 (LA) and 18:3n-3. The majority fatty acid was 18:2n-6 (LA) due to the predominance of corn in the product formulation. The incorporation of 18:3n-3 was observed, and this fatty acid was not affected by the extrusion temperature during the processing or the storage time. The results of sensory evaluation indicated that the product developed with addition of golden flaxseed had mild acceptance among the panelists.

Mridula *et al.*, in 2013 developed omega-3 rich energy bar with flaxseed. Energy bar samples were prepared with different levels of flaxseed (0–20%) in addition to cereals and pulses with varying levels of sweeteners (45, 50, and 55%). Sensory characteristics of energy bar samples were evaluated for different sensory attributes by a group of nine panelists. Sensory

attributes like appearance and colour, texture, odour, flavour and taste and overall acceptability for the samples were assessed using nine point hedonic scale. Results expressed that the mean sensory score for overall acceptability of samples with 10 per cent flaxseed and 55 per cent sweeteners and 15 per cent flaxseed and 45 per cent sweeteners were compare but the omega-3 and other nutrients in the later sample was higher than the former sample. Further the data revealed that different levels of flaxseed and sweeteners significantly affected the hue and chroma values of the energy bar. L values decreased significantly with increasing levels of flaxseed but different levels of sweeteners did not bring about significant difference while reverse trend was observed for values, because of the sample darkening due to addition of brown coloured flaxseed. Hue and chroma varied significantly with the levels of flaxseed and sweeteners due to variation in a and b values. The level of flaxseed in energy bar did not affect the hardness but it was decreased with increasing level of sweeteners except in control sample. Cohesiveness, springiness, chewiness and gumminess were affected by the levels of flaxseed and sweeteners in energy bars. Cohesiveness reduced with increasing levels of sweeteners at the same level of flaxseed. Similar trend was observed for the chewiness except for the control sample. The total calories obtained from the energy bar showed significant increase with the increasing levels of flaxseed, the maximum (397.95 Kcal) being for bars with 20 per cent flaxseed and 45 per cent sweeteners. This energy bar sample also showed the maximum protein (12.41%), crude fat (11.86%), ash (1.65%), iron (3.77 mg/100 g), crude fiber (2.18%) and omega-3 as alpha-linolenic acid (22.50%, fatty acid basis) content. Energy bar samples with 15 per cent flaxseed and 45 per cent sweeteners which were found good in omega-3 fatty acid were taken for a storage period of 90 days in both room temperature and refrigerator condition. Total bacterial count and yeast and mould count (log cfu/g) increased from 3.4 to 4.6 and 3.45 to 3.62, respectively during 90 days storage but were within the acceptable limits of total bacterial count 4.7 log cfu/g. Hence, it can be said that 15 per cent flaxseed and 45 per cent sweeteners along with other ingredients may be

considered for production of an acceptable quality omega-3 fatty acid rich energy bar at commercial scale, which also stored well at refrigerated condition.

Claudia *et al.*, (2014) prepared cereal bar using pulp and kernel of bocaiuva along with oat flakes and oat bran. Two formulations of cereal bar were prepared with pulp dehydrated by osmo convection and kernel of bocaiuva. Sensory evaluation on 9 point hedonic scale was carried out to see acceptability. Results indicated that all formulations had average score of above 6, considered acceptable for consumption. The cereal bar of the formulation B with syrup from osmotic dehydration presented higher acceptability for all attributes, the most preferred by evaluators. This was due to the enhanced flavor of bocaiuva pulp in this formulation, which was observed by several evaluators in the evaluation form. Consumers have the taste as the major reason for purchasing cereal bars. The sensory attributes of aroma, fruit flavor and appearance were also mentioned as important factors to influence the purchase intent of consumers. The evaluators gave best color for formulation B, which agrees with the instrumental analysis. The same way, with respect to texture, panelists preferred formulation B and analysis with a texturometer the sample was softer. The intake frequency reported by 60 per cent evaluators indicated the consumption of cereal bars three times a week. The purchase intent of the bocaiuva cereal bar was 65 per cent for 'probably would buy', pointing out the marketing potential of bars with native fruit.

Sharma *et al.*, (2014) reviewed on 'cereal bars-a healthful choice'. It was stated that, the consumption of fast-foods and snacks has increased in recent years; the desire for healthy and functional foods is also increasing at the same rate. In this sense the development of cereal bar formulation presents itself as an emerging force for this niche market. Epidemiological studies have repeatedly found that whole-grain cereal foods reduce the risk of non communicable diseases. The consumption of cereal bars increased 11 per cent globally leading to an increase in the variety of cereal bars, label and different ingredients in order to attract consumers. Busy life styles and the increasing

demand from consumers for meals and snacks that are quick sources of good nutrition have prompted the food industry to develop foods like nutrition bars that combine convenience and nutrition. Since the consumption of cereals has expanded from the breakfast table to any time of the day, these products have become an excellent vehicle for the inclusion of functional ingredients in the consumer's diet.

Byrappa *et al.*, (2015) formulated three cereal bars viz. low sugar, low fat, dry fruit/nut using sugar substitutes, cereals and nuts. Freshly prepared as well as 90 days stored cereal bars were evaluated for sensory quality. On storage, the cereal bars showed decreased intensity of brown colour and surface stickiness. Hardness of all the three products increased slightly on storage and influenced the overall acceptability scores and hence the shelf life. Chewiness of the cereal bars also decreased on 90 days storage than that obtained for freshly prepared cereal bars. Low sugar bar having Sugar + Maltitol syrup scored the highest among the stored products indicating that it was better than low sugar bar having Sorbitol + Nutriose syrup as it maintained the chewiness and crispness on storage. Cereal bar prepared with sugar showed crystallization and was less chewy. Low sugar with Sorbitol + Nutriose syrup cereal bar was harder and less chewy thus scored the least (4.0) for overall quality.

Rawat and Darappa (2015) investigated the effect of substitution of brown flour with fiber rich ingredient mixture (banana flour, psyllium husk, partially defatted coconut flour and oats) and protein rich ingredient mixture (chickpea flour, sesame, soya protein isolate and whey protein concentrate) at the levels of 25, 50 and 75 per cent on the nutritional quality characteristics of baked energy bars. Nutritional evaluation of most acceptable bars (50 per cent fiber and protein rich ingredient) on the basis of sensory evaluation was done. Data indicated that 50 per cent fiber and protein rich ingredient mixture bar showed increased contents of moisture, fat, total, soluble and insoluble fiber whereas, ash, carbohydrate and energy was lower than control baked energy bar. It was found that the fiber content increased by about 9 times whereas the protein content increased by about 2 times with the use of 50 per cent fiber rich

ingredient mixture and protein rich ingredient mixture in bar respectively. Invitro protein digestibility of control energy bar, fiber and protein rich ingredient mixture bar was 80.24, 79 and 90.5 per cent respectively. The lower protein and digestible values of bars were due to the presence of fiber rich ingredients in fiber rich ingredient bar.

Cereal bar using Acerola Seed Flours (ASF) and Acerola Bagasse Flours (ABF) in different combinations was prepared. CB 1: control - with the addition of 25 per cent brown oats, CB 2: with the addition of 12.5 per cent ASF and 12.5 per cent ABF, CB 3: with the addition of 6.25 per cent ASF and 18.75 per cent ABF, CB 4: with the addition of 12.5 per cent ASF and 12.5 per cent brown oats and CB 5: with the addition of 12.5 per cent ABF and 12.5 per cent brown oats. These bars were sensorial evaluated and CB 1, CB 4 and CB 5 received the highest scores. Evaluation of colour for cereal bars (1, 4 and 5) indicated that  $L^*$  values were between 49.00 and 56.49. Thus, the  $L^*$  values found in the cereal bar (1, 4 and 5) were basically intermediate. Cereal bar 4 and 5 showed a lower lightness, when compared to cereal bar-1 (control). The colour  $a^*$ , which ranges from green to red, indicates the existence of red pigments in positive values. Cereal bar - 4 and cereal bar -5 showed a tendency to the green color, means they had values that indicated small amounts of red pigments. The color  $b^*$  refers to the changes from blue to yellow. In the analyzed cereal bars,  $b^*$  values for cereal bar 4 and 5 was 21.61 and 21.35 respectively. Thus, a darkening occurred (reduced values of the parameters  $L^*$  and  $b^*$ ) in cereal bar 4 and 5, due to the addition of ASF and ABF in the formulation. All bars contained water activity ( $A_w$ ) below 0.6, indicating food safety. For any kind of bacteria, the minimum  $A_w$  value required for growth is 0.75, while osmophilic yeast (which are resistant to mediums with high sugar concentrations), and xerophilic fungi (which survive in mediums with little water) are capable of developing into water activities ranging from 0.61 to 0.65, respectively, using sugars and glucose as substrates (Tamara *et al.*, 2015).

The reviewed literature on the development of functional products such as bread, raisin snack, chapatti, biscuits, energy bar, cereal bar, extruded snack

etc. were developed successfully by incorporating the functional ingredients viz. flaxseed; defatted oilseeds; rice and wheat bran; barley; flaxseed oil; oat; moringa leaves; gum acasia; fenugreek seeds etc. The incorporation of such functional ingredients in various products did not influence the organoleptic parameters adversely. The sensory scores of most of the developed products were with control. Therefore products were very well accepted by the panellist. Some of the functional ingredients such as flax and ginger proved to be promising options to increase the appealing flavours of the developed products. Incorporation of ingredients helped to elevate the nutritional profile of the developed functional foods in terms of protein, iron, calcium, omega 3 fatty acid and both soluble and insoluble fiber as per the functional ingredient used. Such positive change in the structured products over the control would be beneficial in terms of functionality for their use in prevention and treatment of non communicable diseases.

### **2.3 Non Communicable Diseases: Diabetes & Hyperlipidemia**

Non communicable diseases (NCDs) also known as chronic diseases tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors. The main types of NCDs are cardiovascular diseases like heart attacks and stroke, cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes.

These diseases kill 40 million people each year which may count to 70 per cent of all deaths worldwide. These diseases mostly affect the population of low and middle income countries. They affect the people of all age groups. They are responsible for majority of premature deaths globally. Unplanned urbanization, busy lifestyle, unhealthy diet and lack of physical activity are some of the reasons of increasing the risk of dying from NCDs (WHO, 2016).

In the present study two non communicable diseases diabetes and hyperlipidemia were selected to evaluate the impact of functional snack formulated by utilizing various functional ingredients. Hence, the documented

research related to diabetes mellitus and hyperlipidemia is reviewed as presented below.

### **2.3.1 Prevalence and Epidemiological Factors of Diabetes Mellitus**

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. The global prevalence of diabetes among adults over 18 years of age has risen from 4.7 per cent in 1980 to 8.5 per cent in 2014. The number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014 worldwide. In 2014, 8.5 per cent of adults aged 18 years and older had diabetes. In 2012 diabetes was the direct cause of 1.5 million deaths and high blood glucose was the cause of another 2.2 million deaths (WHO, 2016).

Mohan *et al.* (2007) studied the epidemiology of Type II diabetes. India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the “diabetes capital of the world”. According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India is currently around 40.9 million which is expected to rise to 69.9 million by 2025. The National Urban Diabetes Survey conducted a population based study was in six metropolitan cities across India. The results reported that the age standardized prevalence of Type II diabetes was 12.1 per cent. This study also revealed that the prevalence in the southern part of India to be higher i.e. 13.5 per cent in Chennai, 12.4 per cent in Bangalore, 16.6 per cent in Hyderabad, compared to Eastern India (Kolkatta), 11.7 per cent, northern India (New Delhi), 11.6 per cent and western India (Mumbai), 9.3 per cent. This study also suggested that there was large pool of subject with impaired glucose tolerance, 14 per cent with a high risk of conversion to diabetes.

The glycemic status, obesity and waist circumference in Punjabi male Type 2 Diabetics was studied by Ashok Kumar (2011). Two hundred and forty type 2 diabetic Punjabi males with age ranging from 30 to 70 years volunteered to participate in this study as subjects. The glycemic status (fasting blood sugar & glycated haemoglobin), obesity (BMI) & waist circumference (WC) were

recorded with standard procedures. Results revealed that the mean age, height, weight, Fasting Blood Sugar (FBS), glycated haemoglobin (HbA1c), Body Mass Index (BMI) and Waist Circumference (WC) of studied type 2 diabetics were  $50.75 \pm 11.4$  years,  $166.69 \pm 7.6$ cm,  $75.88 \pm 11.8$ Kg,  $146.37 \pm 28.6$  (mg/dl),  $7.34 \pm 1.2$  (%),  $27.29 \pm 3.6$  and  $102.82 \pm 8.0$  (cm) respectively. Based on fasting blood sugar, 10.4 per cent studied type 2 diabetics had normoglycemia ( $\text{FBS} \leq 120\text{mg/dl}$ ), 89.6 per cent were hyperglycemia ( $\text{FBS} \geq 120\text{mg/dl}$ ). Based on glycoslated haemoglobin (HbA1c), 25.4 per cent studied type 2 diabetics had good control of blood sugar ( $\text{HbA1c} \leq 6.5$ ), 30.4 per cent were average control ( $\text{HbA1c} 6.5\text{-}7.5$ ), 26.7 per cent were poor control ( $\text{HbA1c} 7.5\text{-}8.5$ ) and 17.5 per cent were morbid control. Based on BMI, 26.7 per cent, study type 2 diabetics were normal, 55% were overweight, 14.5 per cent were obese Class I, 3 per cent were Obese Class II and 1.8 per cent were Obese Class III. Based on waist circumference of the sample population of type 2 diabetics 10.9 per cent were obese, 24.1 per cent had increased risk for metabolic syndrome [action level I ( $\text{WC} \geq 94\text{cm}$ )] and 61.7 per cent had substantially increased risk [action level II ( $\text{WC} \geq 102\text{cm}$ )].

Prevalence and risk factors of diabetes in North India were investigated by Ravikumar *et al.* (2011). A cross sectional survey of 2227 subjects, aged  $\geq 20$  years and representative of the urban Chandigarh population. Fasting Plasma Glucose (FPG) and 2-h Plasma Glucose (2hPG) following ingestion of 75 g of an anhydrous glucose equivalent were estimated by glucometer in all subjects except those with known diabetes, in whom only FPG was measured. Results evidenced that a total of 349 (15.7 %) subjects had diabetes, comprising 210 (9.4 %) with known diabetes, 139 (6.2 %) with newly diagnosed diabetes and 344 (15.4 %) subjects were prediabetic. The age standardized prevalence of diabetes and prediabetes were 11.1 per cent (95 % CI: 9.7-12.4) and 13.2 per cent (95 % CI: 11.8-14.6), respectively. Age  $\geq 50$  years, a family history of diabetes,  $\text{BMI} \geq 23\text{kg/m}^2$ , abdominal obesity and hypertension were significantly and positively associated with the presence of

diabetes whereas, educational status was negatively associated with diabetes ( $P < 0.001$  for all).

Kamath *et al.* (2011) conducted a study on body mass index and waist circumference in Type 2 Diabetes mellitus patients attending a diabetes clinic. The demographic and clinical data of 446 type 2 DM patients attending a diabetes clinic of a university teaching hospital in Southern India was recorded. BMI  $\geq 25$  and waist circumference  $\geq 90$  cm in males and  $\geq 80$  cm in females was taken as an indicator of obesity. Results expressed that the percentage of diabetics with general obesity was 48.9 per cent while 68.1 per cent had central obesity. Around 44.4 per cent patients had raised BMI and waist circumference, 26.7 per cent had normal BMI and waist circumference, 24.7 per cent had increased waist circumference only and 4.3 per cent had increased BMI alone. It was observed that 86 per cent of females had a waist circumference above the cut off value as compared to 54.7 per cent males ( $p < 0.001$ ). Similarly, 59.9 per cent females had raised BMI compared to 40.9 per cent in males ( $p < 0.001$ ).

Abdominal Circumference as a Screening Measure for Type 2 Diabetes was studied. Fasting and two hours postload glucose levels were assessed on 187 adult males aged 25-67 years. Height, weight, hip circumference, and waist circumference at two anatomical sites, one at the level of the greatest anterior extension of the abdomen i.e. abdominal circumference and the other one at the narrowest part of the torso i.e. minimum waist circumference were measured. Waist hip ratio, body mass index, waist height ratio and conicity index were calculated subsequently. The findings indicated that prevalence of Type 2 Diabetes was 12.3 per cent abdominal circumference revealed the highest odds ratio (OR 2.75; 95% CI 1.45 - 5.23) for Type 2 Diabetes, followed by waist height ratio (OR 1.86; 95% CI 1.05 - 3.32) and minimum waist circumference (OR 1.83; 95%CI 1.03 - 3.26). The area under the receiver operating characteristic curve of abdominal circumference was also larger (68%; 95% CI: 0.57 - 0.79) compared to other adiposity measures in assessing Type 2 Diabetes (Ghosh and Bandyopadhyay, 2012).

A study on socio-economic status and hemoglobin concentration of Type II diabetes mellitus patients attending diabetic clinic in Beni city, Nigeria was carried out by Ehiaghe *et al.*, (2013). The sample population consisted of 142 subjects, 71 patients were known to have Type II diabetes mellitus already on drugs and were confirmed to be diabetic using glucose oxidase method while the other 71 subjects were age matched apparently healthy control subjects on routine check up, they were confirmed to be non diabetic using the glucose oxidase method. Results of study revealed that those under the low income socio-economic status had the highest incidence of Type II diabetes mellitus (49%), closely followed by the middle income socio-economic status (35%) of the diabetic populations. It was also mentioned that irrespective of socio-economic status, type 2 diabetes mellitus was associated with a low haemoglobin concentration.

Frank *et al.*, (2013) conducted a study on measures of general and central obesity and risk of type 2 diabetes in a Ghanaian population. Study consisted of 1221 adults (542 cases and 679 controls). Results expressed the strongest association between diabetes and waist-to-hip ratio: age-adjusted odds ratios per 1 standard deviation difference were 1.95 (95% confidence interval [CI]: 1.64–2.31) in women and 1.40 [CI 1.01–1.94] in men. Also, among women, the odds of diabetes increased with higher waist circumference (1.35 [1.17–1.57]) and waist-to-height ratio (1.29 [1.12–1.50]). Among men, this was not discernible. Rather, hip circumference was inversely related (0.69 [0.50–0.95]). Body mass index was neither associated with diabetes in women (1.01 [0.88–1.15]) nor in men (0.74 [0.52–1.04]). Among both genders, waist-to-hip ratio showed the best discriminative ability for diabetes in this population and the optimal cut-off points were  $\leq 0.88$  in women and  $\leq 0.90$  in men.

Investigation about diabetes complications and associated factors in Type II diabetic patients in Cotonou was carried out by Djrolo *et al.*, (2014). Successive Type II Diabetic patients attending the diabetic center were submitted to a questionnaire and to clinical examination. Data were completed

by consulting their medical reports. A total 150 diabetic patients were included in the study. It was noticed that the global rate of complications was 78.0 per cent. Specific rate for each complication investigated was 57.7 per cent for peripheral neuropathy, 75.0 per cent for erectile dysfunction, 20.0 per cent for nephropathy, 36.6 per cent for retinopathy, 40 per cent for macroangiopathy and 8.0 per cent for foot ulcer. Factors significantly associated with high rate of complications were age above or equal to 50 years ( $p=0.001$ ), the male gender ( $p=0.001$ ), high blood pressure ( $p=0.001$ ), the absence of familial history of diabetes ( $p=0.02$ ), the duration of the disease above 5 years ( $p=0.001$ ) and high HbA1c level ( $p=0.001$ ). Data revealed that Type II Diabetic patients followed up in the Diabetic center in Cotonou showed a high rate of chronic complications which often occurred in a younger age than in developed countries. Numerous socio-demographic and biological factors were significantly associated with the high rate of complications.

In a report on Current state of diabetes mellitus in India it is mentioned that diabetes is fast gaining the status of potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with disease. In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) and United States (17.7 million). It was predicted that by 2030, diabetes mellitus may afflict up to 79.4 million individuals in India, while China (42.3 million) and the United States (30.3 million) will also see significant increase in those affected by the disease. It is also stated that obesity is one of the major risk factors for diabetes. Despite having lower overweight and obesity, India has a higher prevalence of diabetes that may occur at a much lower body mass index (BMI). Relatively lean Indian adults with a lower BMI are at equal risk as those who are obese. Indians are genetically predisposed to the development of coronary artery disease due to dyslipidaemia and low levels of high density lipoproteins; these determinants make Indians more prone to development of the complications of diabetes at an early age (20-40 years) compared with Caucasians (>50 years). Steady migration of people from rural to urban areas, the economic boom, and

corresponding change in life style are also affecting the level of diabetes (Kaveeshwar and Cornwall, 2014).

An experiment on anthropometric and metabolic characteristics of patients with type 2 diabetes mellitus (T2DM) and hypochromia was conducted by Neamtu *et al.* (2014). Thirty patients with T2DM were recruited for this study. Patients diagnosed with diabetes and hypochromia constituted the study group and patients with type T2DM but without hypochromia constituted the control group. The patients in study group were aged between 45 and 72 years and had evolution of diabetes between 4 months and 15 years. Among the patients 7 were from urban and 7 from rural areas. The patients in the control group (16 patients- 8 women and 8 men) were aged between 49 and 77 years, 11 patients of control group were from urban areas and 5 patients from rural areas and had an evolution of diabetes between 6 years and 30 years. Data indicated that the BMI in the study group had an average of  $28.28 \pm 5.70 \text{ kg/m}^2$  compared with controls that had a value of  $31.32 \pm 5.17 \text{ kg/m}^2$ . Five patients (35.71%) of the study group were obese and 5 patients (35.71) were overweight. In the control group the prevalence of obesity was 62.50% (10 patients) while the prevalence of overweight was 25.00% (4 patients). WC of study group ranged between 75 and 116 cm and for control group it was 89-127 cm. Abdominal obesity was present in 10 patients of the study group (71.42%) and 10 patients of the control group (62.50%). In the study group FPG ranged between 113-351 mg/dl, HbA1c between 6.2-12.9 per cent and GFR between 53.01-105.95 ml/min/1.73 m<sup>2</sup>. Only 1 patient of the study group (7.14%) presented chronic kidney disease (CKD). For the control group, FPG ranged between 106-346 mg/dl, HbA1c between 5.1-12.9 per cent and GFR between 49.2-102.9 ml/min/1.73 m<sup>2</sup>. Two patients of the study group (12.50%) had CKD. Study revealed a high prevalence of hypochromia in diabetic patients (46.66%).

Valliyot *et al.* (2014) carried out a study on demographic parameters associated with Type 2 Diabetes Mellitus in North Kerala, India. This cross sectional study was conducted among 1027 patients with Type II diabetes mellitus from 25 to 55 years reported to a rural tertiary care hospital in North

Kerala, India. A pre-tested structured questionnaire used for the study included the socio-economic, demographic and life style characters like age, gender, type of work, religion and duration of onset of diabetes, family history of diabetes. Results revealed that disease was common among males than females. The mean duration of disease had been observed 21.8 months. No significant difference was observed with regard to different religion, 54 per cent patients had a positive family history of diabetes mellitus.

Prevalence and risk of anaemia in Type II diabetic patients was studied. The study group comprised 200 patients (male-100 and female-100) with Type II diabetes. Among selected 200 diabetic patients 143 (71.5%) were poorly controlled diabetics (HbA1C > 7.5%) and 57 (28.5%) were controlled diabetics (HbA1C < 7.5%). Out of 200 patients 126 were suffering with anaemia representing 63 per cent incidence of anaemia. Results confirmed that there was higher incidence and risk of anaemia in females (36 per cent) as compared to males (27 per cent) ( $p < 0.05$ ) and in poorly controlled diabetes (49.5 per cent) compared to those with controlled diabetes (13.5 per cent) ( $p < 0.05$ ). This study indicated that poor glycemic control and gender difference were associated with the incidence of anaemia in Type II diabetes (Sharif *et al.*, 2012).

Diabetes prevalence, awareness & treatment and their correlates in older persons in urban and rural population in the Astana region, Kazakhstan was studied by Supiyev *et al.*, (2016). Participants aged 50-75 years old, residing in Astana city (the capital) and Akmol village were included in cross-sectional study. A total of 953 adults were interviewed and their fasting plasma glucose, blood pressure, height and weight were measured. Data indicated that the overall prevalence of raised fasting plasma glucose was 8.9 per cent, 72 per cent had hypertension and 44 per cent were obese (no individuals were underweight in the study), and 71.9 per cent fulfilled the criterion for central obesity. Fasting plasma glucose, BMI and waist-hip ratio and family history of diabetes were higher in Astana city than in Akmol. It was estimated that the overall prevalence of diabetes was 12.5 per cent and it was almost twice higher

in the urban residents (16.3 %) than in the rural population (8.6 %). Among subjects with diabetes, 72.3 per cent were aware of their condition, 65.6 per cent were on treatment and 27.7 per cent had controlled fasting plasma glucose. Among those aware of the condition, 87.2 per cent were taking medication (only 4 persons aware of diabetes reported to be on diet without medication), among those taking medication, 42.3 per cent had controlled diabetes. Again, there were marked differences between urban and rural areas. The prevalence of awareness and treatment of diabetes were two times higher in urban area. Successful control of diabetes in the rural area was very low (4.9%) compared with the city (39.7%); the difference was less dramatic among those aware of having diabetes (47.7% vs. 15.4%). The odds of diabetes was less than half in rural Akmol compared to urban Astana. The odds of awareness, treatment and control were also substantially lower in the rural vs. urban area. Among the socio-demographic measures, only household items were statistically significantly associated with (increased) diabetes prevalence and control of diabetes. The awareness, treatment and control of diabetes were substantially higher in the urban population and among women.

### **2.3.2 Prevalence & Epidemiological Factors of Hypercholestermia**

According to the Canadian Heart and Stroke Foundation (2005), some of the most significant risk factors of heart attacks are age, sex, family history, tobacco smoking, physical inactivity, alcohol abuse, being overweight, high fat and high calorie diet, hypertension, stress and diabetes. These risk factors fall into the categories of either non modifiable or modifiable risk factors.

WHO (2017) classified the risk factors for CVD into three groups as behavioural risk factors such as tobacco use, physical inactivity unhealthy diet and harmful use of alcohol, metabolic risk factors such as raised blood pressure, raised blood sugar raised blood lipids and raised BMI, other risk factors such as advancing age, stress and ethical factor and excess homocysteine. Long term exposure to behavioural risk factor results in metabolic risk factors. These behavioural and metabolic risk factors often co exists in the same person and act synergistically to increase the individual's

total risk of developing CVD.

Yuan *et al*, 2006 mentioned in a study that hypercholesterolemia affects one in 20 subjects in the general population. It is estimated that there are about 10,000,000 people with Familial Hypercholesterolemia (FH) worldwide. Of these affected subjects, less than 10 per cent are treated with Low Density Lipoprotein (LDL) - lowering drugs. If undiagnosed and untreated, the cumulative risk of Coronary Artery Disease (CAD) by age 60 years is more than 60 per cent among men and 30 per cent among women with heterozygous. This risk ratio could be much higher in Indians due to the early occurrence of CAD.

A study was conducted a study with the distribution of six anthropometric measurements, viz, height, weight, body mass index, waist hip ratio, percent body fat and percent lean body mass and six lipid profiles, viz. serum cholesterol, (Total cholesterol –TC) S. triglycerides, S. HDL-C, S. LDL-C, S.VLDL and TC: HDL-C in 40 randomly selected confirmed cases of diabetes mellitus aged 25-70 years in Amritsar. An adequate number of controls were also taken for comparisons. The results indicated that percent body fat was positively related to VLDL and TC: HDL-C and percent lean body mass vice versa Arora *et al*. (2007).

Cardiovascular diseases are the most prevalent cause of death and disability in both developed as well as developing countries. South Asians around the globe have the highest rates of coronary artery disease (CAD). According to National Commission on Macroeconomics and Health (NCMH), a government of India undertaking, there would be around 62 million patients with CAD by 2015 in India and of these, 23 million would be patients younger than 40 years of age (Enas *et al*, 2007).

Prevalence of hyperlipidemia and associated risk factors among 127 randomly recruited healthy young Saudi females was studied by Hanan *et al*. (2011). Anthropometric and biochemical parameters were measured. Results showed that one third of the study subjects were overweight (28%) and 20 per cent were obese. Hyperlipidemia was highly prevalent in the whole population.

This had persisted in subjects with BMI  $\geq 25$  kg/m<sup>2</sup> and Waist Circumference  $\geq 80$  cm. Prevalence of hyperlipidemia was high in subjects with WC  $\geq 71$  cm. Regression analysis showed that WC was a negative predictor of adiponectin and a positive one of insulin, while BMI was a positive predictor of fasting glucose and lipid profile. Neither WC nor BMI were predictors of HDL-C.

Shankarappa *et al.*, (2013) conducted a study on anthropometric variables predicting risk of Coronary Artery Disease (CAD) in type 2 diabetics. The subjects who were type 2 diabetic males on treatment since last 10 years and more than 50 years of age were included in the study. Subjects with history of hypertension and smoking were also included. The total sample size was 150 individuals with 94 diabetics with CAD as cases and 56 diabetics without CAD as controls. Among anthropometric indices waist height ratio and waist circumference had the greatest predictive value for CAD in diabetics. The odds ratio for BMI was also slightly significant. Waist hip ratio and Conicity Index were not significant. Among non anthropometric risk factors duration of diabetes, smoking, hypertension and triglycerides showed significant impact on the outcome of CAD.

Prevalence of dyslipidemia in urban and rural India [ICMR-INDIAB study] was assessed by Joshi *et al* in 2014. It was conducted in a representative population of three states of India (Tamil Nadu, Maharashtra and Jharkhand) and one Union Territory (Chandigarh), and covered a population of 213 million people using stratified multistage sampling design to recruit individuals  $\geq 20$  years of age. All the subjects (n= 16,607) underwent anthropometric measurements and oral glucose tolerance tests. In every 5<sup>th</sup> subject (n=2,042), a fasting venous sample was collected and assayed for lipids. Data revealed that of the subjects studied, 13.9 per cent had hypercholesterolemia, 29.5 per cent had hypertriglyceridemia, 72.3 per cent had low HDL-C, 11.8 per cent had high LDL-C and 79 per cent had abnormalities in one of the lipid parameters. Regional disparity existed with the highest rates of hypercholesterolemia observed in Tamil Nadu (18.3%), highest rates of hypertriglyceridemia in Chandigarh (38.6%), highest rates of low

HDL-C in Jharkhand (76.8%) and highest rates of high LDL-C in Tamil Nadu (15.8%). Except for low HDL-C in the state of Maharashtra, in all other states, urban residents had the highest prevalence of lipid abnormalities compared to rural residents. Low HDL-C was the most common lipid abnormality (72.3%) in all the four regions studied; in 44.9 per cent of subjects, it was present as an isolated abnormality. Common significant risk factors for dyslipidemia included obesity, diabetes and dysglycemia.

The prevalence of diabetes and hyperlipidemia seems to be increasing worldwide by year and year and had become one of the major causes of death. The documented literature indicates that the prevalence of these two NCDs in India had still steep elevation as compared to rest of the world and it has become the capital of these chronic diseases. The observed risk factors for development of diabetes and dyslipidemia were age more than 50 years, family history, obesity particularly abdominal obesity, waist circumference > 80 cm in women and 90 cm in men, BMI >23 kg/m<sup>2</sup>, sedentary lifestyle and improper dietary choice. Functional food developed in view of prevention and treatment of two non communicable diseases can be a palliative of these two non communicable diseases.

#### **2.4 Effect of Supplementation of Functional Ingredients/ Foods on Blood Glucose & Lipid Profile**

Functional foods such as flaxseed, oats, wheat bran, soyabean, gum acasia etc. play a major role in the prevention and treatments of chronic diseases. Hence, the products prepared by using such ingredients would also be beneficial for prevention and treatment of NCDs. This can be judged clinically by analyzing various blood parameters such as blood glucose, serum cholesterol, haemoglobin etc. and also by anthropometry. Such clinical studies conducted to evaluate the effect of supplementation of functional ingredients or the products developed by utilizing functional ingredients on diabetes and hyperlipidemia are documented below.

Effect of wheat bran on glycemic control and risk factors of cardiovascular disease in type 2 diabetes was assessed by Jenkins *et al.*, (2002).

A total of 23 subjects with type 2 diabetes (16 men and 7 postmenopausal women) were selected. Experiment was conducted in two phases. Each of 3-months duration. In the test phase, bread and breakfast cereals were provided as products high in cereal fiber (19 g/day additional cereal fiber). In the control phase, supplements were low in fiber (4 g/day additional cereal fiber). Results indicated that between the test and control treatments, no differences were seen in body weight, fasting blood glucose, HbA1c, serum lipids, apolipoproteins, blood pressure, serum uric acid, clotting factors, homocysteine, C-reactive protein, magnesium, calcium, iron, or ferritin. LDL oxidation in the test phase was higher than that seen in the control phase ( $12.1 \pm 5.4\%$ ,  $P < 0.034$ ).

Effect of a flaxseed-derived lignin supplement in type 2 diabetic patients was investigated. This was a randomized, double-blind, placebo-controlled, cross-over trial and it was conducted between April and December 2006 in Shanghai, China. Seventy three type 2 diabetic patients with mild hypercholesterolemia were enrolled into the study. Patients were randomized to supplementation with flaxseed-derived lignan capsules (360 mg lignan per day) or placebo for 12 weeks, separated by an 8-week wash-out period. HbA1c, lipid profile, insulin resistance index and inflammatory factors were measured. Sixty-eight patients completed the study and were included in the analyses. Data showed that the lignin supplement significantly improved glycemic control as measured by HbA1c ( $-0.10 \pm 60.65\%$  vs.  $0.09 \pm 0.52\%$ ,  $P = 0.001$ ) compared to placebo; however, no significant changes were observed in fasting glucose and insulin concentrations, insulin resistance and blood lipid profiles. Urinary excretion of lignan metabolites (enterodiol and enterolactone) was significantly higher after the lignan supplement intervention compared to baseline ( $14.2 \pm 18.1$  vs.  $1.2 \pm 2.4$  mg/mL,  $P < 0.001$ ). Data also suggested minimal competition between lignan and isoflavones for bioavailability when measured by the excretion concentrations. Daily lignan supplementation resulted in statistically significant improvements on glycemic control in type 2 diabetic patients without apparently affecting fasting glucose, lipid profiles and insulin sensitivity (Pan *et al.*, 2009).

A study on flaxseed to reduce total and LDL cholesterol concentration in Native American postmenopausal women was conducted by Patade *et al.* (2008). Fifty-five mild to moderately hypercholesterolemic (5.1-9.8 mmol/L) Native American postmenopausal women were randomly assigned to control (A), flaxseed (B) or flaxseed additional oat bran fiber (C) groups. Overnight fasting venous blood was collected at baseline and at the end of the treatment period to analyse lipid parameters. Dietary flaxseed supplementation lowered total cholesterol and low-density lipoprotein cholesterol (LDL-C) by approximately 7 and 10 per cent, respectively. HDL-C significantly decreased by 17 per cent in the control group, whereas there were no changes in either the flaxseed or the flaxseed + fiber groups. The triglyceride levels increased by approximately 18 per cent in the control group and by 3 per cent in the flaxseed group, but decreased by 8.5 per cent in the flaxseed + fiber group, although these changes were not significant when compared with their corresponding baseline values. The lipoprotein (a) levels tended to be lower in the flaxseed group but not in the control or flaxseed + fiber group.

Ruchi *et al.* (2008) studied that hypolipemic effect of flax seed supplementation on at risk coronary heart disease male patients. A sample of 60 male subjects free from serious complications at aged 40- 60 yrs at risk of CHD. The mean age of onset was  $51 \pm 1.53$ ,  $52.3 \pm 1.10$  and  $52.2 \pm 1.73$  yrs in E1, E2 and C groups respectively. The flaxseed powder was provided in zip lock bags to the subjects of experimental groups for 60 days on weekly basis. The subjects of group E1 and E2 were supplemented with 5g and 10 g flaxseeds powder where as C was the control group. The perusal of data clearly indicated that 10 g flaxseed powder was more effective to bring about favourable and significant changes in blood pressure and lipid profile as compared to 5 g flaxseed powder supplementation. So, use of flaxseed as food supplement should be encouraged to improve blood lipid profile which further reduces the incidence of CHD.

Vani *et al.* (2011) studied that effect of oat flour supplementation on dietary intake, anthropometric profile and lipid profile of at risk of coronary

heart disease patient. A total of 60 male objects free from serious complication aged 40-50 yrs. of risk of CHD i.e total cholesterol levels  $\leq 200$  mg/ dl and triglycerides levels  $\leq 160$  mg / dl were selected from the OPD of Punjab agricultural university hospital oat flour supplementation had a significant effect in the improvement of lipid profile of the subject which was mainly due to the presence of soluble fiber B glucan antioxidants and gamma linolenic acid (GLA) which dissolves fat deposits, thus preventing heart problems. Maximum improvements were observed in the values of subjects of E2 group followed by E1 group. From the results, it can be inferred that oat flour supplementation in the ratio of 1:3 for two months is an effective measure to bring favourable and significant improvements in anthropometric profile due to its higher satiety value which thus helps in managing body weight and reducing the factor of CHD patients, oat flour is surely a panacea for patients who are at risk of CHD. Consumption of oat extracts containing soluble glucans causes decline in glucose, insulin and glucagon responses to carbohydrates loads. Incorporation of very modest amounts of the soluble oat extract (50–75 g/day) into foods affects risk factors for disease without altering the acceptability or palatability of diets.

Effect of wheat bran on diabetic subjects was investigated. Thirty diabetic subjects were selected and divided into two groups of 15 each. Group A formed the experimental group to which 60 g of wheat germ was supplemented daily for a period of six months. Group B constituted the remaining 15 diabetic subjects who served as control to whom no supplementation was given. Fasting and post prandial glucose and glycosylated haemoglobin was evaluated initially and after the supplementation period. Data revealed that the mean serum fasting glucose levels ranged from 123.20 to 124.80 mg/dl in the experimental and control groups. Group A supplemented with wheat bran had a reduction of serum fasting glucose of 22.80 mg/dl. The mean serum postprandial glucose levels of the experimental and control groups ranged from 184.40 to 188.53 mg/dl. The final mean serum postprandial glucose levels in the experimental groups after the supplementation ranged

from 113.07 to 123.93 mg/dl. There was a reduction of 39.80 mg/dl noted in Group A supplemented with wheat bran. The mean initial glycosylated hemoglobin levels of the subjects in both the experimental and the control groups were between 8.39-8.45 per cent (unsatisfactory control). The impact evaluation showed that the HbA1C had lowered by the supplementation of wheat bran over a period of six months (Haripriya and Premakumari, 2010).

Choudhary *et al.* (2011) studied that development and evaluation of flour mixes and their biscuits for suitability in diabetic diet. Wheat flour, soy flour and pearl millet flour were mixed thoroughly and biscuits were prepared by using ISI standard (1980) by using mix 1(WSP), mix 2(SPW) and mix 3(PSW) and mixes were analyzed for nutrient evaluation. Moisture content of three flour mixes ranged from 10.61 to 11.05 per cent. The mix 2 (SWP) showed higher crude fibre (2.41%, crude protein (24.34%), crude fat (9.77%) and energy (376 Kcal/100g) but was low in carbohydrate content (49.91%) as compared to mix 1 and mix 3 flours. The higher values of protein and fat in mix 2 flours were due to higher incorporation of soyabean flour. The total dietary fibre content was also highest in mix 2 SWP flour (5.57 %) among three flours.

Babiker *et al.* (2012) carried out a study on effects of gum Arabic ingestion on body mass index and body fat percentage in healthy adult females. A total of 120 healthy females completed the study. They were divided in to two groups: A test group of 60 volunteers receiving GA (30 gm /day) for 6 weeks and a placebo group of 60 volunteers receiving pectin (1 gm/day) for the same period of time. Weight and height were measured before and after intervention using standardized height and weight scales. Skin fold thickness was measured using Harpenden Skin fold caliper. Fat percentage was calculated using Jackson and Pollock 7 caliper method and Siri equation. Pre and post analysis among the study group showed significant reduction in BMI by 0.32 (95% CI: 0.17 to 0.47;  $P < 0.0001$ ) and body fat percentage by 2.18 per cent (95% CI: 1.54 to 2.83;  $P < 0.0001$ ) following regular intake of 30 g/day Gum Arabic for six weeks. Side effects caused by GA ingestion were

experienced only in the first week. They included unfavourable viscous sensation in the mouth, early morning nausea, mild diarrhoea and bloating abdomen.

The effect of flaxseed dietary fiber in different food matrices on blood lipids and fecal excretion of fat and energy in a double-blind randomized crossover study was conducted with 17 subjects. Three different 7-d diets were tested: a low-fiber control diet (Control), a diet with flaxseed fiber drink (3/day) (Flax drink), and a diet with flaxseed fiber bread (3/day) (Flax bread). Total fat and energy excretion was measured in feces, blood samples were collected before and after each period, and appetite sensation registered 3 times daily before main meals compared to control. Results expressed that the flax drink lowered fasting total-cholesterol and LDL-cholesterol by 12 and 15 per cent, respectively, ( $p < 0.01$ ), whereas Flax bread only produced a reduction of 7 and 9 per cent, respectively ( $p < 0.05$ ). Fecal fat and energy excretion increased by 50 and 23% with Flax drink consumption compared to control ( $p < 0.05$ ), but only fecal fat excretion was increased with Flax bread compared to control ( $p < 0.05$ ). Both Flax drink and Flax bread resulted in decreased plasma total and LDL-cholesterol and increased fat excretion, but the food matrix and/or processing may be of importance. Viscous flaxseed dietary fiber may be a useful tool for lowering blood cholesterol and potentially play a role in energy balance (Kristensen *et al.*, 2012).

Amelioration of selected cardiac risk factors through supplementation of diet with flaxseed and soya bean was examined by Katare and Saxena (2013). The subjects were divided into three groups: Experimental group I (E I), experimental group II (E II) and a control group (C). Group E I was given 30 g of roasted flaxseed chutney powder and group E II was given 30 g of soya nuts for 12 weeks. Both groups and the control group were prescribed with similar dietary guidelines. Anthropometric parameters, blood pressure and blood lipid profile were estimated before and after completion of the study. Data indicated that the control group exhibited mean drop of 0.55 per cent in body weight. Mean Reduction of 2.89 per cent and 1.75 per cent of body weight was noticed

in group E-I and group E-II respectively. A mean drop of 0.35 per cent was recorded in systolic blood pressure in the control group whereas group E-I and E-II showed a mean fall of 0.88 per cent ( $P < 0.05$ ) and 1.35 per cent ( $P < 0.05$ ) respectively. The diastolic blood pressure of the control group showed a mean decline of 0.88 per cent and the group E-I and group E-II showed mean fall of 1.91 per cent ( $P < 0.05$ ) and 1.54 per cent ( $P < 0.05$ ) in diastolic blood pressure respectively. Control group exhibited mean lowering of 1.81 per cent in total serum cholesterol level followed by 16.19 per cent ( $P < 0.01$ ) and 3.79 per cent ( $P < 0.01$ ) drop in group E-I and E-II. A highly significant reduction ( $P < 0.01$ ) in TG was noted in groups E-I and E-II with a mean lowering of 13.99 per cent and 11.73 per cent respectively where as a decline of 1.84 per cent was seen in the control group. Elevation of 4.94 per cent ( $P < 0.01$ ) and 3.21 per cent ( $P < 0.05$ ) in HDL level was seen in groups E-I and E-II with a considerable change shown by the control group. LDL-C values were also significantly lowered ( $P < 0.01$ ) in group E-I and group E-II with a mean change of 19.9 and 3.92 per cent. Both experimental groups showed a significant lowering ( $P < 0.05$ ) of VLDL-C with a mean change of 17.94 and 10.37 per cent, whereas mean drop of 5.35 per cent was seen in the control group. A remarkable improvement in atherogenicity indices was noticed. Cardiac risk ratio (CRR), atherogenicity coefficient (AC) and atherogenic index of plasma (AIP) were found to be significantly reduced ( $P < 0.01$ ) in group E-I and group E-II. Body mass index, cardiac risk ratio, atherogenic coefficient and atherogenicity index of plasma were also found to improve significantly.

Pareek and Choudhry (2013) assessed the effect of Indian Gum Arabic pods powder on blood glucose and lipid levels of type 2 diabetic subjects. Forty five subjects with type 2 diabetes: age 45-65 years, male or female, not on insulin therapy, not taking medicine for other health conditions and fasting blood glucose levels between 110–300 mg/dl were divided randomly in three groups. Group I, II and III consumed 2, 3 and 4 g of pods powder daily, respectively for four weeks. The adequacy of diet, body measurements, blood glucose, lipid profile and blood pressure were measured before and after

intervention. Nutritional profile of the subjects of the groups was same before and after intervention (P 0.05). The intervention did not make any significant change in the nutritional profile of the subjects. After 28 days the pods powder reduced the fasting blood glucose (10–19%), post prandial (7–35%), triglyceride (6–18%), LDL (7–100%), total cholesterol (5–11%), VLDL (7–15%), HDL cholesterol (5–10%) and blood pressure (8–13%) of the subjects. Changes were significant in the post prandial glucose level, triglyceride and VLDL cholesterol and blood pressure levels of the third group of subjects who were taking 4 g of pods powder daily. The results of this study suggest that the inclusion of pods powder in the diet of people with type 2 diabetes reduced risk factors associated with diabetes and cardiovascular diseases.

Manisha *et al.* (2013) studied on technological interventions in the development of nutrient and nutraceutical rich food product from rice. Rice is also known for rapid digestion and hence its regular intake affects postprandial glucose homeostasis leading to hyperglycemia which could be a reason for dissuading rice consumption not only for diabetics but also by the population at risk. Hence, work was carried out to produce rice with soy digestible carbohydrate which could be useful for control and nutritional management of diabetes and hyperlipidemia. A process was developed to produce rice by physical treatment with increased insoluble amylase content (18.8%) resistant starch (2.6 fold), dietary fibre content 2 (fold) and about 16% lower in vitro carbohydrate digestibility as compared to native rice. Under milled rice is well known for its better nutrition and nutraceutical quantities. But the main bottleneck for commercial adaption of under milled rice is its poor keeping quality. Suitable processing of paddy carried out at in CFTRI laboratory resulted in nutritious rice with increased shelf stability ~ 6 months. To make brown rice/ under milled /rice available in situ, a domestic scale ‘Tiny Rice Mill’ with 15–20 kg/h capacity and 500W power requirement has been developed. Rice germ (2–3% W/W of rice) is good source of nutrient and accounts for 20–25% of commercial rice bran. It is extremely difficult to separate and purify rice germ. Rice germ was purified from commercial rice

bran by a combination of size separation, pneumatic air classification and pykmic separation techniques. The protein, fat and oryzanol content of hydrothermally treated germ was higher by 5.3%, 2.2% and 1% respectively, compared to raw rice germ. The purified rice germ could be suitable as a raw material to develop health food formulation.

Malathi *et al.* (2013) studied that nutrition intervention with functional food, flax seed powder derived lignan supplement in Type 2 diabetic patients were observed in a randomized, placebo controlled and cross over trial. The present study was conducted as there is an urgent need to validate these findings and explore the efficacy of lignans on Type 2 diabetes. A randomized placebo controlled was conducted with a total sample of 120 patients. The selected sample was randomized into two groups AC and AS. AC was the control group who has undergone all study procedures except flaxseed administration whereas AS was intervention group. The study was conducted for a period of 3 months. Screening was done one month before and after intervention. Significant difference was observed in the glycemic control of intervention group when compared with control group. There was also significant weight loss in diabetic group with control group. There was also significant weight loss in diabetic group with overweight. Flaxseed has proved to have hypoglycaemic effect, hypocholesterolemic effect with high fibre and omega 3 fatty acid content. A personalized diet counselling, incorporation of flaxseed powder to diet in specific dose at regular intervals had shown significant improvement in weight loss in subjects.

Padma *et al.* (2013) studied on effect of functional ingredients mix on the biochemical parameters in Type 2 diabetes. Functional ingredient mix was prepared from different cereals, legumes along with condiments. The supplementation was given to 75 type 2 diabetics through purposive random sampling from diabetic clinic in south Bangalore whose on the higher side, but who were not on lipid lowering drug. The intervention was given in the form of porridge for a period of 3 months. The biochemical parameters before and after the supplementation were obtained and recorded. The results support

dietary intervention as a better method of supplementation as there were improvements in glycemic control and lipid profile. The diabetes study strongly favours 'food based approach' will serve as an effective strategy to improve general nutrition status and promote well being of the type 2 diabetics.

Vidya *et al.* (2013) studied on impact of supplementation of hypocholesterolemic mix on the selected hypercholesterolemic subjects. Hypocholesterolemic mix was formulated using the hypocholesterolemic ingredients such as barley (15 g), soy flour (20g), curry leaves (5 g.), garlic (10 g.) and amla (10 g) and eighty patients were selected for supplementation and divided in 2 group experimental group was supplemented with 100g/day of hypocholesterolemic mix for a period of four months. Supplementations of hypocholesterolemic mix significantly reduced the total cholesterol, LDL, VLDL, triglycerides, TC/ HDL, LDL/ HDL, weight, BMI, WHR, blood pressure and increased the level of HDL. It does not affect the levels of fasting glucose, SGOT, SGPT, alkaline phosphatase, serum creatinine, urea, urea/ creatinine and hemoglobin. Therefore it was proved potential to reduce the consequences of hypercholesterolemic without affecting the function of other vital organs.

Nutrient composition, glycaemic index and anti-diabetic potentials of multi-plant based functional foods in rats were experimented by Ijarotimi (2015). Food materials (popcorn, moringa leaves, wonderful kola and defatted soybean) were obtained from farms and were processed as raw, blanched and fermented flour samples, and blended to obtain nine samples, i.e., R1, B1 and F1 (popcorn 60%, soybean 10%, moringa 20% and groundnut oil 10%), R2, B2 and F2 (popcorn 60%, soybean 10%, wonderful kola 20% and groundnut oil 10%) and R3, B3 and F3 (popcorn 60%, soybean 10%, moringa 10%, wonderful kola 10% and groundnut oil 10%) using Nutri-Survey software. Proximate and mineral compositions of the samples were determined using standard methods. Proximate compositions (g/100g) of the formulated multi-plant based functional foods were as follows: moisture contents ranged from 6.29 in F3 to 8.27 in R3, crude fiber contents from 2.79 in F2 to 4.68 in B3 and

crude protein contents from 23.22 in B1 to 30.39 in F3, while carbohydrate content of the formulations ranged from 52.10 in F3 sample to 56.94 in B2 sample, while energy values were between 421.1 in R1 and 433.7 kcal in B1. Glycemic index and anti-diabetic potentials were determined using rat models. Glycaemic index (GI) of the formulated functional foods ranged from 36.98 per cent in R3 to 44.9.9 per cent in R1 sample, and were significantly ( $<0.05$ ) lower than in glucose (a reference sample). The glycaemic load (GL) of F1 sample had the lowest value (20.3) where as B2 sample had the highest value (25.6). The percentage blood glucose reduction of diabetic-induced rats fed with R1 samples (63.8%) had the highest values; while those rats fed with B2 sample (24.1%) had the lowest blood glucose reduction. Statistically, the percentage blood glucose reduction of the formulated functional foods, particularly R1 and F1, were comparable to metformin (a synthetic anti-diabetic drug) in terms of antidiabetic activities. The study reported the elevated nutritional profile of multi- plant based functional foods prepared from popcorn, soyabean, wonderful kola and moringa leaves.

The clinical experiments conducted by various researchers in India and abroad on the supplementation of functional foods to diabetic and hyperlipidemic individuals showed that the lignin from flaxseed, fiber from wheat bran,  $\beta$  glucan from oats, soluble fiber from gum acacia exerted pro health effects. The consumption of functional supplements by diabetics resulted in significant reduction of fasting and post prandial blood glucose; glycosylated haemoglobin and improvement in glycemic control. Supplementation of functional foods to hyperlipidemic subjects resulted in declining the values of blood pressure, blood triglycerides, LDL and VLDL cholesterol through increasing the oxidation of cholesterol and the fecal excretion of fat. Apart from it, some investigations observed that the functional supplements were helpful in reducing the BMI, body weight waist circumference and hip circumference of overweight and obese individuals.



# **Material and Methods**

## **CHAPTER-III**

### **MATERIALS AND METHODS**

The procedure or method adopted to conduct a study is an important phase of research. If the procedure is followed in a systematic and scientific manner and objectives of the study can be achieved without difficulty. The primary purpose of this chapter is to reveal information pertaining to the methodological steps adopted in carrying out the study. The present study was carried out in two phases - formulation of functional snack and effect of supplementation of developed functional snack on blood sugar and lipid profile of selected subjects (Fig. 1).

#### **Phase I: Formulation of Functional Snack**

##### **3.1 Selection and Processing of Ingredients**

Basic ingredients such as wheat, jowar, skimmed milk powder, fat, sugar, cumin seed, omum and some ingredients having functional components and substantiated health claims viz. wheat bran, flax seed, niger seed, gum acasia, oat and soya chunks were selected for development of functional snack. The selected ingredients were purchased from the local market of Parbhani. The wheat bran was procured from a mill located at MIDC area of Parbhani. The purchased ingredients were cleaned to remove the impurities and were processed. Wheat and jowar were ground in a flour mill to obtain the flour. Oat flakes, flax seed, niger seed, sugar, cumin seed and omum were powdered in mixer grinder. Gum acasia was roasted in microwave oven (L. G. make) (60 g for 3 min.). The roasted gum was ground in mixer to make fine powder. Soya chunks were roasted in open pan on sim flame (200g, 5 min), cooled and made into fine flour in mixer grinder. Skimmed milk powder, fat, salt and baking powder were used as such (Plate 1).

The flavoring components selected for incorporation in functional snack were mint and coriander leaves, garlic, ginger, cardamom and nutmeg. Fresh

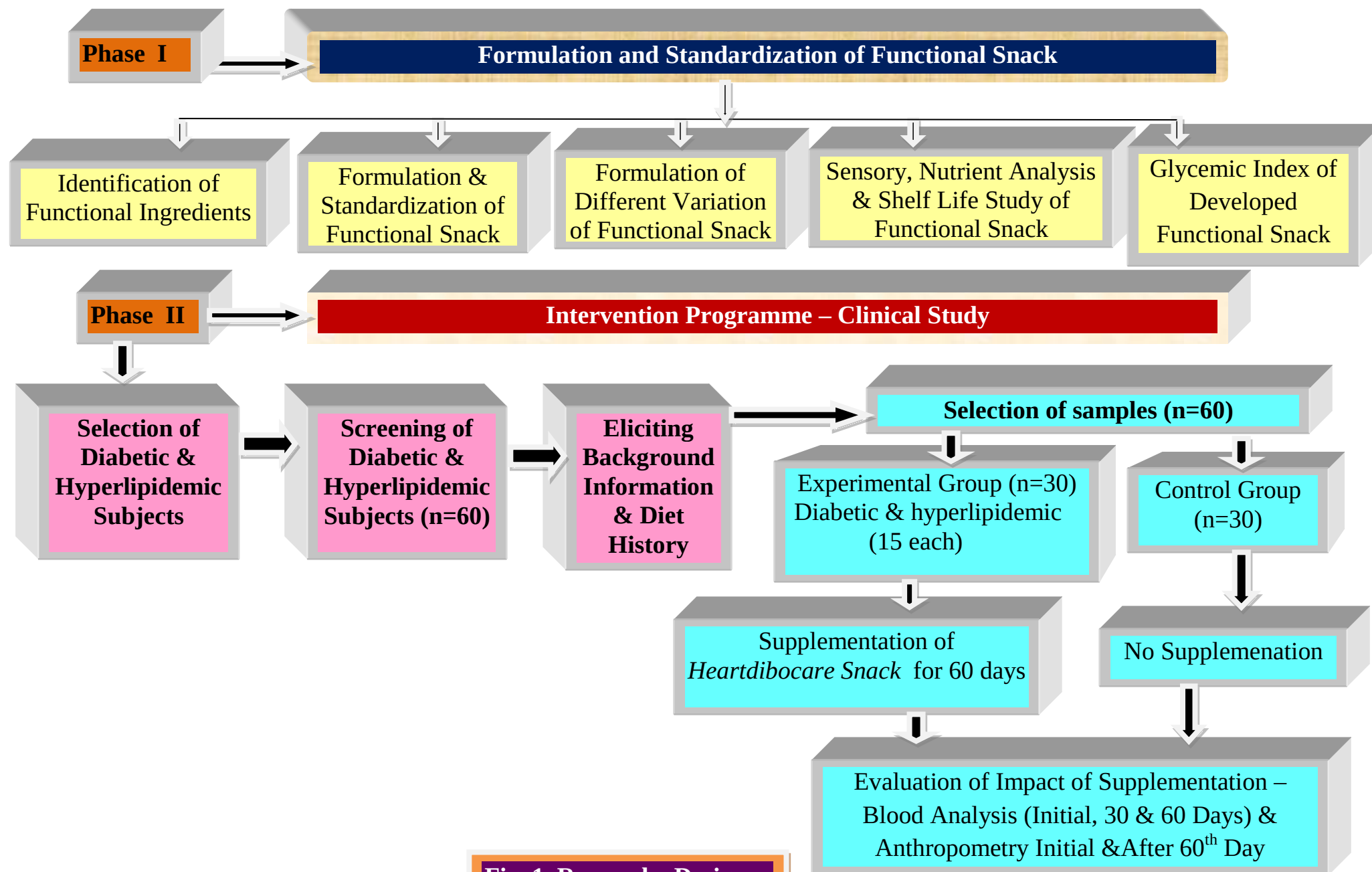


**Fig. 1. Research Design**



INGREDIENTS USED FOR DEVELOPMENT OF FUNCTIONAL  
SNACK

PLATE 1

coriander and mint leaves were washed, surface dried with clean cloth and were chopped finely. Garlic and ginger were peeled and made into paste in a mixer grinder. Cardamom and nutmeg were powdered in a mixer grinder. All the flavouring ingredients were processed just before the use. All the ingredients were processed hygienically and were stored in air tight container at room temperature (Plate 2).

### **3.2 Preparation of Functional Snack**

The selected and processed ingredients were used in various combinations and the trials were taken for preparation of snack. By changing the composition of ingredients 42 trials variations were structured. Each time the product was prepared and evaluated organoleptically.

According to one of the objectives of the study, clinical trials of the developed functional snack were necessary. For this purpose the intervention of supplementation of developed functional snack to diabetic and hyperlipidemic patients was to be undertaken. Therefore, very well accepted snack with longer shelf life was necessary. Among various methods of cooking, baking was one which could be preferred for this purpose as the baked products have some advantages over the products prepared by other methods of cooking. The baked products are ready to eat, convenient, have good taste and texture and are liked by all age groups.

The baked snack was prepared from finalized composition of ingredients in various shapes such as round, rectangular, square and hexagonal and again was evaluated by panel members. The rectangular bar shape was accepted more hence, it was finalized for further study (Plate 3).

### **3.3 Organoleptic Evaluation of Functional Snack**

In today's world consumer expectations and awareness regarding quality of food products has reached heights. For quality assurance several steps are taken out, of which organoleptic evaluation holds an important place. The overall quality of foods may be categorized into characteristics such as



**Plate 2 Grinding of ingredients for product development**

colour, appearance, flavor, texture and taste (Ranganna, 2004). Organoleptic evaluation of the formulated variations of functional snack was carried out by using Nine point Hedonic Scale (BIS,1971) Twenty semi-trained panel members of Dept. of Foods and Nutrition, College of Home Science, VNMKV, Parbhani evaluated the snack using score card with a maximum score of nine and a minimum score of one (Annexure I). The panel members were provided with pure drinking water to rinse their mouth after tasting each variation.

### **3.4 Industrial Trial of Functional Snack for Large Scale Preparation**

Industrial trials were conducted in Bangalore Bakery located in Pune and Kisan and Bushra Bakery at Parbhani for large scale preparation of functional snack. After successful industrial trials the functional snack was prepared in large quantity for clinical experiment i.e. for supplementation to diabetic and hyperlipidemic subjects.

### **3.5 Consumer Acceptability of developed snack**

For testing the consumer acceptance of developed product various population groups were selected viz. school children, adolescents, adults, diabetics and hyperlipidemic individuals and bakery shop customers. The researcher approached the consumers directly from each population group. The heartdiabocare snack was given to these people and their responses were recorded by using nine point Hedonic Scale. When inquired by the consumers they were provided with the information regarding the major ingredient composition of the supplement. They were told that it is nutritious baked snack.

### **3.5 Assessment of Techno-Economic Feasibility of Developed Functional Snack**

Total cost of the developed functional snack was calculated by considering the current prices (2017) of used ingredients, processing and packaging cost. The cost was calculated for 1kg of functional snack (Kulthe 2015).



**Plate 3 Developed *Heartdiabocare* Snack**

### 3.6 Functional Properties of Homogenously Mixed Ingredients

The processed ingredients (powders) were thoroughly mixed to obtain homogenous mixture which served as raw material (flour). Water absorption capacity, fat absorption capacity and least gelation concentration of flour were studied to evaluate their functionality.

#### 3.6.1 Water Absorption Capacity (WAC)

WAC of flour was estimated according to the method given by Smith and Circle (1972). Exactly 5 g of flour was mixed well with 30 ml distilled water in a centrifuge tube using a glass rod. After 5 minutes, the contents were centrifuged at 2000 rpm for 5 minutes. The supernatant was measured using a graduated cylinder. Volume of water absorbed is equal to 30 minus supernatant. Water absorption capacity was recorded as follows:

$$\text{WAC (ml per g flour)} = \frac{\text{Volume of water absorbed}}{\text{Weight of sample}}$$

#### 3.6.2 Fat Absorption Capacity (FAC)

FAC was determined by the method described by Lin *et al.*, (1974). Weighed quantity (1g) of flour was taken in to graduated cylinder and mixed with 6 ml of groundnut oil with glass rod for 1 minute. After a holding period of 30 minutes, the tube was centrifuged at 1610 rpm for 25 minutes. The volume of free oil was measured and FAC was estimated as the amount of oil bound per gram of sample as follows:

$$\text{FAC (ml per g flour)} = \frac{\text{Volume of fat absorbed}}{\text{Weight of sample}}$$

#### 3.6.3 Least Gelation Concentration

The least gelation concentration was determined using method of Coffman and Garcia (1977) cited in Murugkar *et al.*, (2013). The flour dispersions of 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 per cent (w/v) were prepared in 5 ml distilled water, were heated at 90°C for 1 h in a water bath. The tubes

containing the suspensions were then heated for 1 hour in a gentle boiling water bath, after which the tubes were cooled rapidly in water at 4°C for 2 hours. Each tube was then inverted one after the other. The least gelation concentration was determined as that concentration when the sample from inverted tube did not slip.

### **3.7 Physical Quality Assessment**

**3.7.1 Particle size:** Flour was sieved through a scientific sieve BS 40 mesh size.

**3.7.2 Weight:** Weight of the product in raw and in baked form was measured with electronic weighing balance.

**3.7.3 Width:** Developed functional six bars were placed horizontally (edge to edge) in a row and their average diameter was measured using digital vernier calliper with 0.1 mm accuracy (AOAC, 2000).

**3.7.4 Thickness:** Developed functional six bars were placed one on the top of another thickness was measured using digital vernire caliper with 0.1 mm accuracy and the average was calculated (AOAC, 2000).

**3.7.5 Baking time:** The time required for baking the functional snack was noted as baking time.

**3.7.6 Volume:** Volume of product was measured by displacement method (AACC, 1969) and expressed in cubic centimeter (cc).

**3.7.7 Bulk density:** Bulk density of the product was calculated by using weight (g) and volume (ml).

$$\text{Bulk density (gcm}^3\text{)} = \frac{\text{Weight (g)}}{\text{Volume (ml)}}$$

### **3.7.8 Colour Determination**

Colour of the functional snack (L, a and b values) was determined by using Hunter Colorimeter (model no. 45/0 L, made in U.S.A). ‘L’ is known as the lightness and extends from 0 (black) to 100 (white). The other two

coordinates 'a' and 'b' represent redness (+ a value) to greenness (– a value) and yellowness (+ b value) to blueness (– b value), respectively. Hue angle (h0) is the attribute of the colour by means of which the colour is perceived. Chroma (C\*) is the attribute of colour used to indicate the degree of departure of the colour from gray of the same lightness (Plate 4).

### **3.7.9 Texture Profile Analysis**

Texture measurement of developed functional snack bar samples was performed at room temperature using the texture analyzer (TA-Hdi), (Stable Micro systems, UK). Prior to analysis, samples were allowed to equilibrate to room temperature. Texture profile analysis (Bourn, 1978) was performed using five pieces of each sample (2.5×2.5×2cm), which were compressed twice to 50 per cent of the original height with a cylinder probe P/75. A time of 2 s was allowed to elapse between two compression cycles (Plate 5).

## **3.8 Nutritional Evaluation of Functional Snack**

The developed functional snack was analyzed for nutritional quality assessment.

### **3.8.1 Proximate Analysis of Functional Snack**

The parameters analyzed were moisture, total minerals, protein, total fat, dietary fiber, calcium AOAC (1990), iron, zinc, copper and manganese by AAS procedures (Plate 6). Apart from these the invitro protein digestibility of the product was determined using the method described by Mouliswar *et al.*, in 1993 (Annexure II). The values of carbohydrate, energy, water soluble vitamins such as thiamine, riboflavin and niacin were calculated by using the food composition tables (Gopalan *et al.*, 2011).

### **3.8.2. Fatty Acid Profile Estimation**

Saturated and unsaturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fats, omega 3 fatty acids and omega 6 fatty acids were estimated from developed functional snack by using gas



**Plate 4 a. Hunter colorimeter**

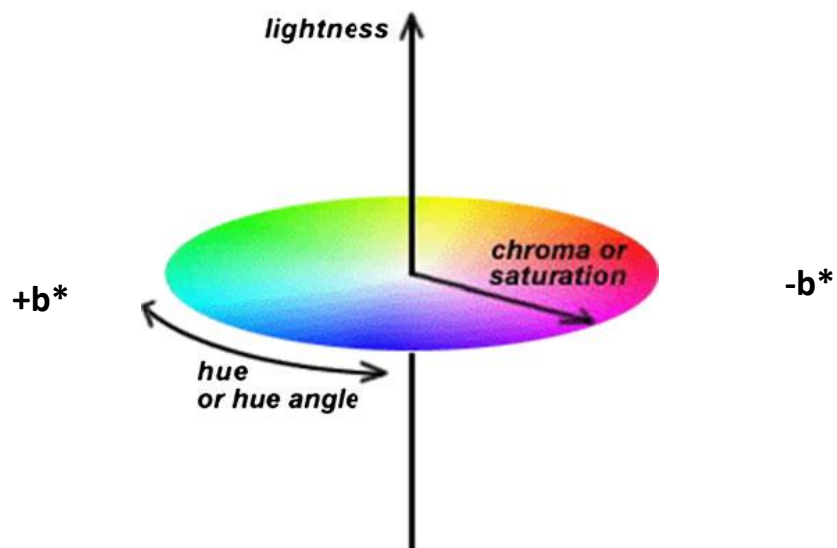


**Plate 4 b Measurement of colour the of developed functional snack**

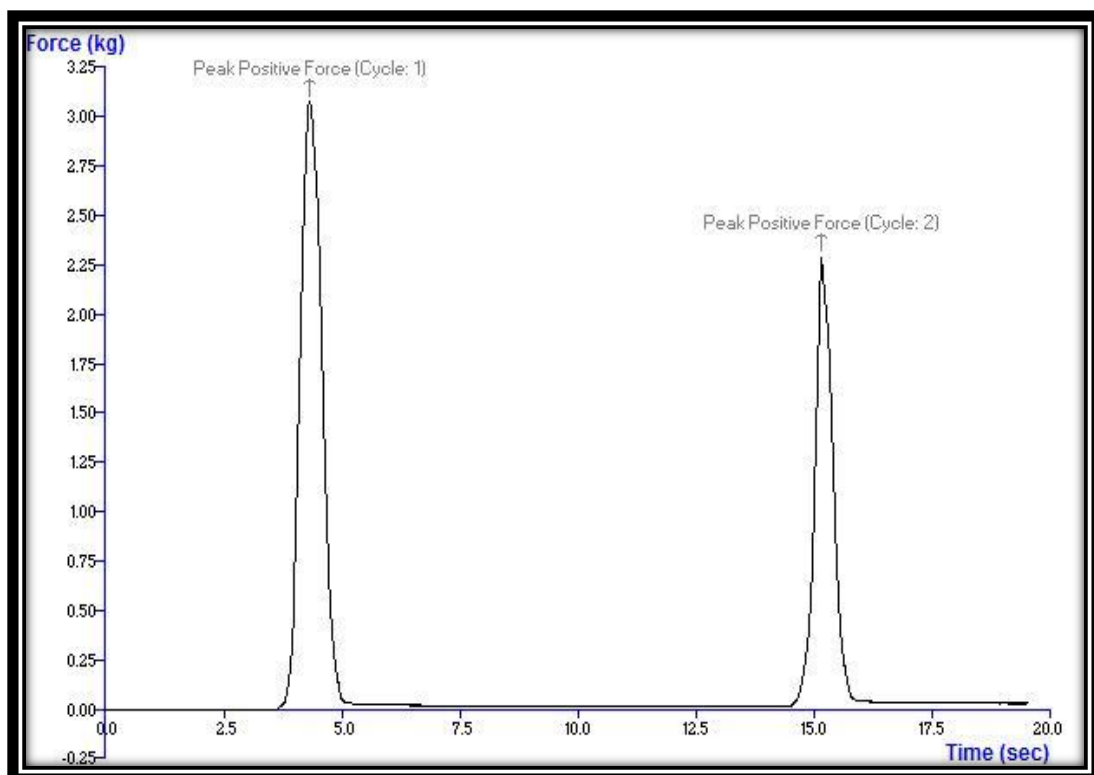
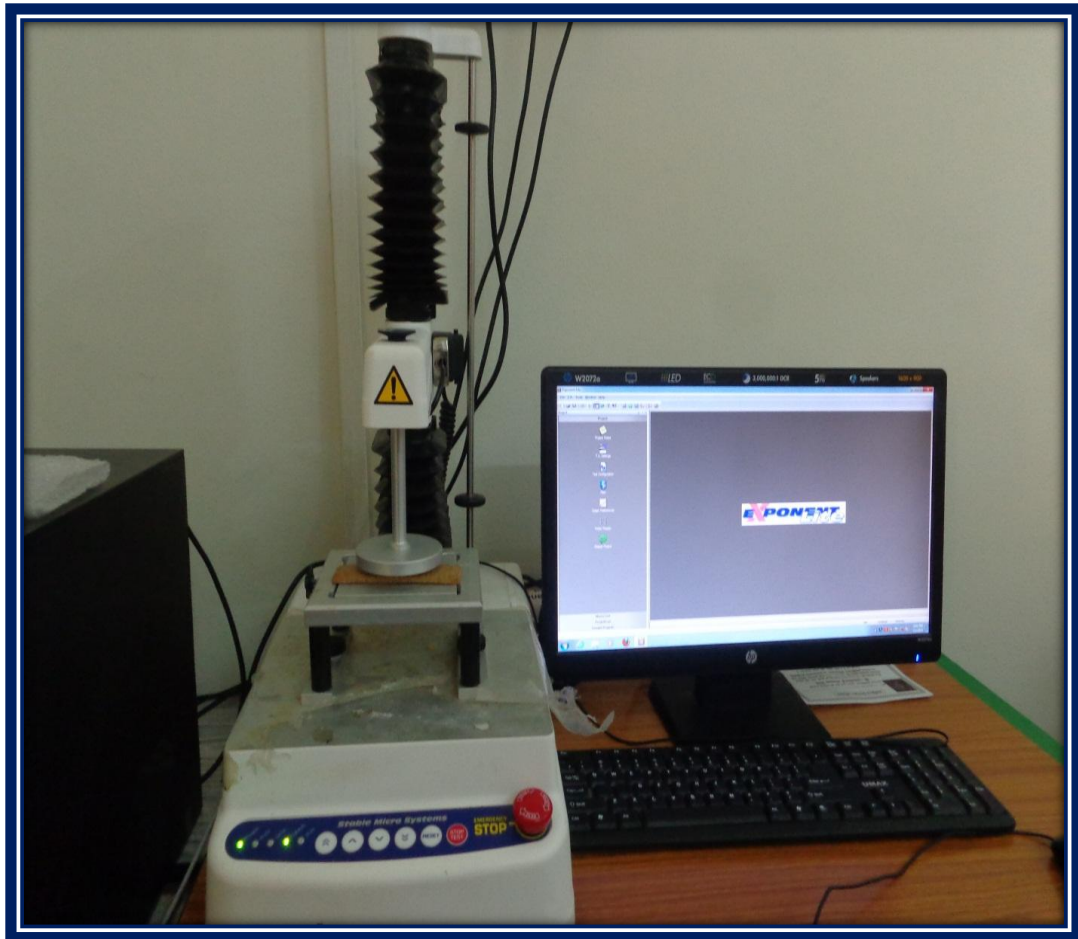


**Plate 5 Measurement of the texture**

chromatography technique (Appelqvist LA, 1968: AOCS, 1978), (Annexure III).

### **3.9 Nomenclature of the Snack**

Looking in to the data pertaining to nutrient contents and fatty acid profile of the developed functional snack it was named as ***Heartdiabocare Snack***'.

### **3.10 Shelf Life Study of the Developed *Heartdiabocare Snack***

The best accepted variation of *Heartdiabocare Snack* was selected for shelf life study. It was packed in LDPE and Laminated aluminium foil pouch and stored at room temperature and refrigeration temperature for a period of 3 months. The samples were drawn fortnightly for assessing the quality in terms of moisture and organoleptic evaluation. Peroxide value, free fatty acids, were estimated at the beginning and at the end of the storage period (Plate 7).

#### **3.10.1 Microbial Evaluation**

Total plate count, yeast count and mould count were estimated before storage and after completion of storage period in all the packages by serial dilution agar technique given by Dubey and Maheshwari in 2004, (Annexure IV), (Plate 8).

### **3.11 Estimation of Glycemic Index**

Step by step procedure followed to estimate the Glycemic Index (GI) in terms of glycemic response of developed functional snack (Jenkins, 2002) is given below.

#### **Step I**

Ten healthy adult female volunteers between the age groups of 22-26 years with normal BMI were selected from 'Rajmata Jijau Girls Hostel', VNMKV, Parbhani to perform a formal experiment. A written consent from the participants was obtained before participating in experiment (Annexure V). The volunteers had no family history of diabetes or any food allergies and were not on any medication or weight loss diet. All the Subjects were asked to attend

the testing session early in the morning after 10-12 hour overnight fast. They were instructed not to consume unusually large meals, not to exercise vigorously and to avoid cycling or walking on previous day. A written consent from the participants was obtained before participating in experiment

## Step 2

In the morning 50 gm of glucose dissolved in 300 ml of water was given to all the subjects in fasting state.

Blood glucose level was measured by finger prick method using glucometer (Accu - Chek Active - Sr. no. GU 04379385). A finger prick blood sample was taken in the fasting state and at 30 min, 60 min, 90 min and 2 hours after consumption of glucose by subject. The area under the resulting curve was measured and it was called the incremental area under the blood glucose response curve or IAUC.

## Step 3

The test food sample i.e. *Heartdiabocare snack* equivalent to 50 g carbohydrates (114 g) was given to the volunteers after they have been in fasting state for at least 10-12 hours. The test was performed in the morning. Water was given with the test food. The blood plasma glucose level for the next two hours was recorded the same way as recorded for 50 gm glucose test. The IAUC was also calculated the same way as the area under the resulting curve.

## Step 4

The glycemic index was calculated by dividing the IAUC for the *Heartdiabocare snack* by the IAUC for the glucose (reference food) and multiplying by 100 for each individual. The following formula was used.

$$GI = \frac{\text{IAUC for tested food}}{\text{IAUC for reference food}} \times 100$$



**Plate 6 Estimation of protein**



**Plate 7 Storage of developed functional snack in LDPE & laminated aluminium pouch**

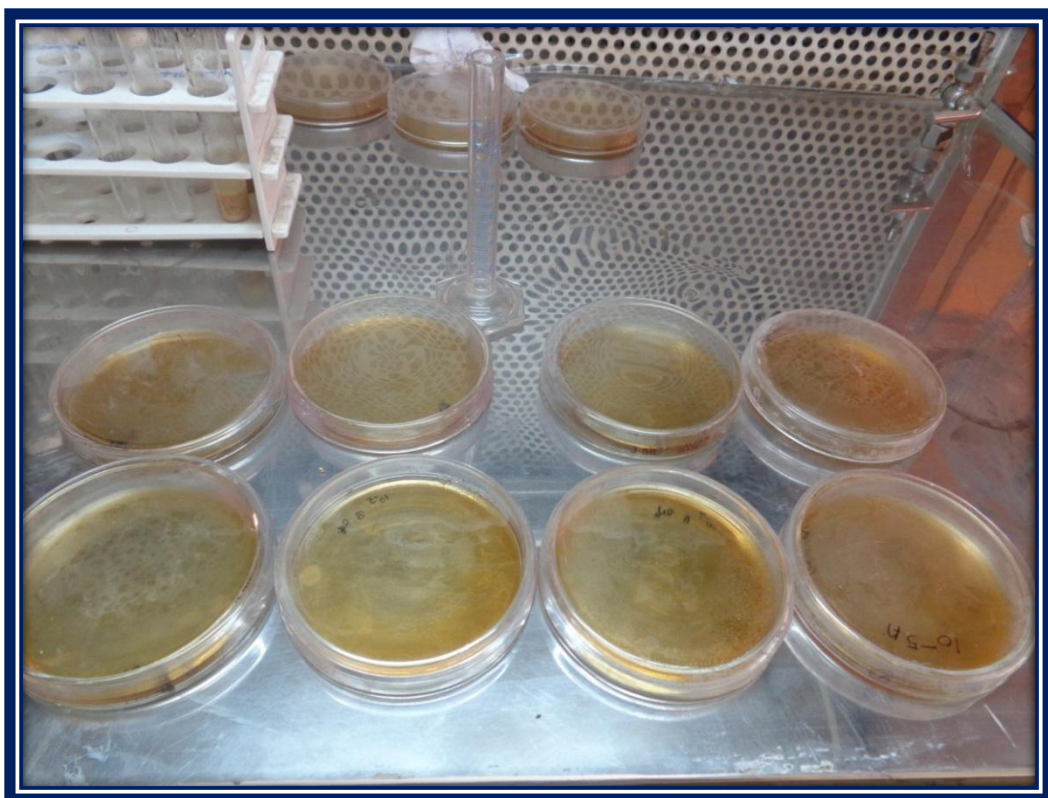


**Plate 8 Microbial analysis**

The final glycemic index of *Heartdiabocare snack* was calculated as the mean of the respective GI's of the ten individuals and compared with the classification of glycemic index of foods.

| <b>Classification of GI</b> | <b>Low</b>  | <b>Medium</b> | <b>High</b> |
|-----------------------------|-------------|---------------|-------------|
| Glycemic Index*             | $\leq 55.0$ | 56-69         | $\geq 70.0$ |

Source: Srilakshmi B. (2005)

## **Phase II**

### **3.12 Intervention Programme (Clinical Study)**

The impact of developed functional snack on blood glucose level of diabetic and lipid profile of hyperlipidemic subjects was assessed by conducting a clinical study.

### **3.13 Selection of Sample**

A total sample of 30 diabetic and 30 hyperlipidemic individuals between 40 to 65 years of age were selected for the study from Parbhani city (Plate 9). The written ethical consent in local language was taken from all the subjects who were willing to participate in the experiment prior to recruitment in the study (Appendix VI a & b), (Plate 10). During the study period the existing lifestyle of the subject was not changed. All the selected subjects were allowed to continue and follow their usual life style, diet, exercise and medicines during the study period.

The subjects were selected with the help of reputed Pathologist. Individuals having fasting blood glucose  $>120$  mg/dl and post prandial blood glucose  $>140$  mg/dl were selected as diabetic and individuals having  $>200$  mg/dl total cholesterol were selected as hyperlipidemic. Hence, a total number of 30 diabetic and 30 hyperlipidemic subjects were selected. Both the diabetic and hyperlipidemic subjects were divided equally into two groups as control group and experimental group (15 each).



**Plate 9 Investigator explaining about the clinical experiment to the subjects**

### **3.14 Collection of Information of the Selected Subjects**

Questionnaires are a popular means of collecting data. A questionnaire consists of a number of questions printed or typed in a definite order on a form or a set of forms (Gupta, 2014 and Kothari, 2011). All the 60 selected subjects were personally interviewed by the investigator with the help of pretested questionnaire so as to elicit the information on their socio-economic background, diet pattern, lifestyle, known risk factors for disease, snacking pattern, functional food consumption and oil seed consumption. Information regarding family history of disease, present health complaints, drugs taken, herbal supplements used & level of physical activity was also recorded (Annexure VII a & b).

### **3.15 Recording Anthropometric Measurements**

Anthropometry is the single most portable, universally applicable, inexpensive and noninvasive method available to assess the proportions, size, and composition of the human body. It reflects both health and nutrition and predicts performance, health and survival. For these reasons it is used for selecting individuals and populations for health and nutrition intervention, as well as monitoring their health and nutrition (Jellief, 1966).

The body measurements of the selected subjects recorded during the experimental period were height (cm), weight (Kg), mid upper arm circumference (cm), triceps skinfold thickness (mm), waist circumference (cm) and hip circumference (cm) by following the standard procedures described by Jelliffe, (1966). Body Mass Index (BMI) and Waist Hip Ratio (WHR) were calculated by using standard formulae.

#### **3.15.1 Height**

Height is a constituent factor in the calculation of BMI and hence the height of all subjects was measured using an anthropometer. The subjects were made to stand erect, barefoot on a leveled surface, with heels together and toes apart. The moving head piece of the anthropometer was placed in the sagittal plane over the head of the subjects applying a slight pressure to reduce the



**Plate 10 Filling ethical consent form by the subjects**

thickness of hair. The reading was taken to the accuracy of 0.1cm (Ray and Iqbal, 2011), (Plate 11).

### **3.15.2 Weight**

Measurement of weight serves as the indicator to profess the presence and progress of ailment. The weight of all the selected subjects in the two groups were determined by making them stand barefoot and erect on a portable weighing scale to the accuracy of 0.1kg before supplementation ((Ray and Iqbal, 2011), (Plate 12).

### **3.15.3 Body Mass Index (BMI)**

BMI determines whether the weight is appropriate for the height or not. It thus has good correlation with fitness (Bamji *et al.*, 2010). WHO (2004) has explained BMI as a simple index of weight for height that is commonly used to classify adults as underweight or overweight. The BMI was calculated from height and weight of the subjects employing the standard formula.

$$\text{Body Mass Index (kg/m}^2\text{)} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

### **3.15.4 Determination of Mid Arm Circumference**

The circumference of the left upper arm of the selected subjects was measured at its midpoint for the determination of mid-arm circumference. Midpoint of the left arm was marked by keeping the left fore arm at 90° at the point of elbow and by placing palm facing down, across the middle of the body. Care was taken to keep the upper arm approximately parallel to the trunk. The tape was used around the arm and the measurement was recorded twice at the marked midpoint to the nearest 0.1 cm, and the mean value was taken as the measure of mid-arm circumference (Plate 13).

### **3.15.5 Determination of Triceps Skinfold Thickness**

Skin fold thickness at triceps was measured by using skin fold caliper. The measurement of skin fold thickness at triceps was made at the midpoint on the back of the left arm over the triceps muscle. The skin fold



**Plate 11 Measuring height of subject**



**Plate 12 Measuring weight of subject**

thickness was recorded to the nearest 0.1 mm while the jaws of the caliper were placed perpendicular to the length of the skin fold at the marked midpoint of left arm. This procedure was repeated twice and the mean value was taken as the measure of skin fold thickness at triceps.

### **3.15.6 Measurement of Waist Circumference**

The subject was made to stand erect with the abdomen relaxed, the arms at the sides and feet together. The investigator faced the subject and placed an inelastic tape around the subject, in a horizontal plane, at the smallest circumference of the torso, which was at the level of the natural waist. It was recorded to the nearest 0.1 cm (Plate 14). All the adult males with waist circumference of  $\geq 102$  cm and females with  $\geq 80$  cm were identified as having abdominal obesity (WHO, 2008 and ICMR, 2010).

### **3.15.7 Measurement of Hip Circumference**

The subject was made to stand erect with the arms at the sides and feet together. The investigator squated at the side of the subject so that the level of maximum extension of the buttock could be seen. An inelastic tape was placed around the buttock, in a horizontal plane at buttock/hip level without compressing the skin. The measurement was recorded to the nearest 0.1cm.

### **3.15.8 Measurement of Waist Hip Ratio**

Measurement of waist and hip circumference was done and the ratios were calculated and compared with the standard value. All the adult males with waist hip ratio of  $\geq 0.95$  and women with  $\geq 0.80$  will be identified as obesity (WHO, 2008; ICMR, 2010).

Waist Hip Ratio was calculated by using following formula.

$$\text{Waist Hip Ratio} = \frac{\text{Waist (cm)}}{\text{Hip (cm)}}$$



**Plate 13 Measuring mid upper arm circumference of the subject**



**Plate 14 Measuring waist circumference of subject**

### **3.12.3.9 Blood Pressure (B.P.)**

Blood pressure of the selected subjects was monitored before, after and at regular monthly interval during the course of the study by using sphygmomanometer. It was measured by a health professional (Plate 15).

### **3.17 Determination of Nutrient Intake of Selected Subjects**

The nutrient intake of the selected subjects was determined by 24 Hours Recall Method. All subjects were interviewed with the help of pretested questionnaire. The information regarding their dietary habits, frequency of consumption of different food groups in a day etc. were collected. The actual food intake of the selected diabetic and hyperlipidemic subjects was collected for the immediate past 24 hours. The intake of different nutrients per day by each selected subject was then calculated from the food intake values using food composition tables (Gopalan *et al.*, 2011). Food and nutrient adequacy was calculated based on balanced diets and Recommended Dietary Allowances respectively (ICMR, 2010).

### **3.18 *Heartdiabocare snack* Supplementation**

All the subjects of experimental group i.e. diabetic (15) and hyperlipidemic (15) were given 60 gm *Heartdiabocare snack* daily for 60 days. They were requested to consume *Heartdiabocare snack* in their breakfast as a replacement for a period of 60 days. Care was taken that the supplement was consumed by subjects in front of the investigator daily. Subjects belonging to control group were not given any supplementation throughout the experiment. Clinical and anthropometric data were recorded before giving the supplementation (one day prior to the supplementation) and on 30<sup>th</sup> and 60<sup>th</sup> day of study period.

#### **3.18.1 Estimation of Blood Glucose and Lipid Profile of Selected Subjects**

The blood samples of all the selected subjects from both control and experimental group were collected and analyzed in the authorized pathological laboratory from Parbhani city. The various parameters analyzed were fasting



**Plate 15 Recording the blood pressure of subject**



**Plate 16 Drawing blood sample for biochemical analysis**

and post prandial blood glucose, total serum cholesterol, triglycerides, HDL, LDL and VLDL cholesterol as given in (Annexure VIII- IX), (Plate 16).

### **3.19 Statistical Analysis**

The collected data was consolidated, tabulated and analyzed statistically. Simple arithmetic means with standard deviations and percentage were calculated to interpret the results. Means and standard deviations were calculated for different parameters of organoleptic scores, biochemical parameters of products, blood profile values, anthropometric measurements, food intake and nutrients intake of all the selected subjects. The 't' test and analysis of variance (ANOVA) were used to know the differences in the parameters. The statistical analysis was carried out by following the procedures prescribed by Gupta (2014).



# Results and Discussion

## CHAPTER-IV

### RESULTS AND DISCUSSION

A sequential description and explanation of each key finding and the statements of facts is result. The results are articulated to view the research conducted regarding the development of functional snack and to assess its impact on blood parameters from various perspectives. The data generated through the research is systematically classified and presented in the form of tables which are explained in text. The visual dimension is given to the data through the graphs and photos. The findings of the investigation are unraveled in this chapter under the following headings/ subheadings. The present investigation was carried out in two phases.

#### **Phase I: Formulation of Functional Snack**

- 4.1 Development of Functional Snack
- 4.2 Consumer Acceptability of Developed *Heartdiabocare Snack*
- 4.3 Functional Properties of Composite Flour
- 4.4 Physical Properties of Developed *Heartdiabocare Snack*
- 4.5 Nutritional Evaluation of *Heartdiabocare Snack*
  - 4.5.1 Fatty Acid Profile of *Heartdibocare Snack*
- 4.6 Shelf Life Study of Developed *Heartdiabocare Snack*
  - 4.6.1. Effect of Storage on Acceptability of *Heartdiabocare Snack*
  - 4.6.2 Effect of Storage on Biochemical Parameters of *Heartdiabocare Snack*
  - 4.6.3 Microbial Evaluation of *Heartdiabocare Snack*
- 4.7 Techno-Economical Feasibility for the Production of '*Heartdibocare Snack*'
- 4.8 Glycemic Index of *Heartdiabocare Snack*

#### **Phase II**

- 4.9 Intervention Programme (Clinical Study)
  - 4.9.1 Selection of Sample
  - 4.9.2 Collection of General Information of the Selected Subjects

- 4.10 Information of Subjects Regarding Various Aspects of Diabetes and Hyperlipidemia
  - 4.10.1 Prevalence of Symptoms among the Diabetic Subjects
- 4.11 Food and Nutrient Intake of the Selected Diabetic and Hyperlipidemic Subjects
  - 4.11.1 Dietary Pattern of Selected Diabetic and Hyperlipidemic Subjects
  - 4.11.2 Oil and Oilseeds Consumption Pattern of the Selected Diabetic and Hyperlipidemic Subjects
  - 4.11.3 Snacking Behaviour of the Selected Subjects
  - 4.11.4 Consumption Pattern of Functional Foods
  - 4.11.5 Purchasing and Purpose of Consumption of Functional Foods
  - 4.11.6 Food and Nutrient Intake of the Selected Diabetic Subjects
    - 4.11.6 .1 Food Intake of the Selected Diabetic Subjects
    - 4.11.6.2 Nutrient Intake of the Selected Diabetic Subjects
    - 4.11.6.3 Food Intake of the Selected Hyperlipidemic Subjects
    - 4.11.6.4 Nutrient Intake of the Selected Hyperlipidemic Subjects
- 4.12 Exercise Pattern of the Selected Subjects
  - 4.12.1 Utilization of Leisure Time by Diabetic and Hyperlipidemic Subjects
  - 4.12.2 Undesirable Habits among the Selected Male Subjects
- 4.13 Anthropometric Measurements of the Selected Diabetic & Hyperlipidemic Subjects
  - 4.13.1 Anthropometric Measurements of Diabetic Subjects Before and after Intervention
  - 4.13.2 Anthropometric Measurements of Hyperlipidemic Subjects Before and after Intervention
- 4.14 Blood Pressure of Selected Subjects Before and After Intervention
- 4.15 Effect of Supplementation of *Heartdiabocare Snack* on Blood Glucose Level and Lipid Profile of the Selected Subjects
  - 4.15.1 Effect of Supplementation of *Heartdiabocare Snack* on Blood Glucose Level of the Selected Diabetic Subjects
  - 4.15.2 Effect of Supplementation of *Heartdiabocare Snack* on Lipid profile of the Selected Hyperlipidemic Subjects

#### 4.1 Development of Functional Snack

The ingredients such as wheat flour, flax seed flour, niger seed powder, wheat bran, skimmed milk powder, gum acasia powder, soy chunk powder, refined wheat flour, green gram dhal flour, roasted bengal gram dhal flour and oat flour were used in the preparation of the snack along with other ingredients like fat, baking powder, powders of cumin seed, omum, spices viz. black pepper, cloves, fenugreek seed, cardamom, cinamom, nutmeg, chilly powder, garlic & ginger paste, coriander leaves, curry leaves and mint leaves. Forty two variations were developed by changing the composition of functional snack. The ingredients used for development of functional snack are given in Table 1.

The ingredient composition used for development of functional snack indicated that wheat flour was used in maximum amount in all the variations. It ranged between 20 to 25 per cent. Flax and niger seed were used in the proportion of 5 to 10 per cent. Very less amount of refined wheat flour was used in the beginning up to variation 8. There after it was omitted from the list of ingredients. As like refined wheat flour, bengal gram dhal and green gram dhal was also used in few variations in the proportion of 4 to 5 per cent. The functional ingredients such as wheat bran and gum acacia were used in the same amount (10% each) in all the variations while, skim milk powder was used from 10-20 per cent. The minimum amount of oats and soya chunk powder was four per cent. The maximum amount of oats was 5 g while soya chunk powder was 10 g/100g. Jowar was not used till 20 variations but after 20<sup>th</sup> variation it was included in all the variations. Cumin seed and omum powders were used in all the variation except last five variations. Salt and baking powder were used in all the variations. In the beginning sugar was not at all used up to 35 variations as the product was planned for diabetics. But for improvement of taste it was included in a very less amount (5%) in the last variations. Similarly to improve the texture 3 to 5 per cent fat was incorporated. Spices were used in the proportion of 1 to 2 per cent in most of the variations. Each time the product was prepared and evaluated organoleptically.

**Table 1. Ingredients composition of various trials of functional snack (g)**

| Variations | Wheat flour | Flax Seed flour | Niger seed flour | Refined flour | Jowar flour | Roasted bengal gram dhal flour | Green gram dhal flour | GA powder | SMP | Wheat bran | Soy chunk powder | Oat flour | Baking powder | Salt | Fat | Sugar powder | Cumin Seed powder | Omum powder | Spices powder             |
|------------|-------------|-----------------|------------------|---------------|-------------|--------------------------------|-----------------------|-----------|-----|------------|------------------|-----------|---------------|------|-----|--------------|-------------------|-------------|---------------------------|
| 1          | 25          | 15              | 15               | 5             | -           | -                              | -                     | 10        | 15  | 10         | -                | -         | 2             | 1    | -   | -            | 1                 | 1           | -                         |
| 2          | 20          | 15              | 15               | 5             | -           |                                | 5                     | 10        | 10  | 10         | 5                | -         | 2             | 1    | 3   | -            | 3                 | 2           | -                         |
| 3          | 20          | 15              | 15               | 5             | -           |                                | 5                     | 10        | 10  | 10         | 5                | -         | 2             | 1    | 3   | -            | 3                 | 2           | -                         |
| 4          | 20          | 15              | 15               | -             | -           | -                              | -                     | 10        | 15  | 10         | -                | -         | 2             | 2    | 3   | -            | 1                 | 2           | Cloves (1)                |
| 5          | 15          | 15              | 15               | -             | -           | 5                              | -                     | 10        | 10  | 10         | 4                | 5         | 2             | 1    | 3   | -            | 2                 | 3           | -                         |
| 6          | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2             | 1    | 3   | -            | 2                 | 2           | -                         |
| 7          | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2             | 1    | 3   | -            | 2                 | 2           | -                         |
| 8          | 15          | 15              | 15               | -             | -           | 5                              | -                     | 10        | 10  | 10         | 5                | 5         | 2             | 1    | 3   | -            | 2                 | 2           | -                         |
| 9          | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2             | 1    | 3   | -            | 3                 | 3           | Cinamom (1)               |
| 10         | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2             | 1    | 4   | -            | 1                 | 2           | Cardamom & cinamom (1)    |
| 11         | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2.5           | 1    | 5   | 5            | 1                 | 1           | Garlic 1& ginger (1.5)    |
| 12         | 15          | 15              | 15               | -             | 5           | -                              | -                     | 10        | 10  | 10         | 5                | 5         | 2.5           | 1    | 4   | 5            | -                 | -           | Garlic (1.5)              |
| 13         | 25          | 15              | 10               | 5             | -           | -                              | -                     | 10        | 10  | 10         | 5                | -         | 2             | 1    | 3   | -            | 2                 | 2           | -                         |
| 14         | 25          | 10              | 10               | 10            | -           | -                              | -                     | 10        | 10  | 10         | -                | -         | 4             | 3    | -   | -            | 4                 | 4           | -                         |
| 15         | 25          | 10              | 10               | 10            | -           | -                              | -                     | 10        | 10  | 10         | -                | -         | 2             | 3    | 4   | -            | 3                 | 3           | -                         |
| 16         | 25          | 10              | 10               | 10            | -           | -                              | -                     | 10        | 10  | 10         | 4                | -         | 2             | 2    | 3   | -            | 2                 | 2           | -                         |
| 17         | 25          | 10              | 10               | -             | -           | -                              | -                     | 10        | 10  | 10         | 10               | -         | 3             | 1    | 5   | -            | 3                 | 3           | Black pepper (1)          |
| 18         | 25          | 10              | 10               | 10            | -           | -                              | -                     | 10        | 10  | 10         | 5                | -         | 2             | 1    | 3   | -            | 2                 | 2           | Black pepper & cloves (1) |
| 19         | 25          | 10              | 10               | 10            | -           | -                              | -                     | 10        | 10  | 10         | 4                | -         | 2             | 2    | 3   | -            | 2                 | 2           | -                         |

|    |    |    |    |   |   |   |   |    |    |    |    |   |     |   |   |   |   |   |                                |
|----|----|----|----|---|---|---|---|----|----|----|----|---|-----|---|---|---|---|---|--------------------------------|
| 20 | 25 | 10 | 10 | - | - | - | - | 10 | 10 | 10 | 10 | - | 3   | 1 | 5 | - | 3 | 3 | Black pepper (1)               |
| 21 | 25 | 10 | 10 | - | - | 5 | - | 10 | 10 | 10 | -  | 5 | 2   | 1 | 5 | - | 3 | 3 | Fenugreek seed, garlic (1)     |
| 22 | 25 | 10 | 10 | - | - | 4 | - | 10 | 10 | 10 | 4  | 5 | 2   | 1 | 4 | - | 2 | 2 | Cinamom (1)                    |
| 23 | 25 | 10 | 10 | - | - | 5 | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 24 | 25 | 10 | 10 | - | - | - | 4 | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | Cardamom(1)                    |
| 25 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | -  | 5 | 2   | 1 | 5 | - | 3 | 3 | Cinamom (1)                    |
| 26 | 20 | 10 | 10 | - | - | - | 7 | 10 | 15 | 10 | 5  | - | 3   | 1 | 5 | - | 2 | 2 | -                              |
| 27 | 20 | 10 | 10 | - | - | - | - | 10 | 15 | 10 | 10 | - | 3   | 1 | 5 | - | 3 | 2 | -                              |
| 28 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 29 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 1 | 2 | Cardamom, garlic & ginger (1)  |
| 30 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 1 |                                |
| 31 | 20 | 10 | 10 | - | 5 | 5 | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 32 | 25 | 10 | 10 | - | - | 5 | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 1 | Chilly powder(1)               |
| 33 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 34 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 35 | 25 | 10 | 10 | - | 4 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 2 | -                              |
| 36 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 2 | 4 | -                              |
| 37 | 25 | 10 | 10 | - | 5 | - | - | 10 | 10 | 10 | 5  | 5 | 2   | 1 | 3 | - | 3 | 3 | -                              |
| 38 | 20 | 5  | 5  | - | 5 | - | - | 10 | 20 | 10 | 5  | 5 | 2.5 | 1 | 5 | 5 | - | - | Ginger (1.5)                   |
| 39 | 25 | 5  | 5  | - | 5 | - | - | 10 | 20 | 10 | 5  | 5 | 2.5 | 1 | 5 | 5 | - | - | Coriander & curry leaves (1.5) |
| 40 | 20 | 5  | 5  | - | 4 | - | - | 10 | 20 | 10 | 5  | 5 | 3   | 1 | 5 | 5 | - | - | Cardamom (2)                   |
| 41 | 20 | 5  | 5  | - | 5 | - | - | 10 | 20 | 10 | 5  | 5 | 3   | 1 | 5 | 5 | - | - | Mint (1)                       |
| 42 | 20 | 5  | 5  | - | 5 | - | - | 10 | 20 | 10 | 5  | 5 | 3   | 1 | 5 | 5 | - | - | Nutmeg (1)                     |

It was noticed that the scores of colour of the functional snack ranged between 6.46 to 8.38 (Table 2). The lowest score for colour was given to variation 1. Variation 40 got highest score i.e. 8.73.

The mean sensory score of flavour ranged between 6.40 to 8.78. The sensory scores of all variations were above 6. There was significant difference in the mean scores of flavour of different variations. The highest score of 8.80 was obtained by variation 40.

The mean sensory score given by the panel members to taste was more than 6 for all the variations. The lowest score (6.40) was obtained by variation 3 and a highest score of 7.95 was obtained by variation 40. There was significant difference in mean scores of taste of various trials.

A highest score of 8.61 was allotted to the texture of functional snack prepared by using the ingredient composition of variation number 40. A minimum score of 6.33 was given to the texture of variation number 4. There was significant difference in texture of all the variations.

The similar trend of results was noticed with regard to over all acceptability mean scores secured by different variations. Variation 40 obtained a score of 8.97 which was highest amongst all the variations. A minimum score of 6.35 was given to the functional snack prepared by ingredients of variation number 7.

The findings indicated that for all the studied sensory parameters, variation 40 proved to be better than all other variations.

Colour is one of the most important sensory attribute that affect directly the consumer preference of the product. The product will obtain colour based on the colour of the ingredients used for preparation of the product. In the present investigation the sensory evaluation for colour of different variations indicated that the inclusion of more amount of flax seed and niger seed resulted in the darker shade of the functional snack. This may be due to the original dark colour of both the grains.

The snack prepared with 15 per cent inclusion of flax and niger seed imparted darker colour to the product. As there was reduction in the amount of flax seed and niger seed, the darkness of the product was reduced and it was looking lighter. Apart from this the other ingredients used for preparation of functional snack such as wheat flour and skim milk powder helped in reducing the intensity of darkness. Therefore, subsequent significant increase in the scores for colour can be noticed. However, it could reach to the score 8 (liked very much) after reducing the amount of flaxseed and niger seed up to 5 per cent each. These observations concluded that 5 per cent flax seed and 5 per cent niger seed may be considered good for production of very well accepted colour of the functional snack. Bhise *et al.*, (2013) also noticed that the chapattis prepared with incorporation of flax seed showed that there was decrease in the lightness and increase in the darkness. Further, it is mentioned that the per cent increase of flaxseed resulted in increasing the darkness and decreasing the lightness of chapattis. Similar results were reported for cereal bar prepared using roasted rice bran. Garcia *et al.*, (2013) reported that cereal bar darkened with increase in the content of roasted rice bran in the formulation which was of brown in colour.

The flavour of any food product is an important sensory parameter to make the food more palatable. Therefore, an attempt was made to improve the scores given for the component flavour. Most of the ingredients used for development of functional snack had mild flavour except flaxseed. Flaxseed has peculiar strong flavour. In the first 13 variations the proportion of flaxseed was more (15%) than compared to the remaining variations. In addition the higher content of alpha linolenic acid may result in to lipid oxidation during heat and baking which may exert little unpleasant aroma. This might be the reason that the judges did not like flavour much and gave scores less than seven. The inclusion of spices such as cumin seed, omum, cinnamon, cardamom, ginger and garlic also could not mask the strong flavour. The reduction in the proportion of flaxseed resulted in the improvement of scores for flavour. Apart from this various flavourings such as cumin seed, omum

powder, cloves, cinnamon, cardamom, black pepper, garlic, ginger, fenugreek seeds, coriander leaves, curry leaves, mint and nutmeg were used to increase the acceptability and palatability of developed functional snack. It is evident from the data that cardamom proved to be promising flavouring option among all as it scored highest for flavour and taste component. Alliani *et al.*, (2011) noticed that addition of high amounts of flaxseed in muffins and snack bars affected the aroma component adversely while, use of orange, cranberry, ginger and clove flavouring resulted in masking the flavour of flaxseed.

Texture of the food depends on many factors. These include the processing of ingredients and the method of cooking used. In the present experiment the expected texture of the final product was crispy. The method of cooking selected for development of functional snack was baking as the baked products will be crispy, tasty and are widely consumed by all age groups. Moreover, the baked products are suitable for clinical trials, can be transported easily and are digested well. Apart from baking, oilseeds, fat and baking powder are known for increasing the crispiness of the products. In the beginning the product was prepared with addition of little less baking powder and more amount of flaxseed and niger seed. But they could not achieve samples good sensory scores. Hence, the amount of baking powder was increased from 2.5 and 3 g and flaxseed & niger seed was reduced to get crispy texture and to achieve the score more than 8. The use of flaxseed, niger seed and baking powder helped to improve the texture of developed snack. Mridula *et al.*, (2011) developed omega 3 rich energy bars by using flaxseed. It was observed that mean sensory scores of texture were reduced with increased amount of flaxseed (>15%). Kalbande (2009) mentioned that incorporation of niger seed in cookies up to 10 per cent level did not affect the texture of cookies adversely but above 10 per cent level of incorporation resulted in lowering the sensory scores. Hussain (2006) noticed that the cookies containing higher amount of flaxseed flour significantly reduced sensory score for texture.

It is observed that the sensory scores given by panellist to the taste were improved with reduction in flax seed and niger seed and due to changes in flavouring ingredients. This may due to the nutty flavour and peculiar taste of the flaxseed. In the beginning the cumin seed and omum powder were used to improve the taste. Even other flavouring spices used solely or in combination such as cloves, cinnamon, black pepper, ginger, garlic etc. could not elevate the taste appeal of the sample. During the earlier variations flaxseed and niger seed were roasted and powdered. Incorporation of roasted flaxseed in functional snack resulted in developing bitterness in the sample which was not liked by judges. It may be due to double heat treatment of the flaxseed and niger seed. Once while processing and secondly while baking. Therefore, after variation 5 these ingredients were used in raw state. Further, the reduction in the level of incorporation of flaxseed, niger seed, roasted bengal gram and green gram dhal flours and inclusion of little amount of sugar (5%) helped to obtain better taste. Further apart from this the use of only cardamom resulted in developing good taste appeal and hence the variation 40 in which 5 per cent flaxseed and niger seed each along with other cereals, functional ingredients and cardamom flavour could get significantly higher scores for taste. Rathi and Mogra (2013) also noticed that the increase in the proportion of flaxseed flavour in biscuits resulted in reduction of sensory scores of taste from 8.2 to 6.4 when it was increased from 20 per cent to 30 per cent.

It is noticed that the sensory scores allotted for overall acceptability by the panel members exhibited the similar trend as they were obtained by the remaining organoleptic parameters. In first few variations the mean scores for overall acceptability was less but the changes in ingredient composition was useful in raising the scores. The mean scores was less (below 6.45) for the variations having 15 per cent flax and 15 per cent niger seed. The variation (40) with reduction in the amount of flax and niger seed received better scores. Hussain *et al.*, (2006) reported significant reduction in overall acceptability scores of cookies when level of flaxseed incorporation was increased. Even the chapattis made from 10 per cent texturized defatted sunflower, soybean and

flaxseed were given maximum overall acceptability scores as compared to higher levels of incorporation. The critical scrutiny of data concludes that to prepare a functional snack worth of achieving score more than 8 liked very much for most of the sensory attributes the ingredients composition of variation number 40 was better than other variations. Hence it was selected for further study and named as *Heartdiabocare Snack*.

**Table 2. Mean sensory Scores of various trials of functional snack**

| <b>Variation</b> | <b>Colour</b> | <b>Flavour</b> | <b>Taste</b>  | <b>Texture</b> | <b>Overall acceptability</b> |
|------------------|---------------|----------------|---------------|----------------|------------------------------|
| 1                | 6.46          | 6.46           | 6.40          | 6.73           | 6.60                         |
| 2                | 6.60          | 6.53           | 6.41          | 6.53           | 6.53                         |
| 3                | 6.46          | 6.40           | 6.41          | 6.73           | 6.60                         |
| 4                | 6.53          | 6.46           | 6.53          | 6.71           | 6.40                         |
| 5                | 6.51          | 6.53           | 6.43          | 6.66           | 6.66                         |
| 6                | 6.50          | 6.56           | 6.33          | 6.63           | 6.63                         |
| 7                | 6.48          | 6.48           | 6.40          | 6.35           | 6.35                         |
| 8                | 6.60          | 6.66           | 6.43          | 6.73           | 6.40                         |
| 9                | 6.56          | 6.63           | 6.46          | 6.50           | 6.50                         |
| 10               | 6.66          | 6.80           | 6.40          | 6.80           | 6.53                         |
| 11               | 6.66          | 6.60           | 6.33          | 6.73           | 6.60                         |
| 12               | 6.53          | 6.66           | 6.66          | 6.40           | 6.40                         |
| 13               | 6.60          | 6.61           | 6.73          | 6.66           | 6.66                         |
| 14               | 6.73          | 6.81           | 6.53          | 6.33           | 6.60                         |
| 15               | 6.73          | 6.86           | 6.63          | 6.53           | 6.80                         |
| 16               | 6.73          | 7.03           | 6.86          | 6.56           | 6.86                         |
| 17               | 7.20          | 7.0            | 6.66          | 7.53           | 6.93                         |
| 18               | 7.13          | 7.06           | 6.70          | 7.66           | 7.06                         |
| 19               | 7.03          | 6.96           | 6.80          | 7.83           | 6.96                         |
| 20               | 7.0           | 7.03           | 7.06          | 7.93           | 7.93                         |
| 21               | 6.86          | 7.02           | 6.80          | 8.01           | 7.86                         |
| 22               | 6.86          | 7.07           | 7.13          | 7.53           | 7.93                         |
| 23               | 7.06          | 7.0            | 6.93          | 8.20           | 7.53                         |
| 24               | 6.80          | 6.93           | 7.33          | 8.06           | 8.06                         |
| 25               | 7.0           | 7.06           | 7.3           | 8.13           | 8.05                         |
| 26               | 6.93          | 7.0            | 7.53          | 7.93           | 8.13                         |
| 27               | 7.0           | 7.04           | 7.40          | 8.0            | 7.93                         |
| 28               | 7.01          | 6.93           | 7.41          | 8.20           | 7.92                         |
| 29               | 6.86          | 6.90           | 7.66          | 8.0            | 7.73                         |
| 30               | 7.0           | 7.08           | 7.26          | 8.26           | 8.0                          |
| 31               | 6.80          | 6.93           | 7.40          | 8.0            | 8.03                         |
| 32               | 6.86          | 7.06           | 7.33          | 8.0            | 8.06                         |
| 33               | 6.93          | 7.20           | 7.46          | 8.06           | 8.13                         |
| 34               | 7.0           | 7.13           | 7.53          | 8.01           | 8.93                         |
| 35               | 7.20          | 7.06           | 7.46          | 8.01           | 8.00                         |
| 36               | 7.93          | 7.0            | 7.46          | 8.03           | 8.03                         |
| 37               | 7.2           | 7.01           | 7.73          | 8.05           | 7.38                         |
| 38               | 8.0           | 8.0            | 7.06          | 8.06           | 8.06                         |
| 39               | 8.06          | 8.06           | 7.86          | 8.0            | 8.13                         |
| <b>40</b>        | <b>8.38</b>   | <b>8.78</b>    | <b>7.95</b>   | <b>8.61</b>    | <b>8.97</b>                  |
| 41               | 8.06          | 8.06           | 7.26          | 8.0            | 8.0                          |
| 42               | 8.0           | 8.20           | 7.6           | 8.06           | 8.03                         |
| <b>Mean</b>      | <b>6.99</b>   | <b>7.01</b>    | <b>6.97</b>   | <b>8.03</b>    | <b>7.38</b>                  |
| <b>F value</b>   | <b>7.56**</b> | <b>7.45**</b>  | <b>7.94**</b> | <b>1.62**</b>  | <b>1.77**</b>                |
| <b>SE ±</b>      | <b>1.81</b>   | <b>1.83</b>    | <b>1.72</b>   | <b>1.78</b>    | <b>1.71</b>                  |
| <b>CD @5%</b>    | <b>5.01</b>   | <b>5.06</b>    | <b>4.77</b>   | <b>4.93</b>    | <b>4.73</b>                  |

\* Significant at 5 percent level      \*\* Significant at 1 percent level

## 4.2 Consumer Acceptability of Developed *Heartdiabocare Snack*

Consumer acceptability testing is important in view of marketing the product. It is usually performed at the end of product development. It is tested by conducting organoleptic evaluation. Nine point Hedonic Scale was used to record the response of consumers towards *Heartdiabocare Snack* (Table 3). It is evident from data that the developed snack was liked very much by majority of the selected consumers. All (100 per cent) adults, diabetics, hyperlipidemic individuals and the bakery shop customers liked the *Heartdiabocare Snack* very much. When the snack was given to school children and adolescents respectively 90 and 83.33 per cent of them liked it very much while 10 per cent and 16.67 per cent of them liked the developed functional snack moderately.

The scores received by the developed functional snack from various groups of consumers were between 7 and 9 indicating that the product was liked moderately to liked very much. None of the consumer gave less than 7 score to the product. Hence, it can be said that the developed *Heartdiabocare Snack* has very good consumer acceptability and is fit for marketing.

**Table 3. Consumer acceptance of developed *Heartdiabocare Snack* (n=165)**

| S. No. | Consumers                  | N  | Liked Very much<br>(Score > 8to < 9) |       | Liked Moderately<br>(Score >7to <8) |       |
|--------|----------------------------|----|--------------------------------------|-------|-------------------------------------|-------|
| 1      | School children            | 20 | 18                                   | 90    | 2                                   | 10    |
| 2      | Adolescents                | 30 | 25                                   | 83.33 | 5                                   | 16.66 |
| 3      | Adults                     | 30 | 30                                   | 100   | -                                   | -     |
| 4      | Diabetic Individuals       | 30 | 30                                   | 100   | -                                   | -     |
| 5      | Hyperlipidemic Individuals | 30 | 30                                   | 100   | -                                   | -     |
| 6      | Bakery Shop customers      | 25 | 30                                   | 100   | -                                   | -     |

### 4.3 Functional Properties of Composite Flour

The selected ingredients were processed as mentioned in the chapter Materials and methods (3.1). The ingredients of variation 40 such as wheat flour, flax seed flour, niger seed flour, wheat bran, skimmed milk powder, gum acacia powder, soya chunk powder, oat flakes flour, jowar flour, baking powder, salt, fat, sugar and cardamom powder were mixed homogeneously and this composite flour was used for preparation of functional snack.

The functional properties of the composite flour were assessed and are presented in Table 4. It is evidence from the data that the water absorption capacity and oil absorption capacity were recorded as 2.26 and 1.98 ml/g respectively and least gelation concentration was 4 percent.

Functional properties are the fundamental physico-chemical properties that reflect the complex interaction between the composition, structure, molecular conformation and physico-chemical properties of food components together with the nature of environment in which these are associated and measured. Functional characteristics are required to evaluate and possibly help to predict how new proteins, fat, fibre and carbohydrates may behave in specific systems.

The functional properties studied in this investigation viz. water and oil absorption capacity and least gelation concentration are important in deciding the organoleptic and especially the texture and mouth feel of developed food product. WAC is important functional characteristic in the development of food products. High water capacity ensures the cohesiveness of the product. The water absorption capacity 2.26 ml/g was in line with the WAC (2.3 – 2.4g /g) of multigrain composite mixes developed by Banu *et al.*, (2010).

The functional properties of flour play an important role in the manufacturing of the products. Water absorption capacity or characteristic represents the ability of product to associate with water under conditions where water is limited (Singh, 2011).

The oil absorption capacity of food product is important as it gives pleasant mouth feel, appealing flavour, texture and palatability to the product. Oil absorption is mainly attributed to physical entrapment of oil. It depends on the ability of the protein in the flour to bind oil which makes it useful for development of desired texture. The oil absorption capacity of developed composite flour (1.98 g/g) was observed to be more than potato flour (168 g/g), green gram flour (160 g/g) wheat flour (146 g/g) and rice bran (124 g/g) which were studied by Chandra and Samsheer (2013). It may be due to the reason that the developed composite flour is a mixture of various ingredients while they studied flours isolately.

The gelation is dependent on the protein aggregation phenomenon which makes the product capable of trapping large amounts of water. The observed LGC (4%) is at par with the LGC percentage observed by Murugkar *et al.*, (2013) in the developed multivitamin mixes. They had recorded the LGC values of 4 - 6 per cent for various base mixes. However, Baljit *et al.*, (2010) reported higher LGC (32 %) for buckwheat flour and refined wheat flour (20 %). Hence, it can be said that the LGC was less for the composite flours while it is more for the individual flours of various grains.

**Table 4. Functional properties of composite flour used for preparation of *Heartdiabocare Snack***

| Parameters                   | Amount     |
|------------------------------|------------|
| Water absorption capacity    | 2.26 (g/g) |
| Oil absorption capacity      | 1.98 (g/g) |
| Least gelation concentration | 4 (%)      |

#### **4.4 Physical Properties of Developed *Heartdiabocare* Snack**

Physical properties describe the unique, characteristic way of food material response to physical treatments involving mechanical, thermal and electrical processes. Physical properties are an important aspect of food quality and relate to food safety. The physical parameters which were studied are baking temperature, baking time, weight of baked snack, weight of each piece, length, width, thickness, volume, bulk density, hardness and colour index value. The baking temperature which was maintained while preparing functional snack at 150° C and the baking time was about 20 minutes. Number of pieces (functional bar) obtained for 100g were seven. The weight of each piece was observed as 15g in electronic weighing balance. The length and width of the snack was 11cm and 3 cm respectively. The thickness of the sample was 0.6 cm. Volume of the snack was measured as 30 ml using measuring cylinder. Bulk density was calculated as 1.23 g/ml and the hardness (texture) of the snack was 3.08 N. The colour of functional snack was recorded as values of L, a, b as 48.28, 6.94 and 22.85 respectively (Table 5).

A physical property is any property that is measurable whose value describes a state of a physical system. While preparing snack it was baked well at 150° C where as it was baked for 20 min. Mishra and Chandra (2012) prepared functional biscuits from soy flour and rice bran. In their study the baking time was 10 min and the temperature was 180 ° C. The width of biscuits ranged between 36.2 to 44 mm and the thickness ranged from 9.2 to 10.6 mm. The values of present study for width and thickness were 3 cm and 6 mm respectively. The differences in the values may be because of different moulds used in both studies.

Bulk density is a measure of heaviness of the product and is generally affected by the particle size and density of the flour. It is important in determining the packaging requirement and material handling of the product. The value of 1.23 g/ml of bulk density of developed functional snack indicated that the packing material required to pack the developed snack should possess good tensile strength.

Hardness or texture profile plays an important role in acceptability of the product. It measures the hardness (firmness) and fracturability of the product. Texture profile plays an important role in justifying the overall acceptability of functional snack. The fracture strength of the developed functional snack (3080 g) was less than the fracture strength of biscuits developed by incorporating buckwheat flour (3144.1 g) by Baljit *et al.*, (2010). This may be attributed to the less use of wheat flour (20 %) for development of functional snack in the present study against 60 per cent in the study of Baljit *et al.*, (2010). This may be due to the reason that the gluten from wheat flour helped in increasing hardness.

The bulk density of the cereal bars developed by Garcia *et al.*, (2013) was less (0.75 - 0.76 g/ml) than the values of present study.

Visual quality encompasses the appearance of the product. Colour is a perceptual phenomenon that depends on the observer and the conditions in which the colour is observed. It is a characteristic of light, which is measurable in terms of intensity and wavelength. The colour of a material becomes visible only when light from a luminous object or source illuminates or strikes the surface (Pathare *et al.*, 2013). Hence the colour measurement is very essential. The L value i.e. lightness of the product under study was 48.28. The lightness of the developed cereal bars ranged from 31.20 to 37.10 while it was between 40.70 and 42.20 for commercial bars (Garcia *et al.*, 2013). The findings of the present study are in agreement with the findings of a study conducted by Salwa *et al.*, (2014) where they had observed the L values of wheat and oat flour composite snacks between 40.4 and 54.90.

**Table 5. Physical properties of *Heartdiabocare Snack***

| Parameters            | Observations |
|-----------------------|--------------|
| Baking temperature    | 150° C       |
| Baking time           | 20 min.      |
| No. of pieces         | 7            |
| Weight of baked snack | 105g         |
| Weight of each piece  | 15 g         |
| Length                | 11 cm        |
| Width                 | 3 cm         |
| Thickness             | 0.6 cm       |
| Volume                | 30 ml        |
| Bulk density          | 1.23 (g /ml) |
| Hardness (Texture)    | 3080 g       |
| Colour (Index values) |              |
| L                     | 48.28        |
| a                     | 6.94         |
| b                     | 22.85        |

#### **4.5 Nutritional Evaluation of *Heartdiabocare Snack***

The nutritional value is one of the major quality parameters of food product. Hence, the proximate composition and important micronutrients need to be analysed to know the nutritional quality of food product. It enhances the degree of acceptability of that product to the consumer. Therefore the proximate composition which included moisture, total minerals, protein, fat and dietary fiber were analyzed from developed *Heartdiabocare Snack*. Apart from these, minerals such as calcium, iron, zinc, copper and manganese were also estimated. The energy value, carbohydrates, thiamine, riboflavin and niacin

were calculated based on the raw ingredients used for the development of functional snack.

Nutritional evaluation of functional snack is presented in Table 6. Results evidenced that moisture, protein and fat content of functional snack were 2.33 per cent, 17.11 per cent and 12.08 per cent respectively. Dietary fiber content of functional snack was 22.28 per cent. The soluble and insoluble dietary fibre were 3.86 and 18.42 percent respectively. The estimated micronutrients were calcium 296.56 mg, iron 7.5 mg, zinc 1.48 mg, copper 0.397 mg and manganese 1.65 mg per 100 g. In vitro protein digestibility of developed functional snack was 82 per cent.

The data with regard to calculated nutrient content indicated that the developed functional snack had 43.97 per cent carbohydrates, can supply 349 Kcal energy per 100g while the values of thiamine, riboflavin and niacin were 0.225, 1.031 and 1.85 mg/100g of snack. It can be observed from the data with regard to nutrient content of developed functional snack that it is very rich in energy, total dietary fiber, soluble fiber, protein, calcium and iron.

Use of ingredients such as wheat bran, gum acacia, oats and cereals resulted in making the snack rich in dietary fiber. The developed *Heartdiabocare Snack* contained 22.08 per cent dietary fiber. This is one of the important characteristic of the product which makes it functional. The importance of food fibers had resulted in large and potential market for fiber rich products. A high amount of soluble fiber (18.42 %) in the developed snack increases its functionality in terms of suitability for diabetic and hyperlipidemic persons because it improves the glucose tolerance in diabetics and reduces serum cholesterol.

Data regarding mineral content of the developed snack indicated that it is rich in calcium (298 mg/100g), iron (7.5 mg/100g) and zinc (1.48 mg/100g). The carbohydrate content of the snack is low (43.97 %). Hence it is advantageous for both diabetics and for hyperlipidemic subjects. The vitamins and minerals present in the snack makes it more valuable in terms of nutritional quality. Baljit *et al.*, (2010) reported moisture content 2.43 to 3.37 per cent in

biscuits developed with incorporation of 40 per cent buckwheat flour which is in line with the present investigation however, they recorded less protein content (5.60 to 7.20), and more amount of fat (21.27 to 23.17 %) and carbohydrates (65.51 to 66.32 %) than the developed *Heartdiabocare Snack*. In contrast to these studies, the study conducted by Byrappa *et al.*, (2015) on moisture sorption curves of fruit and nut cereal bar recorded higher moisture content of bars which was 7.7 to 8.7 per cent. While protein content was less (11 to 12 %). Calcium (324 to 340 mg/100) and iron (6.6 to 7.1 mg /100) contents were at par. The protein digestibility of the snacks under study was 82 per cent. Rawat and Darappa (2015) also noticed the protein digestibility between  $79.0 \pm 0.11$  and  $90.5 \pm 0.12$  per cent of the baked energy bars.

The nutrient content of the developed *Heartdiabocare Snack* makes it suitable for feeding it to diabetic and hyperlipidemic individuals. Therefore, protein content of the snack plays very important role in supplying calories to these individuals. The developed snacks being rich in protein suffice this purpose. The inclusion of skim milk powder and soya chunk powder might have helped in making the product protein rich.

**Table 6. Nutrient content of *Heartdiabocare Snack*/ 100 g**

| Estimated nutrients       |        | Calculated nutrients |        |
|---------------------------|--------|----------------------|--------|
| Nutrients                 | Amount | Nutrients            | Amount |
| Moisture (g)              | 2.33   | Carbohydrate (g)     | 43.97  |
| Protein (g)               | 17.11  | Energy (Kcal)        | 349    |
| Fat (g)                   | 12.08  | Thiamin (mg)         | 0.225  |
| Total dietary fibre (g)   | 22.28  | Riboflavin (mg)      | 1.031  |
| Insoluble fibre (g)       | 3.86   | Niacin (mg)          | 1.85   |
| Soluble fibre (g)         | 18.42  |                      |        |
| Calcium (mg)              | 298    |                      |        |
| Iron (mg)                 | 7.5    |                      |        |
| Zinc (mg)                 | 1.48   |                      |        |
| Copper (mg)               | 0.397  |                      |        |
| Manganese (mg)            | 1.657  |                      |        |
| Protein digestibility (%) | 82     |                      |        |

#### 4.5.1 Fatty Acid Profile of *Heartdibocare Snack*

To understand the quality and composition of fat, in the developed *Heartdiabocare Snack* identification and quantification of fatty acids is essential. Hence, the total fatty acid profile of developed functional snack was estimated (Table 7 and Fig. 2).

The unsaturated fat was more (68.88%) than saturated fat (31%). The polyunsaturated and monounsaturated fatty acid content revealed that PUFA were 61.78 per cent and MUFA were 38.22 per cent. Further the components of PUFA i.e. omega 6 fatty acids and omega 3 fatty acids were recorded as 19.07 and 36.77 per cent of PUFA respectively. Very less amount of trans fats (0.66%) were present in the developed product. The use of defatted milk powder might have helped in reducing the saturated fat while higher percent of omega 3 fatty acid may be due to the incorporation of flax seed.

The fatty acid profile of any edible oils is very important from nutrition point of view. The physical and chemical characteristics of fats are influenced greatly by the type and proportion of fatty acids i.e. saturated and unsaturated fatty acids. Saturated fat can harm the health of heart and hence is considered as unhealthy fat. On the other hand unsaturated fats comprised of mono and polyunsaturated fatty acids are considered as healthy fats ([www.healthyeating.sfgate.com](http://www.healthyeating.sfgate.com)).

Unsaturated fatty acids are essential fatty acids which need to be provided necessarily through diet. The developed *Heartdiabocare Snack* is a good source of PUFA. It exhibited higher percent of PUFA as compared to MUFA. This may be due to the inclusion of flax and niger seeds in the preparation of *Heartdiabocare Snack* which are rich in PUFA (ICMR, 2010; Bhatnagar and Gopalkrishna, 2015). Polyunsaturated fatty acids support the cardiovascular, reproductive, immune and nervous systems. They manufacture and repair cell membranes enable cells to obtain optimum nutrition and expel harmful waste products (Johnson & Saikia, 2009). Mridula et al. (2013) reported 44-58 per cent of omega 3 fatty acid content in flaxseed. Therefore,

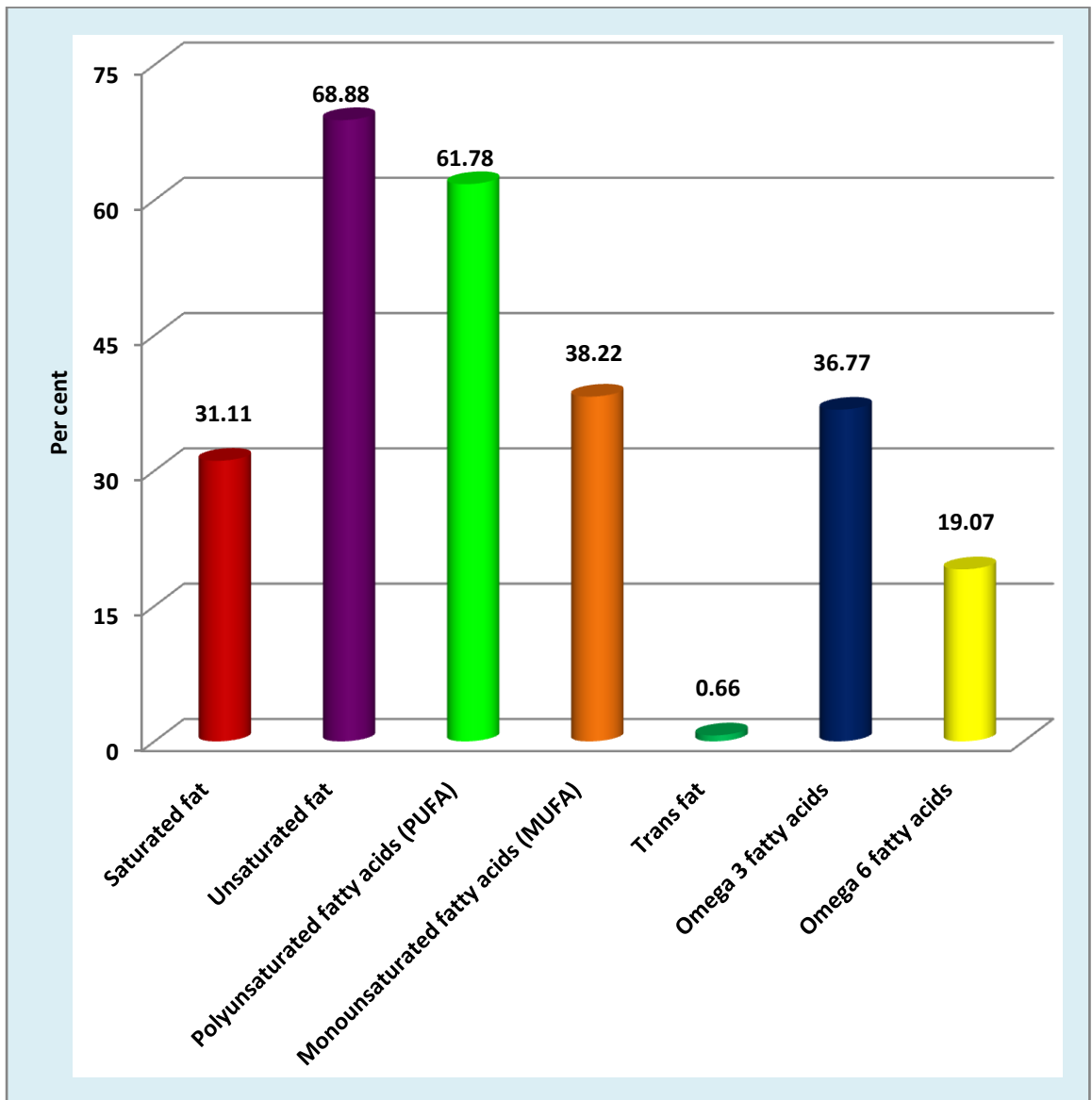


**Fig. 2 Fatty Acid Profile of developed Heartdiabocare Snack**

the developed *Heartdiabocare Snack* will be helpful for maintaining healthy heart.

**Table 7. Fatty acid profile of *Heartdiabocare Snack*/100g**

| Nutrients                          | Amount (g) | Percentage |
|------------------------------------|------------|------------|
| Saturated fat                      | 3.75       | 31.11      |
| Unsaturated fat                    | 8.32       | 68.88      |
| Polyunsaturated fatty acids (PUFA) | 5.14       | 61.78      |
| Monounsaturated fatty acids (MUFA) | 3.17       | 38.22      |
| Trans fat                          | 0.08       | 0.66       |
| Omega 3 fatty acids                | 1.89       | 36.77      |
| Omega 6 fatty acids                | 0.98       | 19.07      |

#### **4.6 Shelf Life Study of Developed *Heartdiabocare Snack***

Storage life is the length of time that a product can be stored before the appearance of the first characteristics that consumers find unacceptable (Loveday *et al.*, 2010). Chemical and physical interactions among the ingredients can occur over time during storage and begin to affect the quality of the product. Hence, shelf life evaluation is essential to note such quality changes in the product during storage.

The effect of storage on sensory parameters was assessed (Table 8 and Fig. 3). It was noticed that on first day of storage mean scores for all sensory parameters were same for all samples stored in the two packaging materials low density polyethylene pouch (LDPE) and laminated aluminium pouch.

The scores were found to be decreased at the end of the storage period from 8.38 to 6.76, from 8.61 to 6.83, from 7.95 to 7.3, from 8.78 to 6.92 and from 8.97 to 6.76 for colour, texture, taste, flavor and overall acceptability respectively for the samples stored in low density polyethylene pouches. The similar trend of decrease was noticed in the snack stored in laminated aluminium pouch where the decrease in the scores of colour, texture, taste, flavor and overall acceptability was noticed from 8.38 to 7.23, from 8.61 to

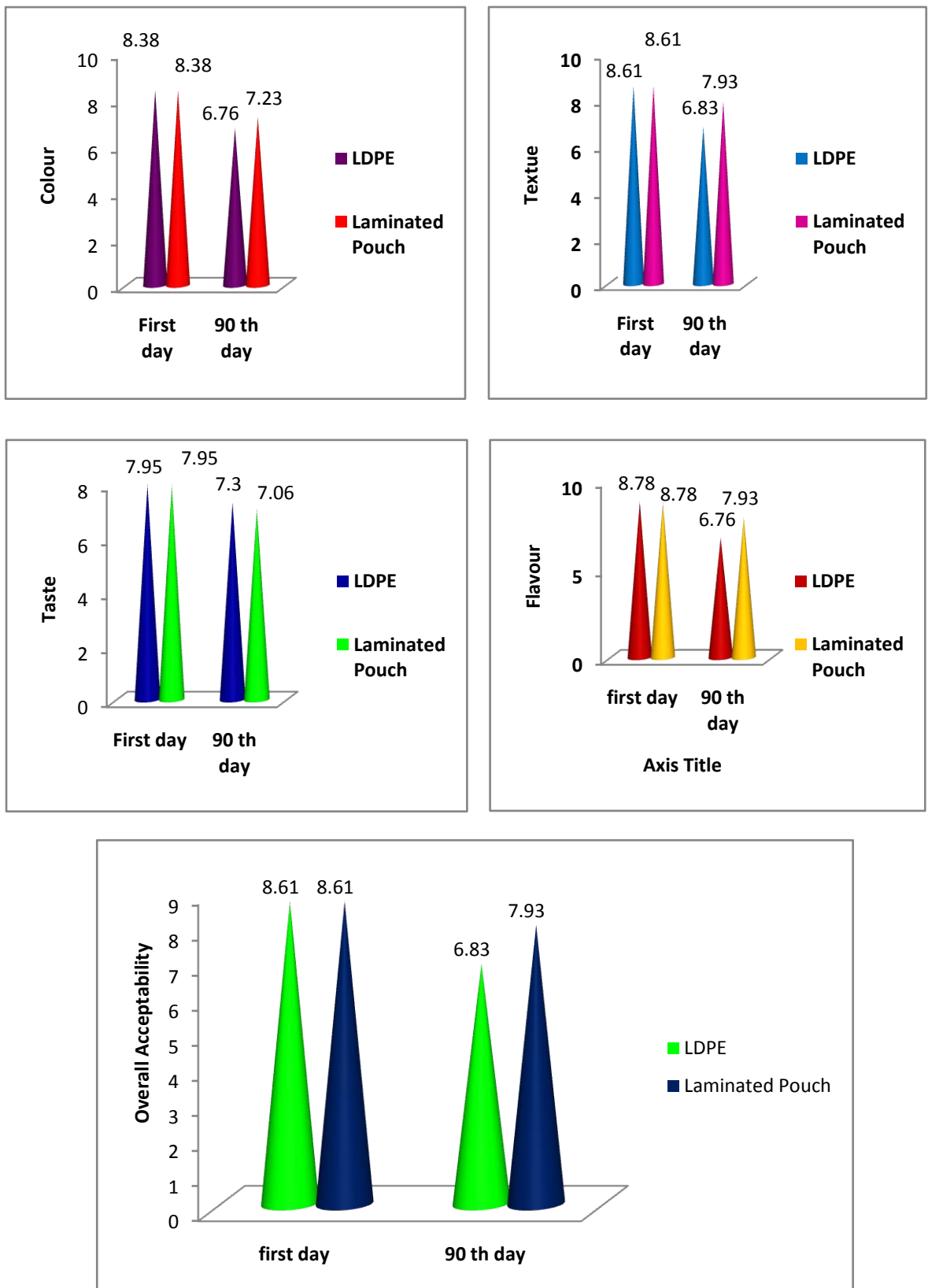


**Fig. 3 Effect of storage and packaging material on sensory parameters of developed functional snack**

7.93, from 7.95 to 7.86, from 8.78 to 8.23 and from 8.97 to 7.93 respectively on 90<sup>th</sup> day of storage.

#### **4.6.1. Effect of Storage on Acceptability of *Heartdiabocare Snack***

The effect of storage period on sensory parameters of *Heartdiabocare Snack* showed that all organoleptic parameters were statistically at par after a period of 90 days storage. Similar observation was recorded by Sharma *et al.*, (2013) for wild apricot bar.

To assess the effect of packaging material on developed *Heartdiabocare Snack* the scores obtained by various sensory attributes for the samples from both type of storage materials on the last day of storage duration were statistically compared. It is evidenced from the data that there was significant difference ( $p < 0.05$ ) in the sensory scores of all parameters. The snack stored in laminated aluminium pouch scored significantly more than the snack stored in LDPE pouch. Such comparison proved that laminated aluminium pouch is the better packaging material than LDPE. This may be because the less permeability of laminated aluminium pouch for moisture and oxygen. Similar evidences have also been reported by Sandhu *et al.*, (2008) for papaya leather and Aanthan *et al.*, (2013) for flax oat nutty bar.

**Table 8. Effect of storage and packaging material on sensory parameters of *Heartdiabocare* snack**

| Parameters                   | LDPE<br>(P1)           |                                   | 't'<br>value       | Laminated aluminium<br>pouch (P2) |                                   | 't' value          | 't' value<br>90 <sup>th</sup> day<br>P1 Vs P2 |
|------------------------------|------------------------|-----------------------------------|--------------------|-----------------------------------|-----------------------------------|--------------------|-----------------------------------------------|
|                              | First day<br>(Mean±SD) | 90 <sup>th</sup> day<br>(Mean±SD) |                    | First day<br>(Mean±SD)            | 90 <sup>th</sup> day<br>(Mean±SD) |                    |                                               |
| <b>Colour</b>                | 8.38±0.04              | 6.76±0.25                         | 0.27 <sup>NS</sup> | 8.38±0.04                         | 7.23±0.25                         | 0.19 <sup>NS</sup> | 5.14**                                        |
| <b>Texture</b>               | 8.61±0.03              | 6.83±0.28                         | 0.30 <sup>NS</sup> | 8.61±0.03                         | 7.93±0.11                         | 0.10 <sup>NS</sup> | 14.16**                                       |
| <b>Taste</b>                 | 7.95±0.20              | 7.3±0.26                          | 0.11 <sup>NS</sup> | 7.95±0.20                         | 7.06±0.11                         | 0.12 <sup>NS</sup> | 3.36**                                        |
| <b>Flavour</b>               | 8.78±0.09              | 6.92±0.06                         | 0.30 <sup>NS</sup> | 8.78±0.09                         | 8.23±0.25                         | 0.08 <sup>NS</sup> | 19.29**                                       |
| <b>Overall acceptability</b> | 8.97±0.08              | 6.76±0.25                         | 0.36 <sup>NS</sup> | 8.97±0.08                         | 7.93±0.11                         | 0.16 <sup>NS</sup> | 16.59**                                       |

\*\* significant at 1 per cent    NS- Non significant

#### 4.6.2 Effect of Storage on Biochemical Parameters of *Heartdiabocare Snack*

Food packaging plays a vital role in determining the biochemical changes of foods as they act as a barrier for oxygen and loss or gain of moisture in foods. Selection of a proper packaging material is most essential to ensure maximum product quality during storage to prevent oxidation of lipids (Seacheol and Zhang, 2005). Therefore, to select the suitable packaging material for packing developed snack biochemical changes taken place in the product during the storage were studied (Table 9 and Fig. 4). The data revealed that moisture content of *Heartdiabocare Snack* had an initial value of 2.33 per cent which was increased gradually up to 3.65 per cent for LDPE packed snack and 3.33 per cent for laminated aluminium pouch at the end of the storage period. Results indicated that the non significant increase was observed in moisture content of the *Heartdiabocare Snack* during storage in both the packaging materials after 3 months storage.

The effect of packaging material on peroxide value indicated that there was non significant difference in peroxide value of developed *Heartdiabocare Snack* which was stored in both LDPE and laminated aluminium pouch. The peroxide value of the product at the end of the storage period found to be increased from initial 0.01 meq/kg to 0.04 meq/kg in LDPE and to 0.03 meq/kg in laminated aluminium pouch samples. The statistical analysis revealed that there was non significant difference in peroxide value during storage of *Heartdiabocare Snack* in both the packaging materials ( $p \leq 0.05$ ).

Initial and final free fatty acid content was estimated for the functional *Heartdiabocare Snack* stored in LDPE and laminated aluminium pouch. The initial value 0.9 per cent of free fatty acid was increased up to 1.06 per cent in LDPE and 1.10 laminated aluminium pouch. Though there was slight increase in values, the statistical difference was not significant.

Similar observations were recorded by Ananthan *et al.*, (2012) for protein rich cereal bar during 9 months of storage in polypropylene, paper-aluminium foil polyethylene, metalized polyester films. It was noticed that free

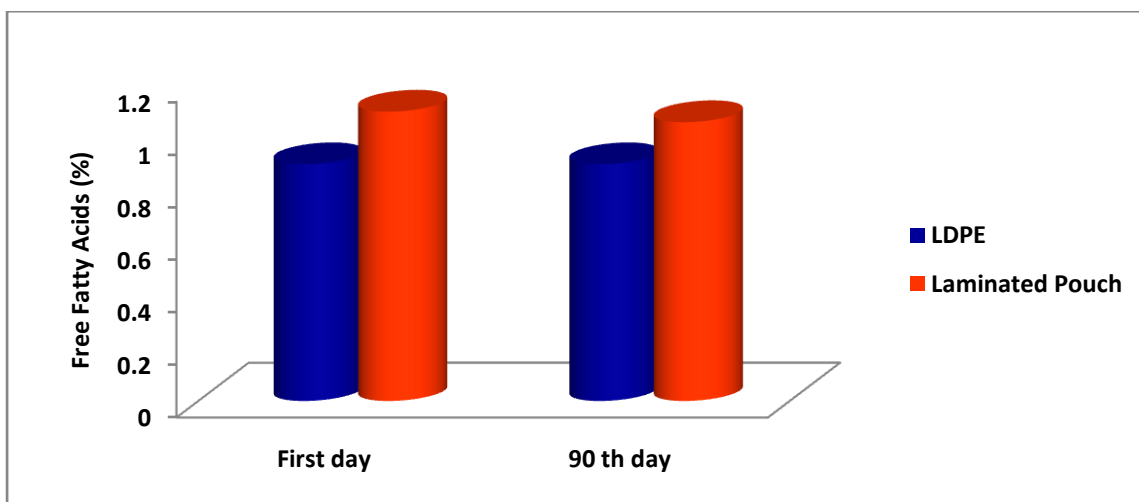
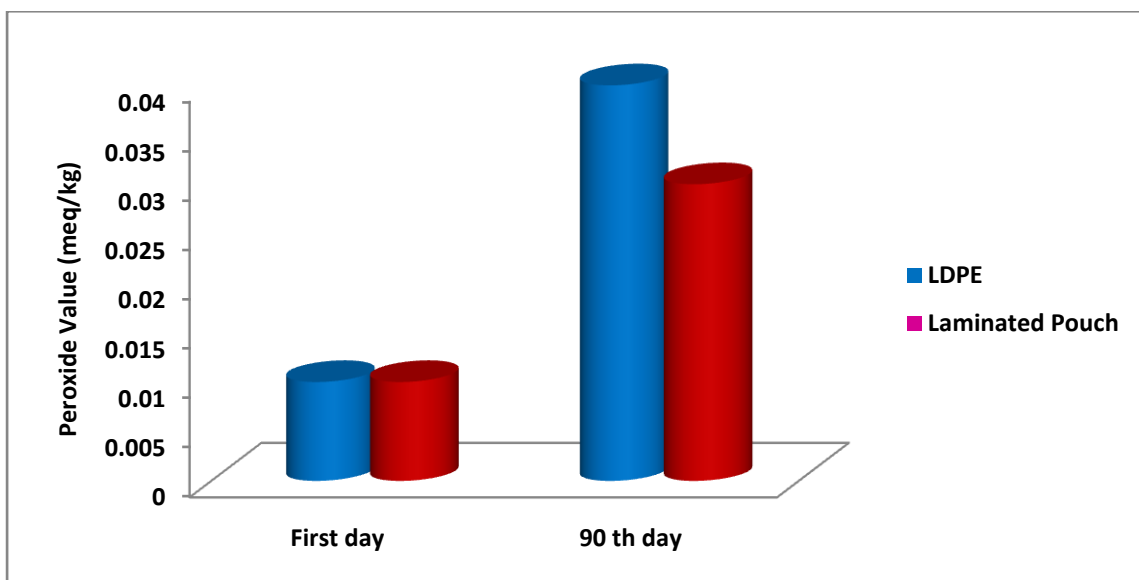
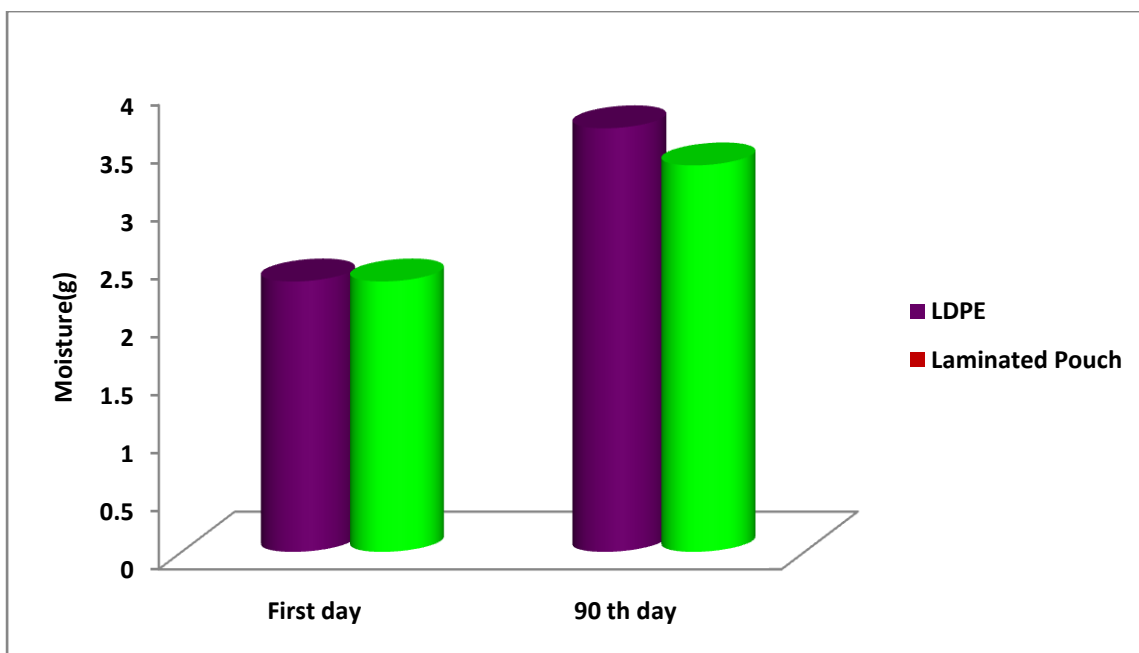


Fig. 4 Effect on storage and packaging material on biochemical parameters

fatty acid and peroxide value were significantly increased in all packaged samples but least changes were observed in metalized polyester sample.

Ananthan *et al.*, (2013) recorded shelf stability of flax oat nutty bar in different packaging material. Metalized packed sample had least free fatty acid and peroxide value after 12 months of ambient storage. Similar increased trend for free fatty acid was observed by Mridula *et al.*, (2013) for flax seed based energy bar which was stored at ambient temperature for 90 days. It was observed that during storage of wheat flour based baked energy bar free fatty acid content was increased from 5.26 to 8.6 per cent and peroxide value was increased from 6.13 to 7.45 per cent during storage of 3 months. The observed increase in free fatty acid content in the present experiment and documented studies may be due to higher water and oxygen transmission rate through packaging material from environment.

**Table 9. Effect of storage and packaging material on biochemical parameters of *Heartdiabocare Snack***

| Parameters              | Packaging material |                                        | ‘t’ value |
|-------------------------|--------------------|----------------------------------------|-----------|
|                         | LDPE<br>(Mean±SD)  | Laminated aluminium<br>pouch (Mean±SD) |           |
| Moisture (g)            |                    |                                        |           |
| Initial                 | 2.33 ± 0.01        | 2.33 ± 0.01                            | NS        |
| Final                   | 3.65 ± 0.01        | 3.33 ± 0.01                            | NS        |
| ‘t’ value               | 0.64 <sup>NS</sup> | 0.53 <sup>NS</sup>                     |           |
| Peroxide value (meq/kg) |                    |                                        |           |
| Initial                 | 0.01 ± 0.01        | 0.01 ± 0.01                            | NS        |
| Final                   | 0.04 ± 0.01        | 0.03 ± 0.01                            | NS        |
| ‘t’ value               | 0.26 <sup>NS</sup> | 0.17 <sup>NS</sup>                     |           |
| Free fatty acids (%)    |                    |                                        |           |
| Initial                 | 0.9 ± 0.01         | 0.9 ± 0.01                             | NS        |
| Final                   | 1.06 ± 0.01        | 1.10 ± 0.01                            | NS        |
| ‘t’ value               | 0.16 <sup>NS</sup> | 0.8 <sup>NS</sup>                      |           |

NS- Non significant

#### 4.6.3 Microbial Evaluation of *Heartdiabocare Snack*

Microbial spoilage is often the major factor limiting the shelf life of product. Spoilage from microbial growth causes economic loss for manufacturer and consumer. These losses can be minimized to some extent by adopting desirable packaging material during storage.

In present study the microbial population of *Heartdiabocare Snack* stored in different packaging materials i.e. in low density polyethylene pouch (LDPE) & laminated aluminium pouch is given in Table 10.

Initially the microbial population of *Heartdiabocare Snack* was found to be nil or below detectable level (BDL). However, it was increased up to  $5 \times 10^{-6}$  cfu/g for *Heartdiabocare Snack* packed in polythene pouch and  $3 \times 10^{-6}$  cfu/g for the *Heartdiabocare Snack* packed in laminated aluminium pouch at the end of the storage period. Both the packed samples had low microbial population and hence were fit for consumption after storage. Yeast and mould count of functional snack stored in both packaging materials was found below the detectable level at the beginning and end of the storage period.

The controlled microbial growth during storage may be because of low moisture content of the product (Table 6). Microorganisms have an absolute demand for water. Hence, the lower the moisture content, the lower will be the microbial activity (Frazier and Westhoff, 1978). Olunlade *et al.*, (2013) observed total microbial content ranged from  $2.9 \times 10^5$  cfu/g to  $5.4 \times 10^5$  cfu/g in maize pigeon pea flour blend and pigeon pea flour respectively.

From the data with regard to the biochemical parameters and microbial study it can be concluded that laminated aluminium foil pouches are better for storage of functional *Heartdiabocare Snack* as the undesirable changes are slightly less in the samples as compared to LDPE pouch.

**Table 10. Microbial count of *Heartdiabocare Snack***

| Period                        | Total plate count  | Yeast and mould | Total plate count          | Yeast and mould count |
|-------------------------------|--------------------|-----------------|----------------------------|-----------------------|
|                               | LDPE Pouch         |                 | Laminated Alluminium Pouch |                       |
| Initial (1 <sup>st</sup> day) | BDL                | BDL             | BDL                        | BDL                   |
| After (90 <sup>th</sup> day)  | $5 \times 10^{-6}$ | BDL             | $3 \times 10^{-6}$         | BDL                   |

#### **4.7 Techno-Economical Feasibility for the Production of '*Heartdibocare Snack*'**

The processing techniques such as grinding, baking, packaging etc. used during development of functional snacks are feasible to be carried out at household level for small scale production and at industrial level for large scale production. The economic feasibility of most acceptable variation of *Heartdiabocare Snack* was assessed by calculating the total cost of production for 1kg of *Heartdiabocare Snack*. The estimation of cost of production was carried out by using standard calculation method based on the raw material cost, processing cost including packaging cost (as 30 per cent of raw material cost).

The economic feasibility of prepared *Heartdiabocare Snack* estimated on basis of laboratory trials is depicted in Table 11. It was evident that cost of packaged one kg *Heartdiabocare Snack* was about Rs. 155/- and each snack bar (approximately 15 gm) was about Rs. 2.5/-. This is comparatively very less than any packaged snack bar sold in market. In addition, this will provide nutritional and therapeutic benefits to the consumer. The *Heartdiabocare Snack* can be prepared / manufactured on home and industrial scale to meet the consumer demands, nutritional security and to serve as therapeutic food for diabetic and hyperlipidemic subjects for their healthy life (Plate 17).

**Table 11. Techno-Economical Feasibility of *Heartdiabocare Snack***

| S. No | Ingredients                                                          | Quantity required (g) | Price/kg (Rs) | Total cost (Rs) |
|-------|----------------------------------------------------------------------|-----------------------|---------------|-----------------|
| 1.    | Whole Wheat flour                                                    | 200                   | 30            | 6.00            |
| 2.    | Flax seed flour                                                      | 50                    | 100           | 5.00            |
| 3.    | Niger seed flour                                                     | 50                    | 100           | 5.00            |
| 4.    | Wheat bran                                                           | 100                   | 200           | 2.0             |
| 5.    | Gum Acasia powder                                                    | 100                   | 400           | 40.00           |
| 6.    | Milk powder                                                          | 200                   | 350           | 7.00            |
| 7.    | Soyachunk powder                                                     | 50                    | 100           | 5.00            |
| 8.    | Oat flour                                                            | 50                    | 250           | 12.5            |
| 9.    | Jowar flour                                                          | 40                    | 250           | 12.5            |
| 10.   | Sugar powder                                                         | 50                    | 38            | 1.9             |
| 11.   | Fat                                                                  | 50                    | 100           | 5.00            |
| 12.   | Baking powder                                                        | 30                    | 220           | 6.6             |
| 13.   | Salt                                                                 | 10                    | 15            | 1.5             |
| 14.   | Cardamom powder                                                      | 10                    | 900           | 9               |
| 14.   | Total cost                                                           |                       |               | 119             |
| 15.   | Packaging and processing cost at 30 % of the total raw material cost |                       |               | 35.7            |
| 16.   | Production cost of 1kg <i>Heartdiabocare snack</i>                   |                       |               | 154.7           |
| 17.   | Number of pieces <i>Heartdiabocare snack</i> obtained in 1kg         |                       |               | 66              |
| 18.   | Cost of one piece of <i>Heartdiabocare snack</i> (app.15 gm each)    |                       |               | 2.32 - 2.5      |



**Plate 17 Large scale production of snack**

#### 4.8 Glycemic Index of *Heartdiabocare Snack*

Glycemic index (GI) is an important parameter that measures how a food raises blood glucose. Foods are ranked depending on their ability to raise the blood glucose in comparison with a reference food mostly glucose. A food with a high GI raises blood glucose more than a food with a medium or low GI. Foods with low GI are recommended to diabetics and to keep normal spectrum of lipoproteins (Subhashini and Ushadevi, 2014). GI of the *Heartdiabocare Snack* was estimated to check its suitability to feed the diabetic subjects. The glycemic response of the subjects after ingestion of glucose and *Heartdiabocare Snack* was measured and the data is presented in Table 12 and Fig. 5. The mean fasting blood glucose of the subjects was 69.7 mg/dl. It was raised gradually after ingestion of 50 g glucose up to 119.9 mg/dl in 30 minutes and reached to peak after 60 minutes to 133.7 mg/dl. Thereafter the blood glucose was reduced to 93.1 mg/dl within 90 minutes and slid down almost to base level within two hours (69.4 mg/dl). The similar trend of blood glucose was noticed in the subjects after consumption of *Heartdiabocare Snack*. The initial value of blood glucose was 67.6 mg/dl. It increased and reached to peak (86.2 mg/dl) within half an hour. After that it started declining and reduced to 83.4, 75.4 and 68.4 mg/dl at the assessment intervals of 60, 90 and 120 minutes respectively. The statistical comparison of data indicated that at the blood glucose assessment intervals of 30, 60 and 90 minutes the difference in the blood glucose levels was significant between the two foods. The increase in the glucose content of blood was significantly less after consumption of developed *Heartdiabocare Snack* than the increase due to ingestion of glucose at 30, 60 and 90 minutes.

The glycemic index value calculated by determining the ratio of area under the glucose response curve for the *Heartdiabocare Snack* and the area for the glucose was 26.27 which is categorized as low according to the classification of glycemic index.

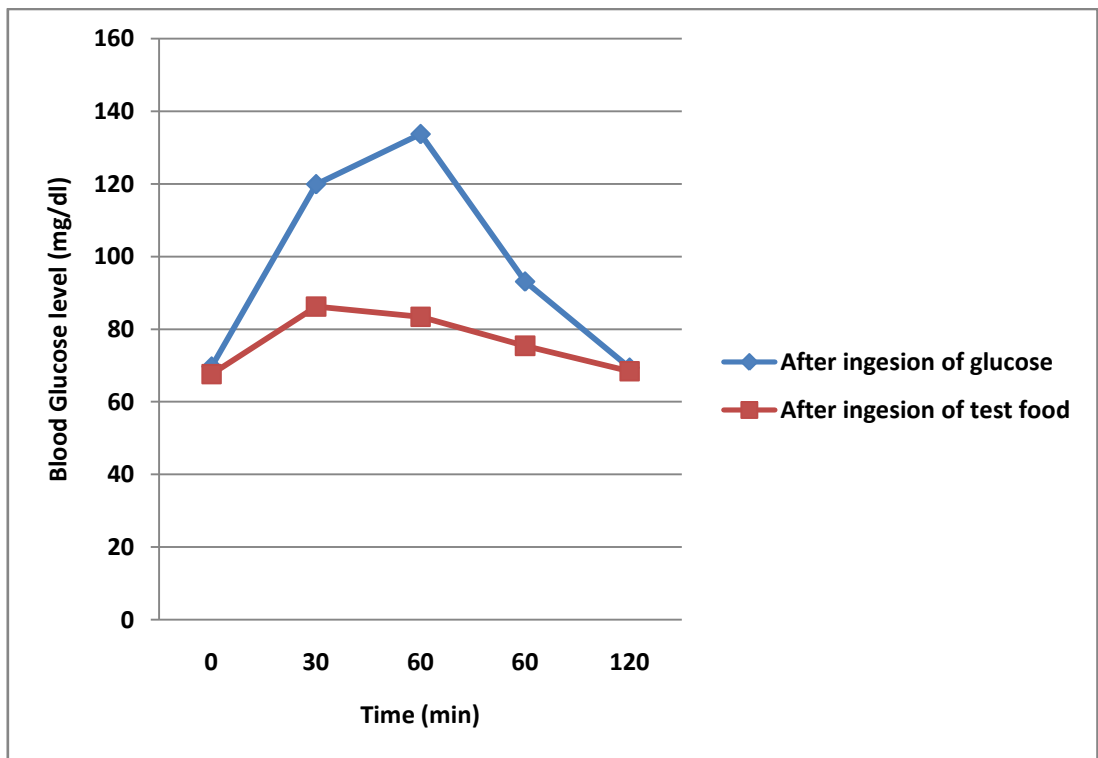


**Fig. 5 Blood glucose levels at fasting and after feeding glucose and Heartdiabocare snack**

The data with regard to glycemic response of the selected subjects towards the glucose and developed *Heartdiabocare Snack* evidenced that the mean blood glucose level significantly increased within 60 minutes when 50 g of glucose was given to them. It is well known fact that glucose is monosaccharide and is readily absorbed in the blood stream from the GI tract. That is the reason why glucose is used as a reference food for conducting glycemic index studies (Wolver *et al.*, 1991).

The data emerged from blood glucose levels of the subjects after consumption of *Heartdiabocare Snack* showed that there was significant increase in the blood glucose values up to 30 minutes over the initial one. The peak value of blood glucose was noticed after 60 minutes.

The significantly lower blood glucose level of the subjects after consumption of test food can be attributed to its ingredient composition. The test food under study was prepared by using various ingredients such as flax seed, wheat bran, oats, soya chunk powder, gum acacia, jowar flour, wheat flour etc. These ingredients may have different particle sizes. The starch type and granules may be different from different foods and hence may affect the physical characteristics of starch with regard to its cooking quality and digestibility. Some starches may be resistant to cooking and digestion (Krezows Ki *et al.*, 1987). The flaxseed gum and gum acacia may help in flattening the glucose curve as they behave like typical viscous fibres. Flax seed portion may also influence blood glucose by its interaction with the gums and also by stimulating insulin secretion (Oomah, 2001). Many foods contain antinutrients such as enzyme inhibitors, phytates, tannins and lectins which have been found to influence starch digestibility and can correlate negatively with glycemic response (Mani *et al.*, 1997). Hence, it can be concluded that though equicarbohydrate portion of *Heartdibiocare Snack* was fed to the subjects, the rise in the blood glucose was significantly less which proves that the developed snack being low in GI is suitable for diabetic patients.

**Table 12. Glycemic response and glycemic index of *Heartdiabocare Snack***

| S. no. | Time<br>(min) | Blood Glucose Level (mg/dl)<br>(mean $\pm$ SD) |                              | 't'<br>Value       | GI of <i>Heartdiabocare<br/>Snack</i> |
|--------|---------------|------------------------------------------------|------------------------------|--------------------|---------------------------------------|
|        |               | After ingestion of glucose                     | After ingestion of test food |                    |                                       |
| 1      | 0(Fasting)    | 69.7 $\pm$ 5.12                                | 67.6 $\pm$ 2.75              | 1.14 <sup>NS</sup> | <b>26.2 <math>\pm</math> 3.83</b>     |
| 2      | 30            | 119.9 $\pm$ 26.66                              | 86.2 $\pm$ 8.76              | 3.76**             |                                       |
| 3      | 60            | 133.7 $\pm$ 21.5                               | 83.4 $\pm$ 10.16             | 6.66**             |                                       |
| 4      | 90            | 93.1 $\pm$ 20.19                               | 75.4 $\pm$ 8.56              | 2.55**             |                                       |
| 5      | 120           | 69.4 $\pm$ 4.78                                | 68.4 $\pm$ 4.32              | 0.49 <sup>NS</sup> |                                       |

## Phase II

### 4.9 Intervention Programme (Clinical Study)

The impact of developed functional snack on blood glucose level of diabetic and lipid profile of hyperlipidemic subjects was assessed by conducting a clinical study.

#### 4.9.1 Selection of Sample

A total sample of 30 diabetic and 30 hyperlipidemic individuals between 40 to 65 years of age was selected for the study from Parbhani city. Information was collected on socio-economic status, health problems and symptoms of the selected diabetic (30), and hyperlipidemic (30) subjects in the urban area of Parbhani city of Maharashtra State. Nutritional status of all the selected subjects was assessed by anthropometry. All the selected diabetic and hyperlipidemic subjects were equally divided into two groups i.e. experimental group (15) and control group (15). The subjects of experimental group were supplemented with 60 gm of *Heartdiabocare Snack* regularly for 60 days. Observations were recorded before giving the supplementation (on first day of experiment), on 30<sup>th</sup> and 60<sup>th</sup> day of study period to assess the effect of supplementation of *Heartdiabocare Snack*. The data collected was tabulated and analyzed statistically.

#### 4.9.2 Collection of General Information of the Selected Subjects

Table 13 shows the general information of both diabetic and hyperlipidemic subjects. It was observed that from both the disorders, subjects were more from 50-60 years age group (63.33 and 76.66 %) respectively. Sex wise data indicated that more number of male were sufferers of diabetes (53.33 %) and hyperlipidemia (70 %). For both disorders maximum subjects were from nuclear families (60 and 50 per cent respectively). There were only 6.66 per cent hyperlipidemic subjects from extended families. Educational status of subjects revealed that there was no specific trend observed according to educational status for both the disorders. Higher secondary school educated subjects were more in both the groups of subjects (33.33 & 26.66 % respectively) than other categories of education except illiterate hyperlipidemic

subjects. It is surprising to note that the sizable number (26.66 %) of illiterate subjects suffered from hyperlipidemia.

Diabetes and hyperlipidemia was observed more among the subjects who were engaged in the service (36.66 % each). The income wise distribution indicated that there was increase in the number of subjects as the income was increased. Maximum number (33.33 and 46.66 %) of subjects were from higher income category (> Rs.40,000 / per month) for both disorders.

It is evidenced from the data that elder population form the selected group was suffering from the disorders. Male patients were more than female patients. A very high per cent (70%) of males were having hyperlipidemia. Shrivastva *et al.*, (2014) while studying the dietary pattern and lifestyle of diabetic patients reported the higher prevalence of diabetes in the age group 46-65 years. As age increases the activity of pancreas and synthesis of HDL cholesterol may be reduced. Snehlatha *et al.*, (2003) also noticed that the prevalence of diabetes was higher in age group above 40 years. Kaur & Karla (2009) and Shrivastva *et al.*, (2014) reported that males were more who were suffering from diabetes as compared to females. This may be due to the more mental and physical stress male members in the family have to face. The findings of the study of Patel *et al.*, (2012) are in line with the findings of present study, but the findings of Shrivastva *et al.*, (2014) are in contrast to these observations. They observed that percentage of females was more who were diabetics. Most of the patients were from nuclear families. Kaur and Karla (2009) reported that in nuclear families the similar trend of observations was noticed in the patients with hyperlipidemia with regard to age and type of family (Haribabu, 2012). The diabetes was more prevalent in higher secondary school educated individuals while hyperlipidemia was observed more among illiterate and higher secondary school educated subjects. As the education increased, the percentage of subjects suffering with both the disorders was reduced.

With increase in education the awareness regarding health will be

increased. People will take care and avoid risk factors responsible for development of such disorders. Hence, there is a negative correlation between education and diabetes. The findings of the study conducted by Haribabu *et al.*, (2012) are in agreement with the present results. The occupational status determines the stress level of the individual which is one of the predisposing factors for the accumulation of fat in the blood vessels which leads to the health risk of the selected hyperlipidemics. The prevalence of diabetes and hyperlipidemia was higher among the subjects whose occupation was service. Next to job holders subjects were from farming occupation. This may be due to the job stress in subjects engaged in service and farming as stress is one of the major risk factors of diabetes and CVD. Agardh *et al.* (2011) also reported that there was association between prevalence of diabetes and work related stress among those who were engaged in agriculture field. Haribabu *et al.*, (2012) reported higher prevalence of hyperlipidemia among the subjects who were retired followed by housewives. It may be because of inactivity among them. Housewives may have sedentary lifestyle which is significant predictor of development of diabetes. The incidence of diabetes and hyperlipidemia was increased with increase in income of the patients. According to Berry *et al.*, (2012), men and women aged 55 years with at least two major risk factors were six times and three times respectively as likely to die from cardiovascular diseases by age 80 than men with no or one CVD risk factor (29.6 per cent vs 4.7 per cent). Thus higher burden of risk factors is associated with a higher lifetime risk of death from cardiovascular disease.

**Table 13. General information of the selected subjects (n=60)**

| S. No. | Particulars                       | Diabetic subjects (n=30) |            | Hyperlipidemic subjects (n=30) |            |
|--------|-----------------------------------|--------------------------|------------|--------------------------------|------------|
|        |                                   | Number                   | Percentage | Number                         | Percentage |
| 1      | <b>Age in years</b>               |                          |            |                                |            |
|        | 40-50                             | 11                       | 36.66      | 07                             | 23.33      |
|        | 50-60                             | 19                       | 63.33      | 23                             | 76.66      |
| 2      | <b>Sex</b>                        |                          |            |                                |            |
|        | Male                              | 16                       | 53.33      | 21                             | 70.00      |
|        | Female                            | 14                       | 46.66      | 9                              | 30.00      |
| 3      | <b>Type of the family</b>         |                          |            |                                |            |
|        | Joint                             | 12                       | 40.00      | 13                             | 43.33      |
|        | Nuclear                           | 18                       | 60.00      | 15                             | 50.00      |
|        | Extended                          | -                        | -          | 02                             | 6.66       |
| 4      | <b>Educational Status</b>         |                          |            |                                |            |
|        | Illiterate                        | 01                       | 3.33       | 08                             | 26.66      |
|        | Primary school                    | 01                       | 3.33       | 05                             | 16.66      |
|        | Secondary school                  | 06                       | 20.00      | 05                             | 16.66      |
|        | Higher Secondary school           | 10                       | 33.33      | 08                             | 26.66      |
|        | Graduate                          | 08                       | 26.66      | 04                             | 13.33      |
|        | Postgraduate                      | 04                       | 13.33      | -                              | -          |
| 5      | <b>Occupation</b>                 |                          |            |                                |            |
|        |                                   | 11                       | 36.66      | 11                             | 36.66      |
|        | Service                           | 05                       | 16.66      | 05                             | 16.66      |
|        | Business                          | 8                        | 26.66      | 6                              | 20.00      |
|        | Farmering<br>Home maker           | 6                        | 20.00      | 8                              | 26.66      |
| 6      | <b>Monthly family Income</b>      |                          |            |                                |            |
|        |                                   | 03                       | 10.00      | 03                             | 10.00      |
|        | Rs.<15,000                        | 09                       | 30.00      | 10                             | 33.33      |
|        | Rs.15,000- 30,000                 | 08                       | 26.66      | 03                             | 10.00      |
|        | Rs.30,000 - 40,000<br>Rs. >40,000 | 10                       | 33.33      | 14                             | 46.66      |

#### **4.10 Information of Subjects Regarding Various Aspects of Diabetes and Hyperlipidemia**

Information of subjects with regard to disorders among the selected subjects is presented in Table 14.

Among the total selected diabetic subjects majority of them (40%) were suffering from more than five years and 33.33 per cent subjects were suffering from 3-5 years. Twenty per cent of respondents (6) were suffering from 1-3 years and only two subjects (6.66%) were suffering from less than one year from diabetes. With regard to hyperlipidemia it was noticed that maximum (43.33%) subjects were suffering from one year followed by the 36.66 per cent subjects had hyperlipidemia suffering from 1-3 years. There were 6.66 per cent and 13.33 per cent subjects who had impaired lipid profile form 3-5 years and > 5 years duration.

Majority of the diabetic subjects (50 %) were not having diabetic history from either of the parent side while 40 per cent having from maternal side and only three (10%) diabetic subjects were having diabetic history from parental side. The hyperlipidemic subjects having family history of disorder were 60 per cent, out of which 33.33 per cent reported it from maternal side and 26.66 per cent from paternal side. There were 40 per cent subjects who did not have family history of hyperlipidemia.

Only twenty per cent diabetic subjects followed the instructions given by doctors while majority of them i.e. 80 per cent did not follow the instructions. The instructions given by doctors were followed by only 13.33 per cent hyperlipidemic subjects. Remaining 86.66 per cent respondents did not follow doctor's instructions.

Among the selected diabetic subjects 66.66 per cent subjects noticed the increase in their weight after diagnosis of diabetes. The remaining subjects did not experience any change in the body weight after diagnosis of disorder. The increase in weight was experienced by all the selected 30 hyperlipidemic subjects after diagnosis of disorder. All the 100 per cent selected diabetic subjects check their blood glucose level. It was checked once in month by

83.33 per cent subjects. Blood glucose was checked fortnightly and weekly by 3.33 per cent subjects whereas ten per cent subjects checked it occasionally. All the hyperlipidemic subjects occasionally checked lipid profile. The duration of diabetes was more than five years for majority of the patients. Ayya and Nalwade (2012) reported the duration of diabetes more than 10 years for 40 per cent subject, 26.66 per cent were suffering from 5-10 years while 33.33 per cent subjects suffered from 2-5 years. Dutta *et al.*, (2014) observed the average duration of diabetes mellitus 7.92 years in selected subjects. Patel *et al.*, (2012) also reported the duration of diabetes as >2-5 years in majority of the subjects. These findings indicate that there is no specific trend in the number of patient registered for study and the duration of diabetes.

There were half of the subjects with family history of diabetes and more than half with family history of hyperlipidemia. Family history reflects not only genetic susceptibility, but also interventions between genetic, environmental, current and behavioural factors. Individuals with genetic susceptibility develop disease at an earlier age (James, 2015).

According to World Heart Federation (2012), our family's history of cardiovascular diseases indicate our risk. If a first-degree blood relative had coronary heart disease or stroke before the age of 55 years (for a male relative) or 65 years (for a female relative) our risk for CVD increases. Patel *et al.*, (2012) reported that 75 per cent selected subjects were having positive history of diabetes. The increase in the weight by all the hyperlipidemic and majority of diabetic subjects was noticed after diagnosis of disorders. It might be due to increased immobility of the subjects. The blood glucose was checked by all the selected diabetic subjects but they were not conscious about it and all the hyperlipidemic subjects checked occasionally lipid profile. Many studies show a strong family history among affected youth with 45-80 per cent having at least one parent with diabetes and 74-100 per cent having a first or second degree relative with type-2 diabetes (Anonymous, 2000)

**Table 14. Information about disorders (n=60)**

| S. No. | Particulars                                           | Diabetic subjects (n=30) |            | Hyperlipidemic subjects (n=30) |            |
|--------|-------------------------------------------------------|--------------------------|------------|--------------------------------|------------|
|        |                                                       | Number                   | Percentage | Number                         | Percentage |
| 1      | <b>Period of Diagnosis (yr.)</b>                      |                          |            |                                |            |
|        | >5                                                    | 12                       | 40.00      | 4                              | 13.33      |
|        | 3-5                                                   | 10                       | 33.33      | 2                              | 6.66       |
|        | 1-3                                                   | 6                        | 20.00      | 11                             | 36.66      |
|        | <1                                                    | 2                        | 6.66       | 13                             | 43.33      |
| 2      | <b>Family history of Disease</b>                      |                          |            |                                |            |
|        | Maternal                                              | 12                       | 40         | 10                             | 33.33      |
|        | Paternal                                              | 3                        | 10         | 8                              | 26.66      |
|        | None                                                  | 15                       | 50         | 12                             | 40.00      |
| 3      | <b>Instructions of Doctors</b>                        |                          |            |                                |            |
|        | Follow                                                | 6                        | 20         | 4                              | 13.33      |
|        | Do not follow                                         | 24                       | 80         | 26                             | 86.66      |
| 4.     | <b>Weight change after diagnosis</b>                  |                          |            |                                |            |
|        | Increased                                             | 20                       | 66.66      | 30                             | 100.0      |
|        | Decreased                                             | -                        | -          | -                              | -          |
|        | No changed                                            | 10                       | 33.33      | -                              | -          |
| 5      | <b>Checking of blood sugar/ lipid profile is done</b> |                          |            |                                |            |
|        | Yes                                                   | 30                       | 100.0      | 30                             | 100.0      |
|        | No                                                    | -                        | -          | -                              | -          |
| 6      | <b>Frequency of blood checkup</b>                     |                          |            |                                |            |
|        | Occasionally                                          | 3                        | 10.00      | 30.00                          | 100.0      |
|        | Monthly                                               | 25                       | 83.33      | -                              | -          |
|        | Fortnightly                                           | 1                        | 3.33       | -                              | -          |
|        | Weekly                                                | 1                        | 3.33       | -                              | -          |

#### 4.10.1 Prevalence of Symptoms among the Diabetic Subjects

The data with regard to prevalence of symptoms among the studied diabetic subjects (Table 15) indicated that the symptom experienced by maximum (56.66 %) subjects was getting tired even after a small activity, followed by polyuria (50%), polyphagia (50 %), polydypsia (40 %), nocturia (36.66 %) and weight loss (33.33 %). There were only 10 per cent subjects having the eye and feet problem each. The symptoms experienced by the respondents under study are very common among the diabetic patients. In diabetic individual glucose uptake by the cells is reduced. Therefore, it becomes difficult to support the increased BMR during physical activities. Hence the selected subjects might be experiencing early tiredness and polyphagia after physical activity. Due to polyuria water loss will be increased subsequently polydypsia will be developed. These symptoms were also noticed by Haripriya and Premakumari (2010); Ayya & Nalwade (2015); Choudhary and Nalwade (2016) among the diabetic subjects.

**Table 15. Prevalence of diabetes mellitus symptoms among the selected subjects**

| S. No. | Symptoms       | Diabetic subjects (n=30) |            |
|--------|----------------|--------------------------|------------|
|        |                | Number                   | Percentage |
| 1      | Easy tiredness | 17                       | 56.66      |
| 2      | Polyuria       | 15                       | 50.00      |
| 3      | Polyphagia     | 15                       | 50.00      |
| 4      | Polydypsia     | 12                       | 40.00      |
| 5      | Weight loss    | 10                       | 33.33      |
| 6      | Nocturia       | 11                       | 36.66      |
| 7      | Eye problem    | 03                       | 10.00      |
| 8      | Feet problem   | 03                       | 10.00      |

## **4.11 Food and Nutrient Intake of the Selected Diabetic and Hyperlipidemic Subjects**

### **4.11.1 Dietary Pattern of Selected Diabetic and Hyperlipidemic Subjects**

Diabetes cannot be cured but it can be well controlled by modification in the diet and lifestyle, provided the person accepts responsibility for doing so. Details regarding the type of diet, daily meal pattern, diet restrictions, consumption of fruits & salads and frequency of fasting are tabulated and discussed below.

Dietary pattern of the selected subjects under study (Table 16) showed that there were 66.66 percent each vegetarian diabetics and non vegetarian hyperlipidemic subjects. Non vegetarian diabetics were 6.66 per cent while vegetarian hyperlipidemic respondents were 26.66 per cent. Ova vegetarians were 26.66 and 6.66 per cent respectively from diabetic and hyperlipidemic group. Most of the subjects (60 %) from both groups were following 3 meal pattern followed by 4 meal pattern (20 % and 16.66 % respectively). Only two respondents from each category were taking meals twice a day, 13.33 per cent diabetic and 16.66 per cent hyperlipidemic subjects were eating five times in a day.

Sugar was restricted by 73.33 per cent diabetic subjects while 50 per cent hyperlipidemic subjects avoided salt followed by sweets (26.66 % each). Bakery products were not restricted by even a single subject from both groups. No restrictions for any ingredient were followed by two diabetic and 5 hyperlipidemic patients. Salad was consumed only by 3 (10 %) diabetic and 43.33 per cent hyperlipidemic individuals under study. Remaining 90 per cent diabetic and 56.66 per cent hyperlipidemics avoided salads.

All the selected subjects included fruits in their diet however, the frequency of consumption was very less. Most of them (63.33 and 50 %) were consuming fruits once a week from diabetic and hyperlipidemic group respectively.

There were only two diabetic and six hyperlipidemic subjects who were practising fasting once a week. Majority of subjects from both the groups did not practice it.

Data with regard to food consumption pattern revealed that most of the diabetic patients were vegetarian. On the contrary majority of the hyperlipidemics were non vegetarians. This may be one of the reasons that their cholesterol levels were high as the animal foods are rich sources of cholesterol. Maximum respondents followed three meal pattern. Sugar was avoided by most of the diabetics while salt was restricted by maximum hyperlipidemic individuals. Very few subjects restricted fat. Infact the selected subjects are overweight subjects according to their BMI (Table 28 and 29). Hence, restriction of fat and refined sugar is essential for both the groups. Moreover fat restriction is essential for hyperlipidemic individuals but it is not restricted by majority of the selected subjects. This might be another reason for increased cholesterol levels.

Fruits and vegetables have a high content of vitamins, minerals, antioxidants and phytochemicals and play a positive role in preventing CVD and diabetes (European Heart Network, 2002). The bakery products restriction should have been there for diabetic subjects in view of their higher glycemic index. Its very surprising that diabetic subjects except very few did not include salad in their diet though it is an essential item in the daily diet it was noticed that all subjects ate fruits. Though the fruits are rich in carbohydrates, their consumption in limited amount is essential for both the group of patients.

**Table 16. Dietary Pattern of selected subjects (n =60)**

| S. No.   | Diet pattern                 | Diabetic subjects (n =30) |            | Hyperlipidemic subjects (n=30) |            |
|----------|------------------------------|---------------------------|------------|--------------------------------|------------|
|          |                              | Number                    | Percentage | Number                         | Percentage |
| <b>1</b> | <b>Food Habits</b>           |                           |            |                                |            |
|          | Vegetarian                   | 20                        | 66.66      | 8                              | 26.66      |
|          | Non vegetarian               | 2                         | 6.66       | 20                             | 66.66      |
|          | Ovo vegetarian               | 8                         | 26.66      | 2                              | 6.66       |
| <b>3</b> | <b>Meal pattern</b>          |                           |            |                                |            |
|          | 2 meals a day                | 02                        | 6.66       | 02                             | 6.66       |
|          | 3 meals a day                | 18                        | 60.00      | 18                             | 60.00      |
|          | 4 meals a day                | 06                        | 20.00      | 05                             | 16.66      |
|          | 5 meals a day                | 04                        | 13.33      | 05                             | 16.66      |
| <b>4</b> | <b>Diet restrictions</b>     |                           |            |                                |            |
|          | Sugar                        | 22                        | 73.33      | -                              | -          |
|          | Sweets                       | 08                        | 26.66      | 08                             | 26.66      |
|          | Salt                         | 05                        | 16.66      | 15                             | 50.00      |
|          | Fat                          | 03                        | 10.00      | 02                             | 6.66       |
|          | Fluid                        | 04                        | 13.33      | -                              | -          |
|          | Bakery Products              | -                         | -          | -                              | -          |
|          | None                         | 02                        | 6.66       | 05                             | 16.66      |
| <b>5</b> | <b>Consumption of Salads</b> |                           |            |                                |            |
|          | Yes                          | 3                         | 10         | 13                             | 43.33      |
|          | No                           | 27                        | 90         | 17                             | 56.66      |
|          | <b>Amount consumed</b>       |                           |            |                                |            |
|          | ≥100g                        | 2                         | 6.66       | 5                              | 16.66      |
|          | 50- 100g                     | 1                         | 3.33       | 8                              | 26.66      |
| <b>6</b> | <b>Consumption of Fruits</b> |                           |            |                                |            |
|          | Yes                          | 30                        | 100.0      | 30                             | 100.0      |
|          | No                           | -                         | -          | -                              | -          |
|          | <b>Frequency</b>             |                           |            |                                |            |
|          | Daily                        | 1                         | 3.33       | 1                              | 3.33       |
|          | 2-4 time in a week           | 6                         | 20.00      | 6                              | 20.00      |
|          | Weekly                       | 19                        | 63.33      | 15                             | 50.00      |
|          | Occasionally                 | 03                        | 10.00      | 03                             | 10.00      |
| <b>7</b> | <b>Fasting</b>               |                           |            |                                |            |
|          | Yes                          | 02                        | 6.66       | 06                             | 20.00      |
|          | No                           | 28                        | 93.33      | 24                             | 80.00      |
| <b>8</b> | <b>Frequency of fasting</b>  |                           |            |                                |            |
|          | Once a week                  | 02                        | 6.6        | 02                             | 6.66       |
|          | ≥ 2 times                    | 00                        | 00         | 03                             | 10.00      |
|          | Fortnightly                  | -                         | -          | 1                              | 3.33       |

#### **4.11.2 Oil and Oilseeds Consumption Pattern of the Selected Diabetic and Hyperlipidemic Subjects**

Oil and oil seed consumption pattern of the selected diabetic and hyperlipidemic subjects is presented in table 17. Soybean oil was preferred by 83 per cent diabetics followed by sunflower (33.33 %), groundnut (26.66 %). Soybean oil was used by 60 per cent hyperlipidemic subjects.

Nuts and oilseeds were consumed by all 100 per cent selected diabetic and hyperlipidemic subjects. Gingelly seeds, groundnut and coconut were consumed by all the diabetic respondents. They consumed niger seed (86.66 %), flaxseed (83.33 %), almonds (60 %) and cashew nuts (40 %) while few of them (10% each) consumed garden cress seed, pistachio nuts and walnuts. All 100 per cent hyperlipidemic subjects consumed groundnuts, gingelly seed, coconut, flaxseed and niger seed. The next preference was given to cashew nuts (80 %) and almonds (73.33%). Other nuts and oilseeds were consumed by less number of hyperlipidemics.

Oilseeds were consumed daily by 26.66 per cent diabetics and 60 per cent hyperlipidemic respondents. Maximum diabetic subjects (73.33 %) consumed it 2-4 times in a week. An amount of 10 to 25g oil seeds were consumed by 80 per cent diabetic and 40 per cent hyperlipidemic subjects, followed by 25 to 50 g consumption by 36.66 per cent hyperlipidemic subjects. Very few respondents from both groups consumed oilseeds less than 10g and more than 50g.

The oil consumption practices of the selected subjects were healthy. They used different oils which might be helping them to make up the fatty acid ratio. Different types of oilseeds were consumed by respondents. Consumption of healthy oilseeds such as flaxseed and almonds are advantageous for improving the cardiac function while niger seed being rich in iron and protein may help to built up haemoglobin level. There was variation in consumption frequency of oilseeds by both types of subjects.

**Table 17. Oils and oilseeds consumption pattern of the selected subjects  
(n=60)**

| S.<br>No. | Consumption pattern                         | Diabetic subjects<br>(n =30) |            | Hyperlipidemic subjects<br>(n=30) |            |
|-----------|---------------------------------------------|------------------------------|------------|-----------------------------------|------------|
|           |                                             | Number                       | Percentage | Number                            | Percentage |
| <b>1.</b> | <b>Oil used for cooking</b>                 |                              |            |                                   |            |
|           | Sunflower                                   | 10                           | 33.33      | 8                                 | 26.66      |
|           | Soybean                                     | 25                           | 83.33      | 18                                | 60.00      |
|           | Safflower                                   | 5                            | 16.66      | 03                                | 10.00      |
|           | Groundnut                                   | 8                            | 26.66      | 18                                | 60.00      |
| <b>2.</b> | <b>Consumption of nuts<br/>and oil seed</b> |                              |            |                                   |            |
|           | Yes                                         | 30                           | 100        | 30                                | 100.0      |
|           | No                                          | -                            |            | -                                 |            |
| <b>3.</b> | Gingelly seeds                              | 30                           | 100.0      | 30                                | 100.0      |
|           | Groundnuts                                  | 30                           | 100.0      | 30                                | 100.0      |
|           | Coconut                                     | 30                           | 100.0      | 30                                | 100.0      |
|           | Flaxseed                                    | 25                           | 83.33      | 30                                | 100.0      |
|           | Niger seed                                  | 26                           | 86.66      | 30                                | 100.0      |
|           | Almond                                      | 18                           | 60.00      | 22                                | 73.33      |
|           | Cashew nuts                                 | 12                           | 40.00      | 24                                | 80.00      |
|           | Garden cress seed                           | 3                            | 10.00      | 2                                 | 6.66       |
|           | Pistachio                                   | 3                            | 10.00      | 4                                 | 13.33      |
|           | Walnut                                      | 3                            | 10.00      | 6                                 | 20.00      |
| <b>4.</b> | <b>Frequency of oilseed<br/>consumption</b> |                              |            |                                   |            |
|           | Daily                                       | 8                            | 26.66      | 18                                | 60.00      |
|           | 2-4 times in a week                         | 22                           | 73.33      | 5                                 | 16.00      |
|           | Weekly                                      | -                            | -          | 3                                 | 10.00      |
|           | Occasionally                                | -                            | -          | 4                                 | 13.33      |
| <b>5.</b> | <b>Amount consumed (g)</b>                  |                              |            |                                   |            |
|           | <10                                         | 1                            | 3.33       | 03                                | 10.00      |
|           | 10-25                                       | 24                           | 80.00      | 12                                | 40.00      |
|           | 26-50                                       | 1                            | 3.33       | 11                                | 36.66      |
|           | >50                                         | 4                            | 13.33      | 4                                 | 13.33      |

#### 4.11.3 Snacking Behaviour of the Selected Subjects

Snacks are inseparable part of Indian Cuisine. They are prepared in almost all Indian homes regularly or occasionally. They are linked by all age groups. They have greater taste appeal as compared to other foods. The importance of snacks has increased remarkably in the last few years. Selling of snacks is an important means of obtaining income. They may be healthy or unhealthy. Healthy snacks provide people with vitamins and other nutrients need to keep one healthy and full of energy. They are low in sugar, fat and salt. On the other hand unhealthy snacks are rich in sugar, fat and salt (Parsons, 2008). With the spread of convenience stores, packaged snacks are widely available even at lower prices with convenient portion sizes. They are easily available and are ready to eat. Snacks are being consumed by the selected subjects under study. Hence, the information regarding snacking behaviour of selected subjects was gathered and data is tabulated (Table 18).

Snacking was followed by all diabetic and hyperlipidemic subjects. Sixty and seventy per cent among them respectively were consuming more than 100 g snack. The frequency of snack consumption was daily in 60 per cent respondents in both the groups. The remaining respondents consumed snacks 2-4 times a week (16.66% each), weekly (6.66 and 10% respectively) and occasionally (13.33% each). The diabetic subjects consuming snacks while watching TV were 83.33 per cent. The corresponding percentage of hyperlipidemic subjects was 86.66. All of subjects from both groups consumed snacks purchased from market and prepared at home. The frequently consumed snacks data indicated that many types of snacks were consumed by selected subjects. All of the 100 per cent respondents from diabetic group consume *chakli*, *chiwada*, *shev*, *panipuri*, *bhel* and *pavbhaji*. From hyperlipidemic group chips, *vadapav*, bakery products, *chakli*, *chiwada*, *shev*, *sonpapdi*, *panipuri*, *bhel* and various sweets were consumed by all 100 per cent of them. Burger and pizza were consumed by very few respondents from both the groups. Majority of them were consuming puff, bread, biscuits, noodles, *kurkure*, *sonpapdi* and *Manchurian*. Majority of them consumed snacks very frequently.

All of them consumed bakery products. All of them consumed bakery products which are not at all suitable and healthy food items especially for diabetic subjects as their glycemic index is high and are empty calorie foods. Most of these snacks contain trans fats which have deleterious effects on health and which produce harmful type of cholesterol in the body. They stay in blood stream for longer resulting in higher fasting glucose concentrations and lower insulin sensitivity (Folsam *et al.*, 1996; Vessby *et al.*, 1994 and Mozaffarian *et al.*, 2009). Trans fat are not essential in human diet. Trans fat increases the risk of CVD.

The observed snacking behaviour of the subjects may be responsible for increased cholesterol and even for having BMI more than 25 among all the selected subjects. A study published in Science News (2012), proved that people who consume fast food even once a week increase their risk of dying from coronary heart disease by 20 percent in comparison to people who avoid fast food.

**Table 18. Information regarding snacking behaviour of selected subjects (n=60)**

| S. No.    | Snacking pattern                                                                      | Diabetic subjects (n =30) |                               | Hyperlipidemic subjects (n =30) |                                  |
|-----------|---------------------------------------------------------------------------------------|---------------------------|-------------------------------|---------------------------------|----------------------------------|
|           |                                                                                       | Number                    | Percentage                    | Number                          | Percentage                       |
| <b>1</b>  | <b>Snacking</b><br>Yes<br>No                                                          | 30<br>-                   | 100.0<br>-                    | 30<br>-                         | 100.0<br>-                       |
| <b>2</b>  | Amount<br>>100g<br><100g                                                              | 18<br>12                  | 60.00<br>40.00                | 21<br>09                        | 70.00<br>30.00                   |
| <b>3</b>  | <b>Frequency of snacking</b><br>Daily<br>2-4 time in a week<br>Weekly<br>Occasionally | 18<br>05<br>02<br>04      | 60.0<br>16.6<br>6.66<br>13.33 | 18<br>05<br>03<br>04            | 60.00<br>16.66<br>10.00<br>13.33 |
| <b>4</b>  | <b>Snacking while watching TV</b><br>Yes<br>No                                        | 25<br>05                  | 83.33<br>16.66                | 26<br>04                        | 86.66<br>13.33                   |
| <b>5.</b> | <b>Type of snack consumed</b><br>Home prepared<br>Purchased                           | 30<br>30                  | 100.0<br>100.0                | 30<br>30                        | 100.0<br>100.0                   |
| <b>6.</b> | <b>Frequently consumed snacks</b>                                                     |                           |                               |                                 |                                  |
| i         | Chakli                                                                                | 30                        | 100.0                         | 30                              | 100.0                            |
| ii        | Chiwada                                                                               | 30                        | 100.0                         | 30                              | 100.0                            |
| iii       | Shev                                                                                  | 30                        | 100.0                         | 30                              | 100.0                            |
| iv        | Bakery products                                                                       | 30                        | 100.0                         | 30                              | 100.0                            |
| v         | Biscuits                                                                              | 21                        | 70.00                         | 22                              | 73.33                            |
| vi        | Bread                                                                                 | 24                        | 80.00                         | 30                              | 100.0                            |
| vii       | Puff                                                                                  | 24                        | 80.00                         | 23                              | 76.66                            |
| viii      | Pastry                                                                                | 22                        | 73.33                         | 20                              | 66.66                            |
| ix        | Chips                                                                                 | 23                        | 76.66                         | 30                              | 100.0                            |
| x         | Sandwich                                                                              | 22                        | 73.33                         | 22                              | 73.33                            |
| xi        | Sonpapdi                                                                              | 28                        | 93.33                         | 30                              | 100.0                            |
| xii       | Panipuri                                                                              | 30                        | 100.0                         | 30                              | 100.0                            |
| xiii      | Bhel                                                                                  | 30                        | 100.0                         | 30                              | 100.0                            |
| xiv       | Burger                                                                                | 03                        | 10.00                         | 2                               | 6.66                             |
| xv        | Pizza                                                                                 | 02                        | 6.66                          | 4                               | 13.33                            |
| xvi       | Noodles                                                                               | 20                        | 66.66                         | 25                              | 83.33                            |
| xvii      | Maggi                                                                                 | 12                        | 40.00                         | 22                              | 73.33                            |
| xviii     | Pavbhaji                                                                              | 30                        | 100.0                         | 30                              | 100.0                            |
| xix       | Kurkure                                                                               | 21                        | 70.00                         | 22                              | 73.33                            |
| xx        | Manchurian                                                                            | 18                        | 60.00                         | 25                              | 83.33                            |
| xxi       | Chinese                                                                               | 16                        | 53.33                         | 20                              | 66.66                            |
| xxii      | Sweets                                                                                | 22                        | 73.33                         | 30                              | 100.0                            |

#### 4.11.4 Consumption Pattern of Functional Foods

The data on functional food ingredient consumption by selected subjects are presented in Table 19. Among the diabetic subjects, all subjects consumed garlic, tomatoes and citrus fruits. While 80 to 93.33 per cent subjects consumed fermented foods, flaxseed and soybean. The consumption of most of the functional foods found to be just by 6.66 to 30 per cent subjects. Green tea and omega 3 fatty acids capsules consumption was reported to be of its lowest (6.66 per cent subjects).

Almost similar pattern of functional ingredients consumption was noticed in hyperlipidemic subjects. The functional ingredients viz. garlic, tomatoes and citrus fruits were also consumed by all these subjects. In addition flaxseed and fermented foods were reported to be increased nearly by 17 and 7 per cent hyperlipidemic subjects respectively. The other functional food ingredients were found to be consumed by less number of hyperlipidemic subjects. The interpreted results indicated that functional food ingredient consumption not varied significantly. The interpreted results indicated that there was little variation among both groups of subjects in the consumption pattern of functional ingredients.

**Table 19. Consumption of functional foods by the selected subjects (n=60)**

| S. No. | Functional foods             | Diabetic Subjects (n=30) |            | Hyperlipidemic Subjects (n=30) |            |
|--------|------------------------------|--------------------------|------------|--------------------------------|------------|
|        |                              | Number                   | Percentage | Number                         | Percentage |
| 1      | Flaxseed                     | 25                       | 83.33      | 30                             | 100.0      |
| 2      | Soybean                      | 24                       | 80.00      | 22                             | 73.33      |
| 3      | Garden cress seeds           | 3                        | 10.00      | 2                              | 6.66       |
| 4      | Oats                         | 4                        | 13.33      | 3                              | 10.00      |
| 5      | Multigrain flour             | 9                        | 30.00      | 8                              | 26.66      |
| 6      | Garlic                       | 30                       | 100.0      | 30                             | 100.0      |
| 7      | Tomatoes                     | 30                       | 100.0      | 30                             | 100.0      |
| 8      | Fermented foods              | 28                       | 93.33      | 30                             | 100.0      |
| 9      | Green tea                    | 2                        | 6.66       | 3                              | 10.00      |
| 10     | Wheat bran                   | 3                        | 10.00      | 6                              | 20.00      |
| 11     | Citrus fruits                | 30                       | 100.0      | 30                             | 100.0      |
| 12     | Omega 3 fatty acids capsules | 2                        | 6.66       | 2                              | 6.66       |
| 13     | Millets                      | 8                        | 26.66      | 6                              | 20.00      |
| 14     | Anti diabetic tea            | 3                        | 10.00      | 4                              | 13.33      |

#### **4.11.5 Purchasing and Purpose of Consumption of Functional Foods**

Less than 50 percent subjects were aware about the functional foods. Health professionals could influence only 33.33 per cent subjects about the functional ingredients from both categories. Maximum (83.33 diabetics and 86.66% hyperlipidemics) subjects purchased it as its price was less, followed due to the reasons that these foods are tasty (73.33 and 76.66 % respectively). Thus it can be concluded that cost, taste and availability of functional food in the market are most influenceable reasons of purchasing functional foods in both type of subjects.

Majority of the subjects belonging to both the groups consumed it believing that it helps for maintenance of good health (60% diabetics and 53.33% hyperlipidemics). Some of them (43.33 % both groups) thought that such foods help to lower cholesterol, aid in red blood cell formation (43.33 & 26.66 %) and aid in maintaining health of skin and membranes (40 and 43.33 %) respectively. Reasons of purchasing and purpose of consumption of functional foods cited in Table 20 clearly showed that cost was the most influenceable factor in purchasing of these foods followed by good taste and its availability in the market in both type of subjects. Health professional's influence on purchase of functional food was at its lowest followed by its awareness. When the subjects were interviewed for purpose of functional food consumption, it was observed that in general it was consumed for maintenance of good health.

This finding tallies with the statement that a significant purchase driver for food in Mauritius is price being the key determinant (Austrade, 2007).

**Table 20. Purchasing and purpose of consumption of functional foods by the selected subjects**

| S. No.    | Functional foods                                        | Diabetic Subjects (n=30) |            | Hyperlipidemic Subjects (n=30) |            |
|-----------|---------------------------------------------------------|--------------------------|------------|--------------------------------|------------|
|           |                                                         | Number                   | Percentage | Number                         | Percentage |
| <b>1.</b> | <b>Reasons of purchasing of functional foods</b>        |                          |            |                                |            |
| i         | Awareness/ knowledge                                    | 13                       | 43.33      | 12                             | 40.00      |
| ii        | Health professional influence                           | 10                       | 33.33      | 10                             | 33.33      |
| iii       | Availability in market                                  | 20                       | 66.66      | 22                             | 73.33      |
| iv        | Good taste                                              | 22                       | 73.33      | 23                             | 76.66      |
| v         | Low Cost                                                | 25                       | 83.33      | 26                             | 86.66      |
| <b>2</b>  | <b>Purpose of consumption</b>                           |                          |            |                                |            |
| i         | Helps lower cholesterol                                 | 13                       | 43.33      | 12                             | 43.33      |
| ii        | Helps for the formation and maintains of bone and teeth | 9                        | 30.00      | 8                              | 26.66      |
| iii       | Dietary antioxidant                                     | 3                        | 10.00      | 4                              | 13.33      |
| iv        | Maintaince of good health                               | 18                       | 60.00      | 16                             | 53.33      |
| v         | Help build antibodies                                   | 3                        | 10.00      | 6                              | 20.00      |
| vi        | Promotes regularity                                     | 5                        | 16.66      | 8                              | 26.66      |
| vii       | Helps build and repair body tissue                      | 10                       | 33.33      | 9                              | 30.00      |
| viii      | Aids in maintaining the health of skin and membranes    | 12                       | 40.00      | 13                             | 43.33      |
| Ix        | Aids in red blood cell formation                        | 13                       | 43.33      | 8                              | 26.66      |

#### **4.11.6 Food and Nutrient Intake of the Selected Diabetic Subjects**

##### **4.11.6.1 Food Intake of the Selected Diabetic Subjects**

Intake of all the food groups among the male and female diabetic subjects studied in present investigation (Table 21 and Fig. 7 & 8) clearly show that except fat and oils intake of all foods was deficient. According to American Heart Association (2012), high amounts of fats and sugar go hand in hand in triggering obesity, diabetes and CVD. The same study revealed that south Indian populations carry more fat mass for a given BMI which increases the risk for diabetes and CVD. Intake of fruits was lowest (46.2 %) in male diabetic subjects intake of other vegetables was lowest (-40.9%). Further it was noticed that intake of sugar and jaggery was less in female diabetic subjects (-30.4 %). Next to fruits, intake of sugar and jaggery (-37.8%), other vegetables (-37.6 %), milk and milk products (-35.6 %) and roots and tubers (-36 %) found to be less than ICMR suggested amount in the female subjects. In both the groups the intake of only fats and oils is excess which is not desirable. However, the less consumption of sugars and jaggery is beneficial for the diabetic subjects. A study conducted on lifestyle and nutritional profile of NIDDM patients by Kaur and Karla (2009) showed that the average intake of cereals, milk and milk products, fats and oils was more than suggested intakes.

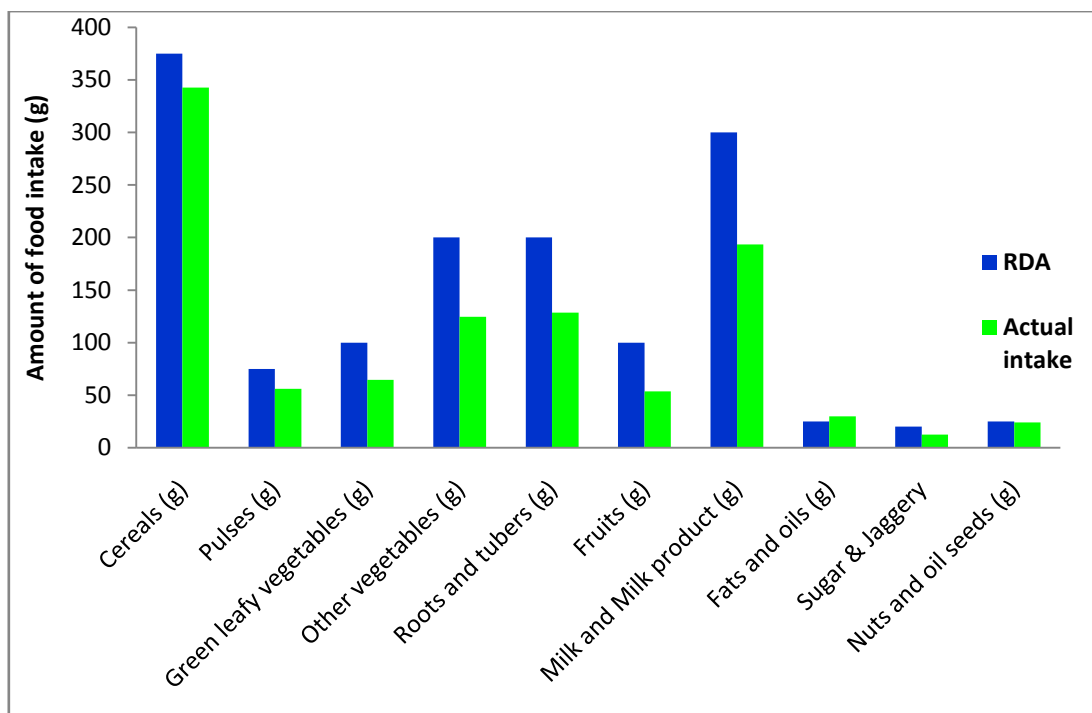


**Fig. 6 Food intake of the selected diabetic male subjects**

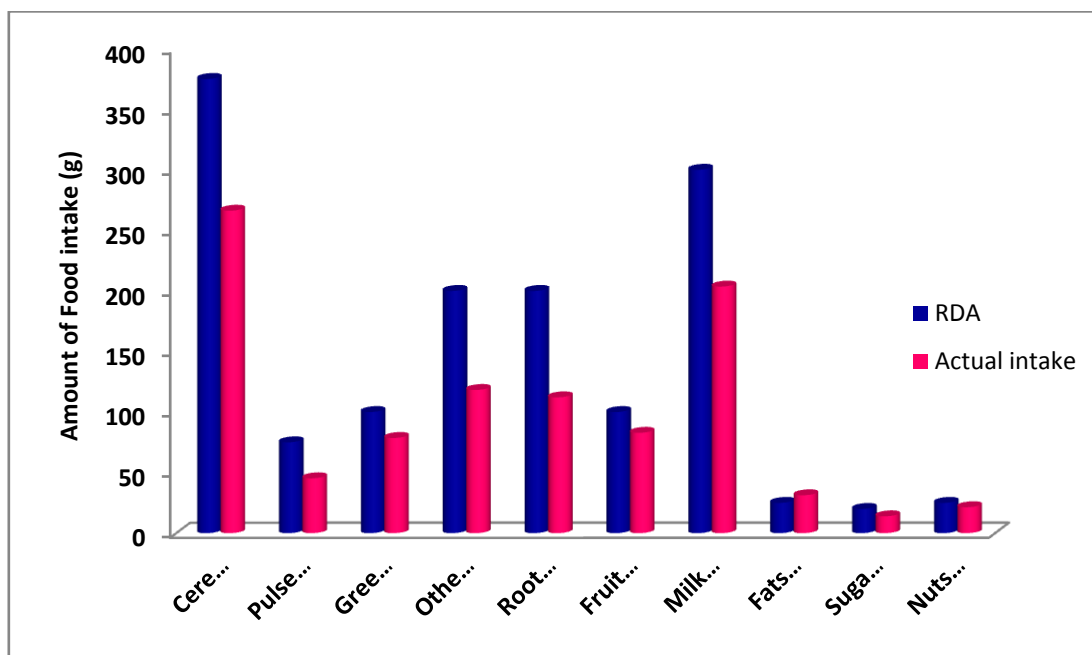


**Fig. 7 Food intake of the selected diabetic female subjects**

**Table 21. Food intake of the selected Diabetic subjects (n= 30)**

| S. No | Food Groups                | Diabetic Male Subjects<br>( n= 16)  |                |                      |                     | Diabetic Female Subjects<br>( n= 14) |                   |
|-------|----------------------------|-------------------------------------|----------------|----------------------|---------------------|--------------------------------------|-------------------|
|       |                            | Suggested<br>Intake<br>ICMR<br>2010 | Actual Intake  | Excess/<br>Deficit % | RDA<br>ICMR<br>2010 | Actual Intake                        | Excess/ Deficit % |
| 1     | Cereals (g)                | 375                                 | 342.62 ± 65.51 | -8.8                 | 270                 | 266.21 ± 48.5                        | -1.41             |
| 2     | Pulses (g)                 | 75                                  | 56.06± 8.84    | -25.4                | 60                  | 45.28 ±15.82                         | -24.5             |
| 3     | Green leafy vegetables (g) | 100                                 | 64.68± 31.05   | -35.3                | 100                 | 78.57±32.31                          | -21.3             |
| 4     | Other vegetables (g)       | 200                                 | 124.62± 54.08  | -37.6                | 200                 | 118.21± 38.21                        | -40.9             |
| 5     | Roots and tubers (g)       | 200                                 | 128.68± 37.25  | -36                  | 200                 | 112.12± 51.57                        | -44               |
| 6     | Fruits (g)                 | 100                                 | 53.75± 32.83   | -46.2                | 100                 | 82.85±34.95                          | -17.15            |
| 7     | Milk and Milk product (g)  | 300                                 | 193.31± 45.08  | -35.6                | 300                 | 203.57±36.5                          | -32.15            |
| 8     | Fats and oils (g)          | 25                                  | 29.81± 6.20    | +19                  | 20                  | 31.28±5.1                            | +56.00            |
| 9     | Sugar & Jaggery            | 20                                  | 12.5 ± 5.7     | -37.8                | 20                  | 13.92±6.84                           | -30.4             |
| 10    | Nuts and oil seeds (g)     | 25                                  | 24.12± 8.66    | -3.6                 | 25                  | 21.42± 8.4                           | -14.35            |

#### 4.11.6.2 Nutrient Intake of the Selected Diabetic Subjects

Nutrient intake of selected diabetic subjects was calculated and the data there on are presented in Table 22.

Nutrient intake of the diabetic male and female subjects showed that fat calcium, thiamine, ascorbic acid and carbohydrate intake in male diabetic subjects surpassed by 181.2, 106, 159 and 107 per cent respectively over the RDA suggested by ICMR, 2010. While in female diabetic subjects the adequacy of fat, calcium, riboflavin, niacin, ascorbic acid and carbohydrate intake was 193, 101, 113, 104, 180 and 109 per cent. The intake of these nutrients was higher than suggested by ICMR for female subjects.

Rest of the nutrients intake was found to be lower than the RDA. Among the studied nutrients fibre intake was lowest which was only 35.9 and 37.95 percent, respectively in male and female diabetic subjects. The protein and energy intake was also found to be deficient. Another nutrient which was deficient in male (-11mg) and in female (-23.07 mg) was iron.

These results clearly show that protein, energy, iron and fiber intake was lower than the RDA of ICMR among both these subjects. While fat consumption exceeded than RDA given by ICMR.

The observed deficit intake of protein and excess intake of fats and carbohydrates among both male and female diabetic individuals is not recommended. It may lead to obesity and even it may complicate the health condition of the subjects.

Jain *et al.*, (2013) reported deficient nutrient intake of all the nutrients except fat among diabetic subjects. The average energy intake was  $1307.40 \pm 204.05$  Kcal among women and it was  $1171.80 \pm 183.27$  among women which is far less than the present study. Kaur and Karla (2009) reported 1413 Kcal energy, 220 g carbohydrates, 62g protein, 32 g fat and 11.9 g dietary fiber intakes per day by NIDDM subject from Punjab. In another study conducted by Garg and Varmani (2014) it was noticed that intake of fat, calcium and vitamin C was significantly higher than RDA in diabetic adults. These findings are in line with the findings of present investigation.

**Table 22. Nutrient Intake of the selected Diabetic Subjects (n=30)**

| S. No | Nutrients         | Diabetic Male Subjects ( n= 16) |                  |                      |               |                     | Diabetic Female Subjects ( n= 14) |                      |            |
|-------|-------------------|---------------------------------|------------------|----------------------|---------------|---------------------|-----------------------------------|----------------------|------------|
|       |                   | RDA<br>ICMR<br>2010             | Actual<br>Intake | Excess/ Deficit<br>% | %<br>Adequacy | RDA<br>ICMR<br>2010 | Actual<br>Intake                  | Excess/<br>Deficit % | % Adequacy |
| 1     | Energy (kcal)     | 2320                            | 2273 ± 318       | -2.20                | 97.9          | 1900                | 1811.01 ± 4.14                    | -4.68                | 95.31      |
| 2     | Protein (g)       | 60                              | 47.49 ±8.2       | -20.85               | 79.15         | 55                  | 41.48 ±11.14                      | -24.5                | 75.4       |
| 3     | Fat (g)           | 25                              | 54.31±6.28       | +81.2                | 181.2         | 20                  | 38.70±4.4                         | +93.5                | 193        |
| 4     | Fiber (g)         | 40                              | 11.9 ±7.15       | -64.1                | 35.9          | 40                  | 15.18± 3.8                        | -62.05               | 37.95      |
| 5     | Calcium (mg)      | 600                             | 789±92.38        | +31.6                | 131           | 600                 | 607.07± 13.51                     | +1.17                | 101        |
| 6     | Iron (mg)         | 17                              | 15.13±3.03       | -11                  | 89            | 21                  | 16.01±3.59                        | -23.07               | 76         |
| 7     | β –carotene (µg)  | 4800                            | 2930±15.09       | -38.95               | 61            | 4800                | 3046±120.07                       | -36.5                | 63.4       |
| 8     | Thiamine (mg)     | 1.2                             | 1.28±0.33        | +6.2                 | 106           | 1.0                 | 0.88±0.35                         | -14                  | 88         |
| 9     | Riboflavin (mg)   | 1.4                             | 1.34±0.42        | -4.3                 | 95.7          | 1.1                 | 1.25±0.57                         | +13.6                | 113        |
| 10    | Niacin (mg)       | 16                              | 15.33±2.83       | -2.94                | 97            | 12                  | 12.5±0.57                         | +4.1                 | 104        |
| 11    | Vitamin C (mg)    | 40                              | 63.85±12.91      | +59.6                | 159           | 40                  | 72.15±15.38                       | +80.3                | 180        |
| 12    | Carbohydrate ( g) | 380                             | 409±83.61        | +7.8                 | 107           | 380                 | 416.72±87.4                       | +9.66                | 109        |

#### **4.11.6.3 Food Intake of the Selected Hyperlipidemic Subjects**

Food intake data of the selected hyperlipidemic subjects presented in Table 23 and Fig. 9 showed that male and female subjects consumed less amount of cereals, pulses, roots and tubers, green leafy vegetables, other vegetables, fruits and milk and milk products. The percent deficit over suggested intakes was 15.2, 32, 46.8, 48, 45.5, 44, 32 for male and 5.73, 19.45, 35.54, 37.78, 33.32, 14.15 and 27.78 for female subjects respectively. Observations recorded above revealed that in general the deficit of food intake was more pronounced in males than female hyperlipidemic subjects. Further scrutiny of data from Table 23 indicated that fats and oil, sugar or jaggery, nuts and oil seeds consumption was excess than the suggested dietary intake ICMR, 2010. In males it was 32, 55 and 4 per cent excess respectively while in females it was 83.3, 67.2 and 16.82 per cent excess respectively.

The magnitude of deficit food intake was more alarming in hyperlipidemic males than their counter part females. Similarly the consumption of fats, sugar and nuts was less in the males than females. However, its intake was more than the suggested intakes given by ICMR (2010). The gross deficit of pulses, green leafy and other vegetables and milk and milk products is not desirable as those are major protective food groups. Its good that they are consuming less amount of roots and tubers as they are rich in carbohydrates and all the hyperlipidemic subjects are obese (Table 29).

**Table 23. Food intake of the selected hyperlipidemic subjects (n=30)**

| S. No | Food Groups                   | Hyperlipidemic Male Subjects<br>( n= 16) |                |                      |                                     | Hyperlipidemic Female<br>Subjects( n= 14) |                      |
|-------|-------------------------------|------------------------------------------|----------------|----------------------|-------------------------------------|-------------------------------------------|----------------------|
|       |                               | Suggested Intake<br>ICMR<br>2010         | Actual Intake  | Excess/<br>Deficit % | Suggested<br>Intake<br>ICMR<br>2010 | Actual Intake                             | Excess/<br>Deficit % |
| 1     | Cereals (g)                   | 375                                      | 318.33 ± 87.39 | -15.2                | 270                                 | 254.55 ± 42.35                            | -5.73                |
| 2     | Pulses (g)                    | 75                                       | 51.66±19.51    | -32                  | 60                                  | 48.33±25.73                               | -19.45               |
| 3     | Green leafy<br>vegetables (g) | 100                                      | 52.42±28.77    | -48                  | 100                                 | 62.22±38                                  | -37.78               |
| 4     | Other vegetables (g)          | 200                                      | 109.52± 32.78  | -45.5                | 200                                 | 133.77± 23.20                             | -33.32               |
| 5     | Roots and tubers (g)          | 200                                      | 107.61± 32.35  | -46.8                | 200                                 | 128.33± 23.18                             | -35.84               |
| 6     | Fruits (g)                    | 100                                      | 56.19±21.78    | -44                  | 100                                 | 85.55±24.55                               | -14.45               |
| 7     | Milk and Milk<br>product (g)  | 300                                      | 204.04±52.95   | -32                  | 300                                 | 216.66±35.35                              | -27.78               |
| 8     | Fats and oils (g)             | 25                                       | 33.05±8.56     | +32                  | 20                                  | 36.66±10.89                               | +83.3                |
| 9     | Sugar & Jaggery               | 20                                       | 31.04 ±9.11    | +55                  | 20                                  | 33.44±12.66                               | +67.2                |
| 10    | Nuts and oil seeds (g)        | 25                                       | 26.47± 11.44   | +4                   | 25                                  | 29.2± 9.18                                | + 16.82              |

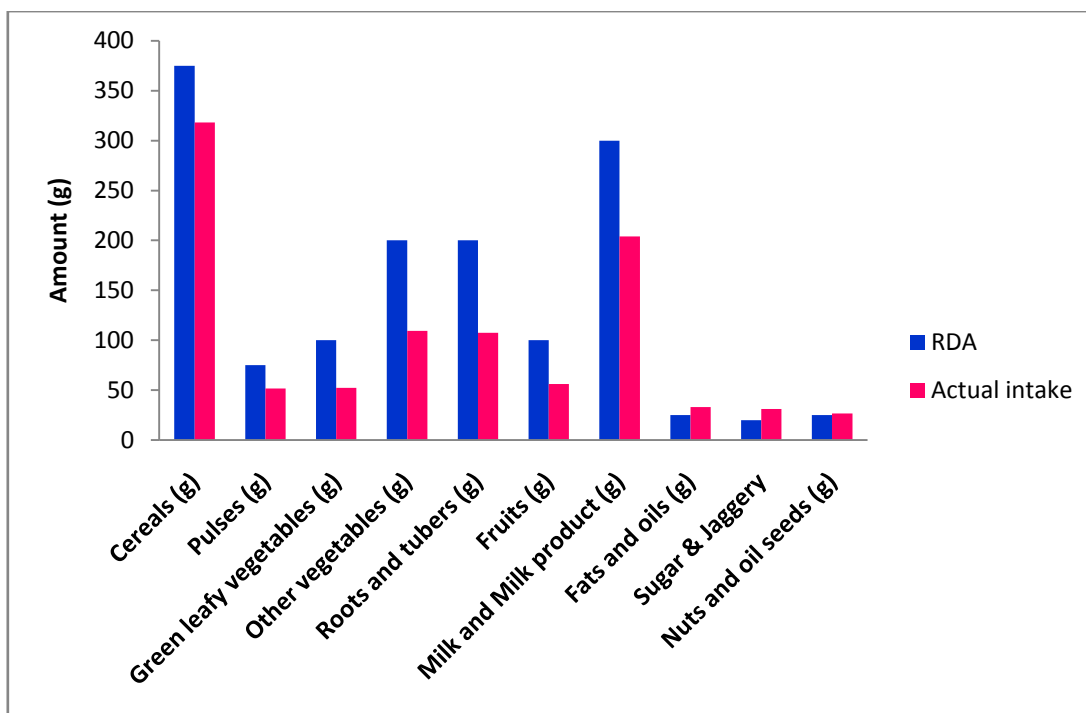


Fig. 8 Food intake of the selected hyperlipidemic male subjects

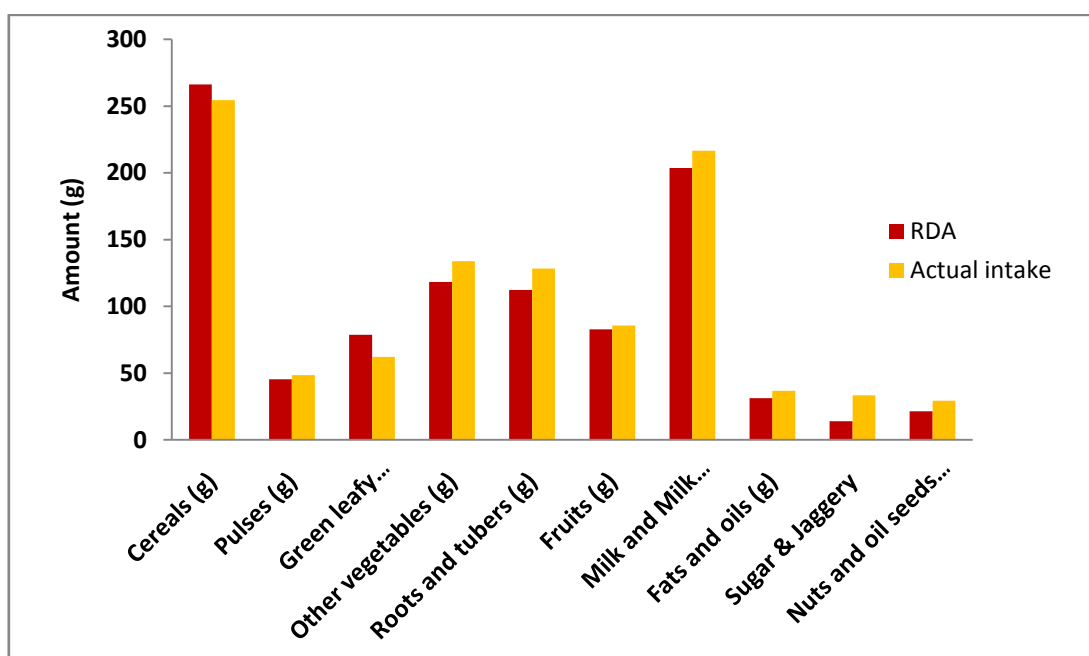


Fig. 9 Food intake of the selected hyperlipidemic female subjects

#### **4.11.6.4 Nutrient Intake of the Selected Hyperlipidemic Subjects**

In hyperlipidemic male subjects (Table 24) energy, protein, fiber, riboflavin and niacin intake found to be lower than the recommended dietary allowances. Maximum deficit (-52.26%) was recorded in fiber intake followed by protein (-17.85 %) and energy (-10.2 %). On the other hand intake of fat (+ 81 %), calcium (+ 28.90%),  $\beta$  carotene (-45.0 %), thiamine (+ 9.1%), ascorbic acid (54.1%) and carbohydrate (+ 100%) was surplus.

In case of female hyperlipidemic subjects almost similar pattern was exhibited. Fiber intake was lowest and it was 40 per cent of the RDAs. The second important nutrient found to be deficient was protein which was nearly 20 per cent lower than the RDAs. Further it can be observed that thiamine intake was 15 per cent lower for RDAs prescribed by ICMR for females. Fat, calcium, riboflavin, niacin, ascorbic acid and carbohydrate intake was more than recommended dietary allowances which were 259, 103, 109, 115, 195 and 107 per cent respectively.

These results clearly expressed deficit intake of very important nutrients viz. protein and iron in the diet of both hyperlipidemic male as well as females. On the other hand fat intake was more followed by ascorbic acid intake. Excessive consumption of fats and oils by hyperlipidemic male and female subjects is deleterious to health in view of their elevated blood cholesterol.

**Table 24. Nutrient Intake of the selected Hyperlipidemic Subjects (n=30)**

| S. No | Nutrients         | Hyperlipidemic Male Subjects<br>( n= 16) |               |                      |            |                     | Hyperlipidemic Female Subjects<br>( n= 14) |                      |               |
|-------|-------------------|------------------------------------------|---------------|----------------------|------------|---------------------|--------------------------------------------|----------------------|---------------|
|       |                   | RDA<br>ICMR<br>2010                      | Actual Intake | Excess/<br>Deficit % | % Adequacy | RDA<br>ICMR<br>2010 | Actual<br>Intake                           | Excess/<br>Deficit % | %<br>Adequacy |
| 1     | Energy (kcal)     | 2320                                     | 2084.66 ± 478 | -10.2                | 89.85      | 1900                | 1946.95 ± 19.1                             | + 0.38               | 102.4         |
| 2     | Protein (g)       | 60                                       | 49.29 ± 9.18  | -17.85               | 82.15      | 55                  | 44.10± 6.45                                | -19.8                | 80.1          |
| 3     | Fat (g)           | 25                                       | 45.46± 9.54   | +81                  | 180        | 20                  | 51 ± 11.45                                 | +159                 | 259           |
| 4     | Fiber (g)         | 40                                       | 19.09± 13.44  | -52.26               | 47.7       | 40                  | 16.03± 1.8                                 | -59.25               | 40.7          |
| 5     | Calcium (mg)      | 600                                      | 773.44±120.9  | +28.9                | 128.9      | 600                 | 620.8± 19.1                                | +3.33                | 103           |
| 6     | Iron (mg)         | 17                                       | 16.89±4.00    | -0.47                | 99.3       | 21                  | 17.72±1.15                                 | -15.61               | 84.3          |
| 7     | β –carotene (µg)  | 4800                                     | 2627.06±186.2 | -45.2                | 54.7       | 4800                | 3164.8±105.29                              | -34                  | 65.9          |
| 8     | Thiamine (mg)     | 1.2                                      | 1.31±0.34     | +9.1                 | 109        | 1.0                 | 0.85±1.81                                  | -15                  | 85            |
| 9     | Riboflavin (mg)   | 1.6                                      | 1.38±0.21     | -1.5                 | 98.5       | 1.1                 | 1.26±0.0.39                                | +9.09                | 109           |
| 10    | Niacin (mg)       | 16                                       | 15.33±5.3     | -1.69                | 98.31      | 12                  | 1.38±3.9                                   | +15                  | 115           |
| 11    | Vitamin C (mg)    | 40                                       | 61.64±10.79   | +54.1                | 154        | 40                  | 78.20±9.50                                 | +95.5                | 195           |
| 12    | Carbohydrate ( g) | 380                                      | 419.7±149.6   | +10.4                | 110.2      | 380                 | 409.9±49.05                                | +7.88                | 107           |

#### **4.12 Exercise Pattern of the Selected Subjects**

Exercise makes an individual lead a healthy life as well as increases the lifespan tremendously. Exercise plays an important role in an every individual's life. It also plays a major role in many of the degenerative diseases like cardiovascular disease, diabetes, obesity and hypertension. It also helps to reduce high blood pressure, increased blood cholesterol levels as well as increased blood glucose levels (Dietary Guidelines, ICMR, 2010).

Exercise or physical activity plays an important role in diabetes and cardiovascular diseases. Regular exercise can increase the sensitivity of body tissues to insulin by more than 30 per cent (WHO, 2016). It helps to correct the associated lipid abnormalities and can increase cardiovascular fitness.

The data related to exercise pattern, type of exercise and its frequency are reported in Table 25. Seventy per cent diabetic subjects and 40 per cent hyperlipidemic subjects do exercise while rest of the subjects were not performing the exercise. In respect of type of exercise 70 per cent diabetic subjects go for walking while 23.33 hyperlipidemic subjects opt walking as an exercise. Yoga found to be performed by 53.33 per cent diabetic subjects while only 10 per cent hyperlipidemic indicated performed yoga as an exercise. Thirty percent diabetic subjects do yoga and pranayam while only 6.66 per cent hyperlipidemic subjects do yoga and pranayam. Only two diabetic subjects go for aerobics. The higher percentage of diabetic subjects (43.33%) found to perform exercise daily whereas only 13.33 hyperlipidemic subjects practice it daily. Both diabetic and hyperlipidemic subjects (26.66% each) go for walking weekly.

It is inferred from interpretation of data of table 25 that diabetic subjects are more aware about their health and hence, their number was found to be more in performance of exercise. This observation is supported by the studies quoted by Gupta (2000), establishing the risk factor- sedentary life style for CVD and other metabolic disorders like diabetes and obesity.

Regular physical activity and exercise are important components in the prevention of diabetes. In addition to lowering blood glucose, exercise

improves insulin action, contributes to weight loss, and reduces several risk factors for cardiovascular disease and diabetes (Castaneda C, *et al.*, 2003).

**Table 25. Exercise pattern of the selected subjects (n=60)**

| S. No. | Particulars                  | Diabetic subjects<br>(n = 30) |            | Hyperlipidemic subjects<br>(n= 30) |            |
|--------|------------------------------|-------------------------------|------------|------------------------------------|------------|
|        |                              | Number                        | Percentage | Number                             | Percentage |
| 1.     | <b>Exercise performed</b>    |                               |            |                                    |            |
|        | Yes                          | 21                            | 70         | 12                                 | 40         |
|        | No                           | 9                             | 30         | 18                                 | 60         |
| 2.     | <b>Types of Exercise</b>     |                               |            |                                    |            |
|        | Walking                      | 21                            | 70.00      | 7                                  | 23.33      |
|        | Yoga                         | 16                            | 53.33      | 3                                  | 10.00      |
|        | Yoga and pranayam            | 9                             | 30.00      | 2                                  | 6.66       |
|        | Aerobics                     | 2                             | 6.66       | -                                  | -          |
| 3.     | <b>Frequency of exercise</b> |                               |            |                                    |            |
|        | Daily                        | 13                            | 43.3       | 4                                  | 13.33      |
|        | Weekly                       | 8                             | 26.6       | 8                                  | 26.66      |

#### **4.12.1 Utilization of Leisure Time by Diabetic and Hyperlipidemic Subjects**

The utilization of leisure time by diabetic and hyperlipidemic subjects are presented in Table 26. It is reported from data that 100 per cent diabetic and hyperlipidemic subject spent their time in watching TV, chit chatting with family and friends, where as 86.66 per cent diabetic subjects and 83.33 per cent hyperlipidemic subjects spent their time in reading and watching.

There was no variation in respect of duration of leisure time among two groups of subjects. However, more number of subjects (53.33 %) takes two hour leisure time, while 40 per cent subjects used 1-2 hour leisure time and only two subjects out of 30 had less than one hour leisure time.

All subjects of both the categories watch TV regularly. Maximum number of subjects do their own food shopping, data showed that 76.66 per cent diabetic subjects preferred their own food shopping while little less i.e. 73.33 per cent hyperlipidemic subjects food shopping.

These results clearly indicated that watching TV and chitchatting found to be more common leisure time activity among the subjects. All of them are very regular in TV watching and do their own food shopping.

This observation is supported by the studies quoted by Gupta (2000), while establishing the risk factor- sedentary life style for CVD and other metabolic disorders like diabetes and obesity. Television viewing time, the predominant leisure-time sedentary behavior, is associated with biomarkers of cardiometabolic risk (Dunstan *et.al*, 2010, Hu FB, 2002). Prolonged TV viewing was associated with increased risk of type 2 diabetes, cardiovascular disease, and all-cause mortality (Grøntved A, and Hu FB, *et.al*, 2010).

**Table 26. Utilization of leisure time by selected subjects (n=60)**

| S. No. | Particulars                     | Diabetic subjects (n = 30) |            | Hyperlipidemic subjects (n= 30) |            |
|--------|---------------------------------|----------------------------|------------|---------------------------------|------------|
|        |                                 | Number                     | Percentage | Number                          | Percentage |
| 1.     | <b>Activity</b>                 |                            |            |                                 |            |
|        | Watching TV                     | 30                         | 100        | 30                              | 100.0      |
|        | Reading and writing             | 26                         | 86.6       | 25                              | 83.33      |
|        | Chitchatting with family        | 30                         | 100        | 30                              | 100.0      |
|        | Chitchatting with friend        | 30                         | 100        | 30                              | 100.0      |
| 2      | <b>Duration of leisure time</b> |                            |            |                                 |            |
|        | >2hr                            | 16                         | 53.3       | 16                              | 53.3       |
|        | 1-2 hr                          | 12                         | 40         | 12                              | 40         |
|        | < 1hr                           | 2                          | 6.6        | 2                               | 6.6        |
| 3      | <b>Watching TV regularly</b>    |                            |            |                                 |            |
|        | Yes                             | 30                         | 100        | 30                              | 100        |
|        | No                              | 0                          | 0          | 0                               | 0          |
| 4.     | <b>Food shopping</b>            |                            |            |                                 |            |
|        | Yes                             | 23                         | 76.6       | 22                              | 73.3       |
|        | No                              | 7                          | 23.3       | 8                               | 26.6       |

#### 4.12.2 Undesirable Habits among the Selected Male Subjects

The lifestyle pattern is mainly affected by the epidemiological transition with increased globalization. As most of the population was busy in their day-to-day activities they are much prone to easily accessible foods like ready to eat and fast foods etc., which is mainly affecting the lifestyle of a particular individual.

The data regarding undesirable habits among selected subjects was gathered and tabulated (Table 27). There were 16 (53.28 %) diabetic and 21 (70%) hyperlipidemic men who had some or other undesirable habit. Not even a single female subject had undesirable habits listed in the table. There were 31.25 per cent and 36.09 per cent hyperlipidemic subjects who were drinking alcoholic beverages. The frequency of consumption was weekly (12.5 and 14.28 %) and occasionally (18.75 and 23.80 %) among diabetic and hyperlipidemic subjects respectively. Tobacco chewing was noticed among 37.5 and 42.85 per cent diabetic and hyperlipidemic subjects respectively. The diabetic subjects were chewing it daily while 33.33 per cent hyperlipidemic subjects chewed it daily and 9.52 per cent subjects were chewing once a week. Out of 16 diabetic men six men were smoking cigarettes. A large number of hyperlipidemics (57.14 %) were smoking, out of which 38.09 per cent subjects smoke daily. Few hyperlipidemic subjects (2%) smoke weekly or occasionally.

The factors listed in the table are potential risk factors for development of cardiovascular diseases and diabetes. Alcohol can cause many health problems such as heart failure, stroke and irregular heart beat. It can be a cause of hypertension. Using tobacco can cause rise in blood pressure and contribute to damage arteries. In a WHO (2016) health sheet, it is mentioned that more than 3.3 million annual deaths attributes to alcohol use and tobacco accounts for 7.2 million deaths every year.

A study by Arora (2012) showed that among Indians even low levels of alcohol consumption increases the risk of coronary artery diseases by 40 per cent. Patel *et al.*, (2012) noticed while studying the factors associated with type 2 diabetes that 24 per cent subjects under study were smokers and 8 per cent were consuming alcohol.

Cigarette smoking is thought to be major risk factor and an important cause of morbidity and mortality in developed and developing countries. In a crosssectional study by Yathish *et al.*, (2011) it is showed that the occurrence of coronary artery disease was higher in the smokers (61 per cent), as compared to the non-smokers (36 per cent), which was significant. They also

concluded that, smoking not only accelerates the early onset of coronary artery disease but also increases the risk of the development of coronary artery disease by more than 80 per cent. In another case-controlled study carried out by Ram and Trivedi (2012) it is reported that smokers and smokeless tobacco users were significantly higher among the cases as compared to controls. Significant association was also observed between current smokers, smokeless tobacco users and coronary artery disease. Strong associations were also observed between frequency and duration of smoking with coronary artery disease.

**Table 27. Undesirable habits among selected male subjects (n=37)**

| S. No. | Particulars                      | Diabetic subjects<br>(n = 16) |            | Hyperlipidemic subjects<br>(n= 21) |            |
|--------|----------------------------------|-------------------------------|------------|------------------------------------|------------|
|        |                                  | Number                        | Percentage | Number                             | Percentage |
| 1.     | <b>Drink alcoholic Beverages</b> |                               |            |                                    |            |
|        | Yes                              | 05                            | 31.25      | 08                                 | 38.09      |
|        | No                               | 11                            | 68.75      | 13                                 | 61.90      |
|        | <b>Frequency of consumption</b>  |                               |            |                                    |            |
|        | Daily                            | -                             | -          | -                                  | -          |
|        | Weekly                           | 2                             | 12.5       | 3                                  | 14.28      |
|        | Occasionally                     | 3                             | 18.75      | 5                                  | 23.80      |
| 2      | <b>Tobacco</b>                   |                               |            |                                    |            |
|        | Yes                              | 6                             | 37.5       | 9                                  | 42.85      |
|        | No                               | 10                            | 62.5       | 12                                 | 37.14      |
|        | <b>Frequency</b>                 |                               |            |                                    |            |
|        | Daily                            | 6                             | 37.5       | 7                                  | 33.33      |
|        | Weekly                           | -                             | -          | 2                                  | 9.52       |
| 3      | <b>Cigarette smoking</b>         |                               |            |                                    |            |
|        | Yes                              | 6                             | 37.5       | 12                                 | 57.14      |
|        | No                               | 10                            | 62.5       | 9                                  | 42.85      |
|        | <b>Frequency</b>                 |                               |            |                                    |            |
|        | Daily                            | 2                             | 6.66       | 8                                  | 38.09      |
|        | Weekly                           | 3                             | 10.00      | 2                                  | 9.52       |
|        | Occasionally                     | 1                             | 3.33       | 2                                  | 9.52       |

## **4.13 Anthropometric Measurements of the Selected Diabetic & Hyperlipidemic Subjects**

### **4.13.1 Anthropometric Measurements of Diabetic Subjects Before and after Intervention**

Anthropometry is a simple technique to measure body size and proportions. The quantification of the measurements of body weight, length, width, various circumferences and skinfold thickness is done with this technique. The advantages of this technique are that it is portable, non invasive, in expensive, useful and reliable method. It is most widely used method to measure body composition.

In present investigation weight, height, mid upper arm circumference, triceps skinfold thickness, waist circumference and hip circumference were measured. The BMI and WHR were calculated before and after giving the supplementation of developed *Heartdiabocare Snack*.

Gender wise anthropometric measurements of selected diabetic subjects (Table 28 and Fig 10-23) indicated that the average weight of diabetic men 73.5 to 74.33 kg and that of women ranged between 67.2 to 68.4 kg before supplementation. There was no significant difference in recorded anthropometric measurements of experimental and control group men and women before and after supplementation of *Heartdiabocare Snack*. However, there was slight decrease in the weight of experimental group men and women (1 and 1.2 Kg respectively). The height of the selected men was between 168 and 169.83 cm and of women was 154.8 and 155.66 cm. The BMI values indicate that in the beginning of the intervention it was 25.87 to 26.54 for men while it was 25.20 to 28.66 for women at the end of the intervention. All the selected subjects were categorized as obese as they had more than 25 BMI. No significant change was noticed in the BMI values of both experimental and control group men and women. The mean initial MUAC of experimental group men was 30.39 cm which was reduced to 30.02 cm. The mean initial values of MUAC in experimental group women 29.2 cm which was reduced to 28.8 cm after supplementation. In control group men MUAC was 28.33 cm and for

women it was 26.5 cm at the beginning of the experiment. It was 27.83 cm for men and 27.25 cm for women after intervention.

In male diabetics TSFT was 24.37 mm and 22.83 mm initially while the final values were 24.12 mm and 22.5 mm in experimental group and control group respectively. The female diabetics from experimental and control group exhibited 24.2 mm and 24.75 mm TSFT before the experiment respectively. After supplementation TSFT values were 23.6 and 24.5 respectively for experimental and control group women.

Waist circumference of experimental group men was 99.87 cm while it was 98.33 cm in control group men initially. The final values were 98.75 cm and 98.3 cm in both groups respectively. The WC was 100.6 cm in experimental group women which was reduced to 99.8 cm after supplementation. Among control group women the waist circumference was 97.75 cm initially which was slightly increased to 98.37cm within two months.

The hip circumference of experimental and control group men in the beginning and of experiment was 104.87 cm, 101.33 cm and 103.75 cm and 101.66 cm respectively. The female respondents recorded these values as 107.6 cm, 106.37 cm and 106.8 cm, 107.12 cm respectively.

The waist hip ratio is also one of the determinants for the major health risks in life at present situation.

The waist hip ratio of the men from both groups and women from control group remained same even after supplementation which was 0.95 for experimental group men 0.97 for control group males and 0.92 for control group women. There was slight reduction in WHR of experimental group females after supplementation.

The tabulated data regarding anthropometry of selected subjects indicated that none of the anthropometric measurements changed significantly due to supplementation with *Heartdiabocare Snack*. Though statistically it was not proved, the scrutiny of data reveals that there was reduction of at least one to two kg weight among both male and female respondents in two months period. This may be due to the higher fiber content of the supplement. If the

supplement is continued as a breakfast food for longer period it may be possible for the subjects to attain desired body weight.

All of the selected diabetic subjects were in obese category based on BMI as it exceeded the value  $23\text{kg/m}^2$  which is cut off value given by WHO (2010) for Asian population. Reduction in the measurements of MUAC from 30.39 to 30.02 cm for men and from 29.2 to 28.8 cm in women, TSFT from 24.37 to 24.12 mm in men and from 24.2 to 23.6 in women, WC from 99.87 to 98.75 in men and 100.6 to 99.8 cm for women and for Hip circumference from 140.87 to 103.75 in men and 107.6 to 106.8 cm for women was noticed. Such reduction in experimental group subjects is an indication of the effectiveness of the developed *Heartdiabocare Snack* for acquiring normal body measurements, provided it is consumed for longer duration than two months.

Pan *et al.*, (2009) reported in a study conducted on 'Effect of flaxseed derived lignin supplement in type II diabetic patients' that no differences were observed after supplementation in weight and BMI of the subjects. Kaur *et al.*, (2009) observed BMI 24.98, waist circumference 89.7cm, WHR 0.93 in Industrial Employees enrolled in a study conducted for predicting hypertension and Type II diabetes. Shankarappa *et al.*, (2013) recorded mean weight 65.77 to 66.86 kg, BMI 22.60 to 23.0, WHR 0.96 in type II diabetic men subjects while conducting a study on anthropometric variables predicting risk factors of coronary artery disease among type II diabetic patients. Thakur *et al.*, (2009) also noticed that there was no significant change in BMI and WHR in diabetic subjects after supplementation with flaxseed

### **.13.2 Anthropometric Measurements of Hyperlipidemic Subjects Before and after Intervention**

Gender wise anthropometric measurements of selected hyperlipidemic subjects before and after supplementation are shown in Table 29. The similar trend of observations with respect to gender wise anthropometric measurements of the selected hyperlipidemic subjects was noticed (Table 29 and Fig. 24-37).

The weight of hyperlipidemic subjects was 75.62 kg and 70.87 kg at the time of selection for experimental and control group respectively. While the experimental and control group women weighed 70.4 kg and 65.25 kg respectively. After the implementation of intervention there was reduction in the weight of experimental group male and female hyperlipidemic subjects. The weight of men was reduced by 1.5 kg and of women it was reduced by 2 kg. However, it could not reach to the level of significance when it was compared statistically. The weight of control group men remained same while it was increased in women after a period of two months.

The mean height of hyperlipidemic men ranged between 169.1 and 170.0 cm. The mean values of height of female subjects ranged from 153.5 to 156.8 cm.

Initially BMI of the male respondents from experimental group and control group was 26.5 and 24.52 respectively. It was slided down to 25.99 in the experimental group, after consuming *Heartdiabocare Snack* for two months. This reduction can be attributed to the reduction in the weight of the subjects. Similarly the BMI of experimental group women was also declined from 27.47 to 28.63 after intervention. There was no change in the BMI of control group men and an increase by 0.87 was noticed in control group women. There was no change in the BMI of control group men and an increase by 0.87 was noticed in control group women.

MUAC of hyperlipidemic experimental group and control group men was 31.25 and 32.37 cm initially and 31.25 and 32.37 cm post intervention respectively. Female respondents of experimental and control group exhibited

mean MUAC 32.24 and 29.75 cm pre intervention while 31.84 and 29.25 cm after supplementation respectively.

Mean TSFT in men was 28.25mm in the supplemented group and 27.62 mm in non supplemented group before and after supplementation, the corresponding values were 28.12 and 27.37 respectively. For women hyperlipidemics of supplemented group mean TSFT was 26.4 mm initially which was reduced to 26.2 mm after feeding trials. Control group female subjects had 27.25 mm and 26.75 mm TSFT before and after supplementation.

The similar trend of observations was recorded by waist circumference, hip circumference and WHR. While there was no change or slight increase in the control group was noticed. There was slight decrease in the values after feeding experiments. Neither the reduction nor the increase could reach to statistical significance in both the group.

There was reduction in the mean values of MUAC, TSFT, WC, HC and WHR by 0.25 cm, 0.13 mm, 1.38cm, 0.5cm and 0.01 respectively among men during post supplementation period. Alike men the reduction in the corresponding measurements of experimental group women was 0.4 cm, 0.20 mm, 1.4 cm, 1.2 cm respectively. Though there was numerical decrease in the above said measurements it was not significant statistically. These observations concluded that the *Heartdiabocare Snack* supplementation for 60 days could not bring noticeable change in various body measurements. Supplementation of diet with flaxseed to dyslipidemic subjects for 12 weeks resulted in decreasing weight by 2.2 kg and in BMI by 0.13 with flaxseed and 0.87 with soybean supplementation (Katara and Saxena, 2012).

**Table 28. Gender wise anthropometric measurements of selected diabetic subjects before and after supplementation (mean  $\pm$  SD)**

| Anthropometric Measurements | Experimental Group men (n-10) |                   |                    | Control Group men (n- 6) |                   |                    | Experimental Group women (n- 5) |                  |                    | Control Group women (n-9) |                   |                    |
|-----------------------------|-------------------------------|-------------------|--------------------|--------------------------|-------------------|--------------------|---------------------------------|------------------|--------------------|---------------------------|-------------------|--------------------|
|                             | Initial                       | Final             | 't' Value          | Initial                  | Final             | 't' Value          | Initial                         | Final            | 't' Value          | Initial                   | Final             | 't' Value          |
| <b>Weight (Kg)</b>          | 73.5 $\pm$ 8.86               | 72.5 $\pm$ 8.29   | 0.26 <sup>NS</sup> | 74.33 $\pm$ 7.76         | 74.66 $\pm$ 7.20  | 0.07 <sup>NS</sup> | 68.4 $\pm$ 15.07                | 67.2 $\pm$ 14.35 | 0.12 <sup>NS</sup> | 61.22 $\pm$ 9.65          | 61.88 $\pm$ 9.10  | 0.14 <sup>NS</sup> |
| <b>Height (cm)</b>          | 168 $\pm$ 7.31                | 168 $\pm$ 7.31    | ---                | 169.83 $\pm$ 6.4         | 169.83 $\pm$ 6.49 | ---                | 154.8 $\pm$ 2.94                | 154.8 $\pm$ 2.94 | ---                | 155.66 $\pm$ 3.53         | 155.66 $\pm$ 3.53 | ---                |
| <b>BMI</b>                  | 26.54 $\pm$ 4.92              | 26.17 $\pm$ 4.75  | 0.17 <sup>NS</sup> | 25.87 $\pm$ 3.54         | 25.99 $\pm$ 3.28  | 0.06 <sup>NS</sup> | 28.66 $\pm$ 6.81                | 28.15 $\pm$ 6.50 | 0.12 <sup>NS</sup> | 25.20 $\pm$ 4.63          | 25.48 $\pm$ 4.45  | 0.13 <sup>NS</sup> |
| <b>MUAC (cm)</b>            | 30.39 $\pm$ 2.50              | 30.02 $\pm$ 2.08  | 0.35 <sup>NS</sup> | 28.33 $\pm$ 3.44         | 27.83 $\pm$ 2.31  | 0.29 <sup>NS</sup> | 29.2 $\pm$ 4.43                 | 28.8 $\pm$ 3.96  | 0.15 <sup>NS</sup> | 26.5 $\pm$ 3.81           | 27.25 $\pm$ 3.69  | 0.42 <sup>NS</sup> |
| <b>TSFT (mm)</b>            | 24.37 $\pm$ 2.44              | 24.12 $\pm$ 2.10  | 0.24 <sup>NS</sup> | 22.83 $\pm$ 2.31         | 22.5 $\pm$ 2.07   | 0.26 <sup>NS</sup> | 24.2 $\pm$ 3.83                 | 23.6 $\pm$ 3.28  | 0.26 <sup>NS</sup> | 24.75 $\pm$ 2.54          | 24.5 $\pm$ 2.50   | 0.21 <sup>NS</sup> |
| <b>WC (cm)</b>              | 99.87 $\pm$ 10.21             | 98.75 $\pm$ 9.05  | 0.25 <sup>NS</sup> | 98.83 $\pm$ 6.17         | 99.33 $\pm$ 5.60  | 0.14 <sup>NS</sup> | 100.6 $\pm$ 5.3                 | 99.8 $\pm$ 4.65  | 0.25 <sup>NS</sup> | 97.75 $\pm$ 4.26          | 98.37 $\pm$ 3.58  | 0.33 <sup>NS</sup> |
| <b>HC (cm)</b>              | 104.87 $\pm$ 10.11            | 103.75 $\pm$ 8.37 | 0.26 <sup>NS</sup> | 101.33 $\pm$ 4.88        | 101.66 $\pm$ 4.58 | 0.12 <sup>NS</sup> | 107.6 $\pm$ 7.36                | 106.8 $\pm$ 6.6  | 0.18 <sup>NS</sup> | 106.37 $\pm$ 7.19         | 107.12 $\pm$ 6.59 | 0.23 <sup>NS</sup> |
| <b>WHR</b>                  | 0.95 $\pm$ 0.12               | 0.95 $\pm$ 0.11   | ---                | 0.97 $\pm$ 0.08          | 0.97 $\pm$ 0.08   | --                 | 0.94 $\pm$ 0.10                 | 0.93 $\pm$ 0.09  | 0.16 <sup>NS</sup> | 0.92 $\pm$ 0.07           | 0.92 $\pm$ 0.06   | --                 |

MUAC- Mid upper arm circumference, TSFT -Triceps skin fold thickness, WC -Waist circumference, HC -Hip circumference and WHR - Waist hip ratio

NS-Non Significant

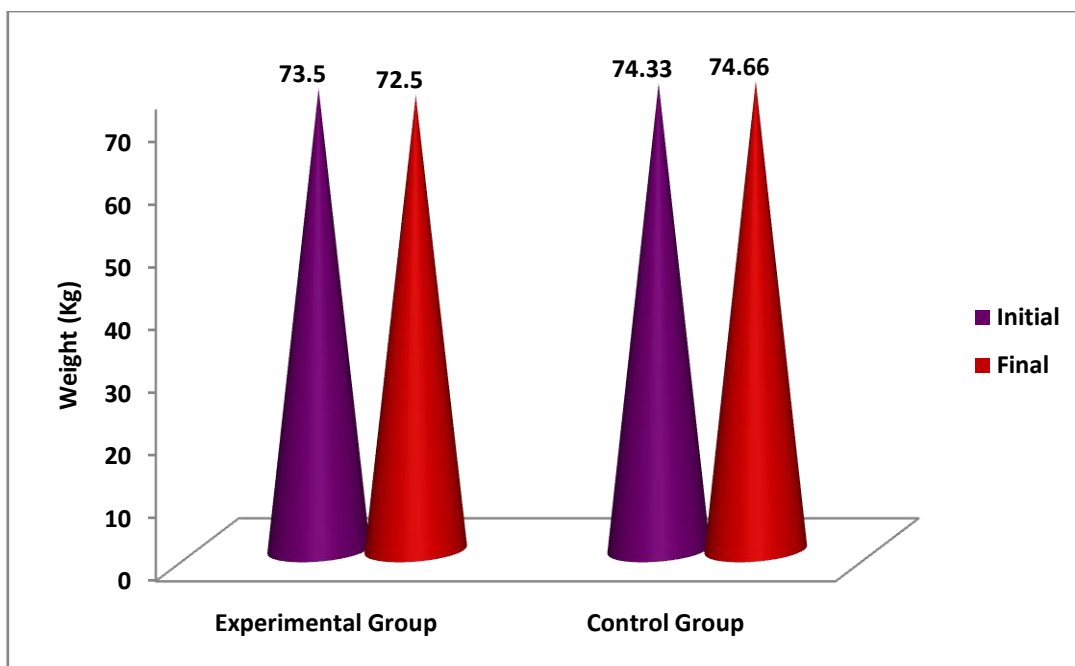


**Fig. 10 Weight of male diabetic subjects before and after supplementation**

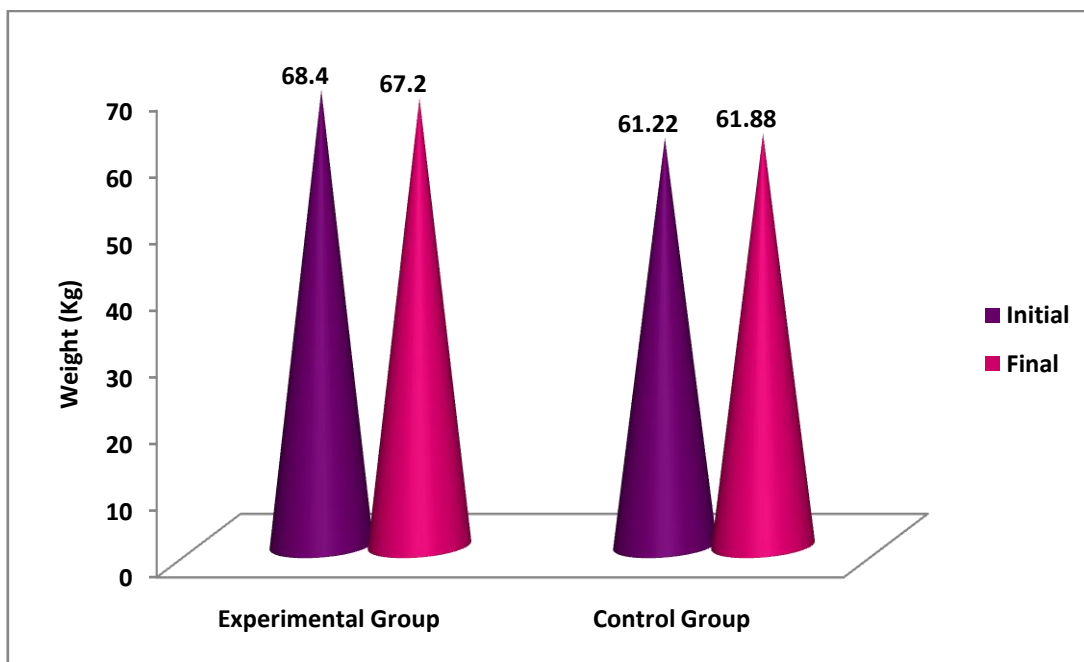


**Fig. 11 Weight of female diabetic subjects before and after supplementation**

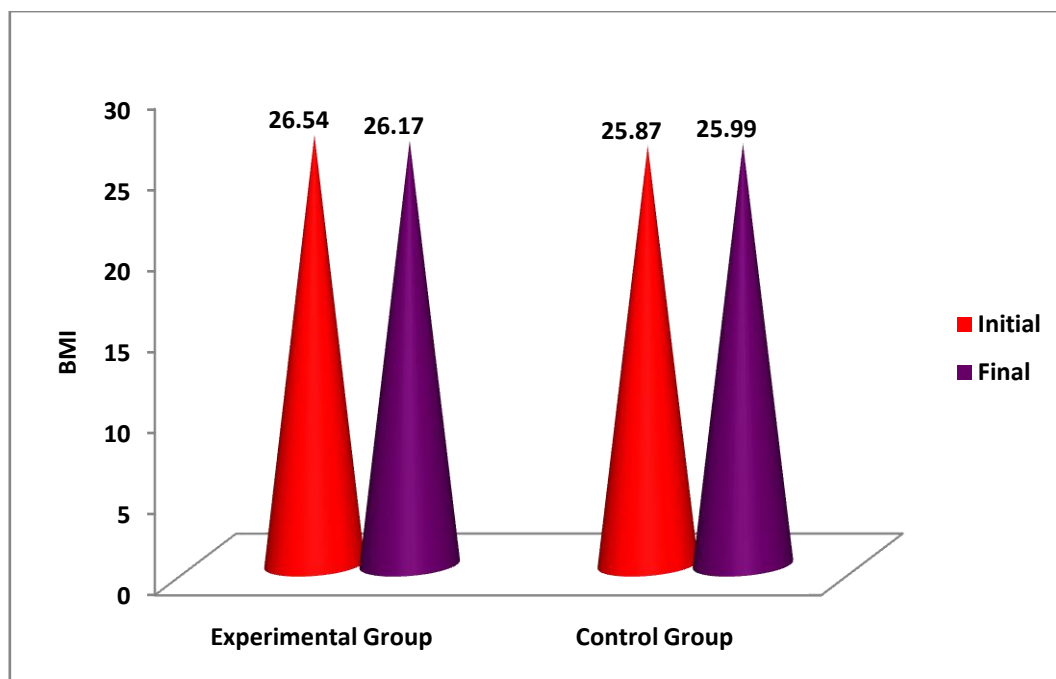


**Fig. 12 BMI of diabetic male subjects before and after supplementation**

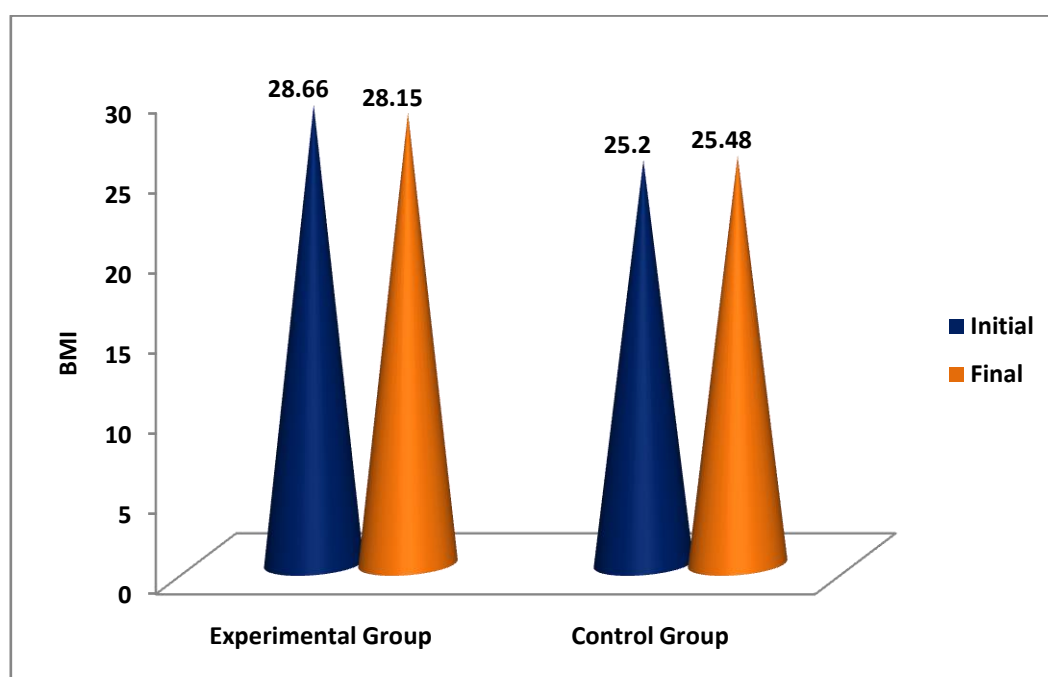


**Fig. 13 BMI of diabetic female subjects before and after supplementation**

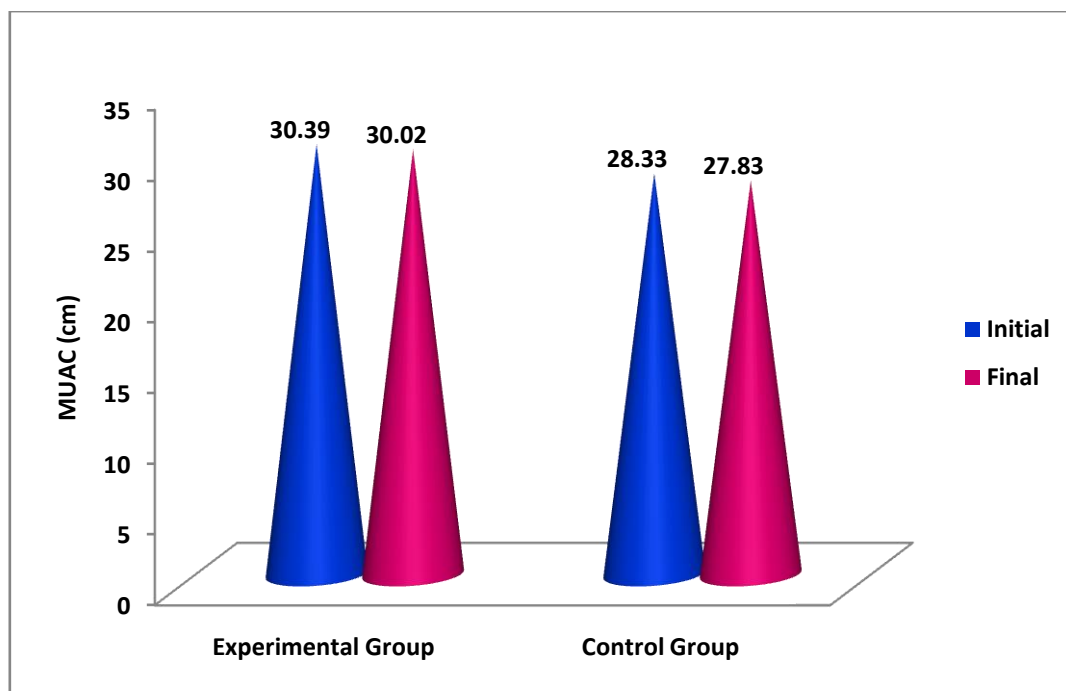


**Fig. 14** Mid upper arm circumference of diabetic male subjects before and after supplementation

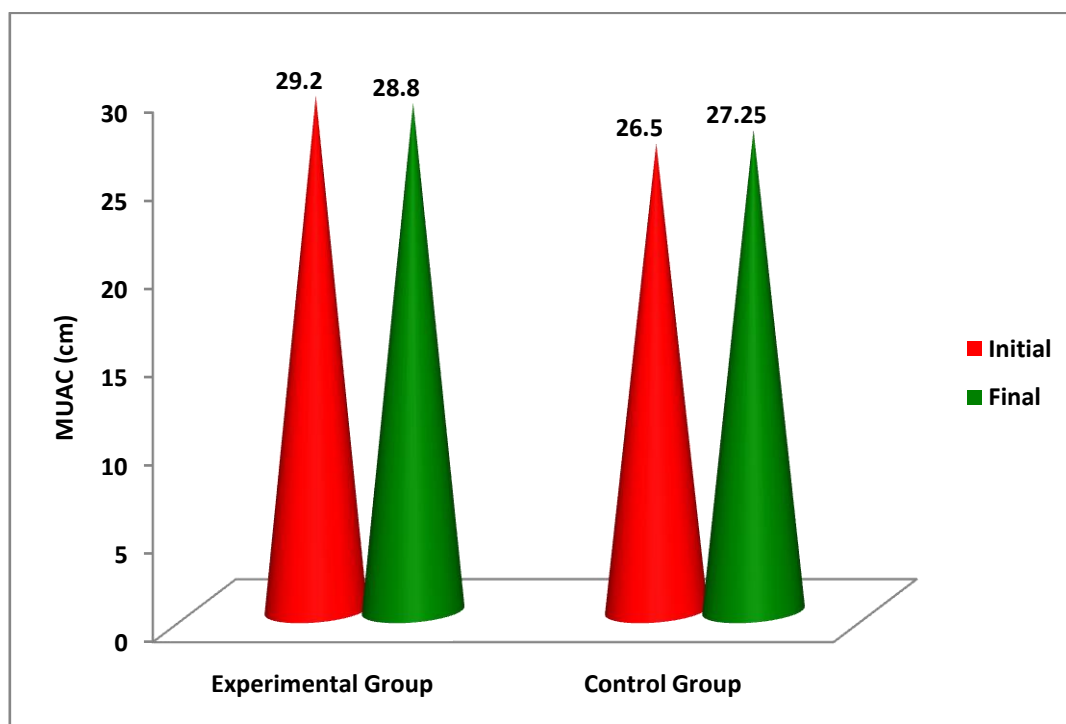


**Fig. 15** Mid upper arm circumference of diabetic female subjects before and after supplementation

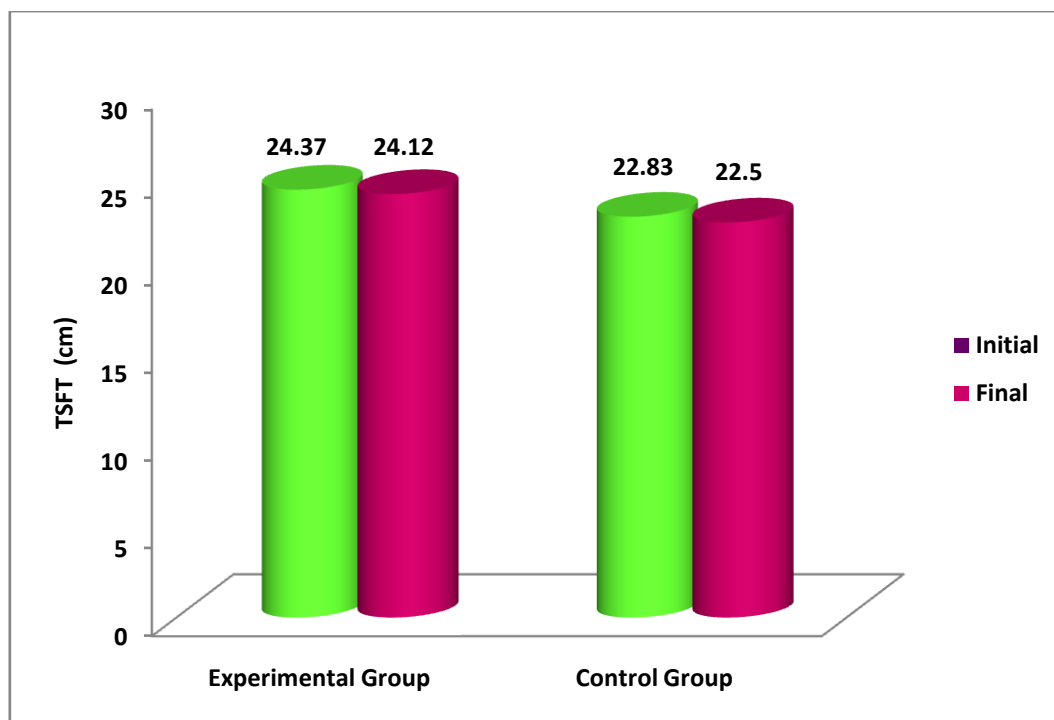


**Fig. 16 Triceps skinfold thickness of diabetic male subjects before and after supplementation**

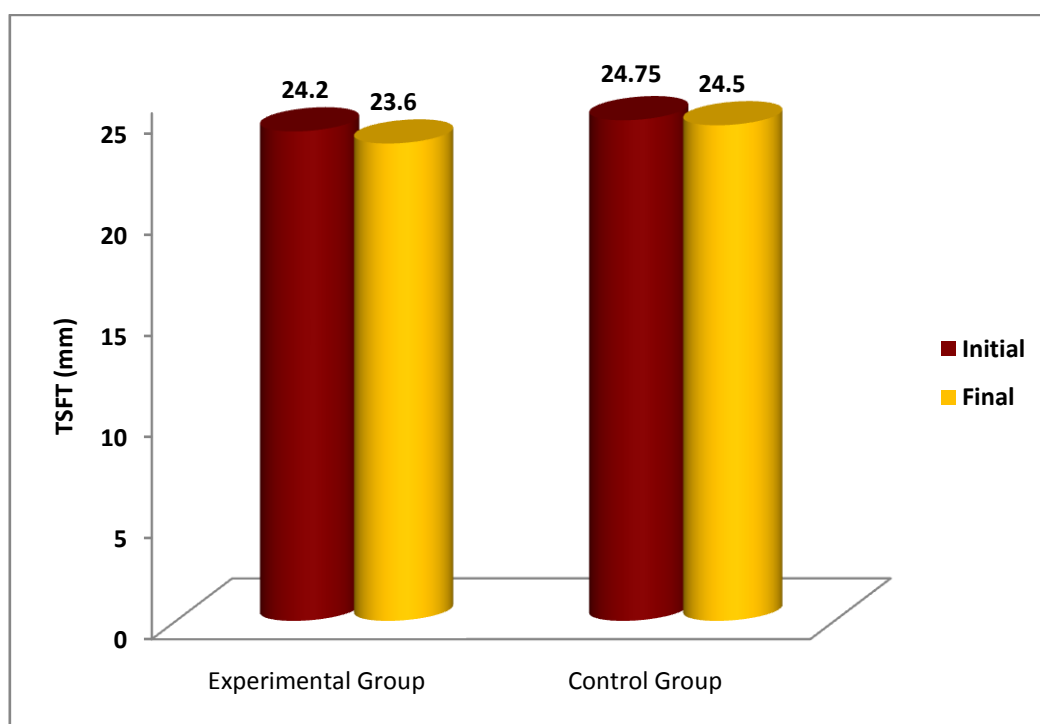


**Fig. 17 Triceps skinfold thickness of diabetic female subjects before and after supplementation**

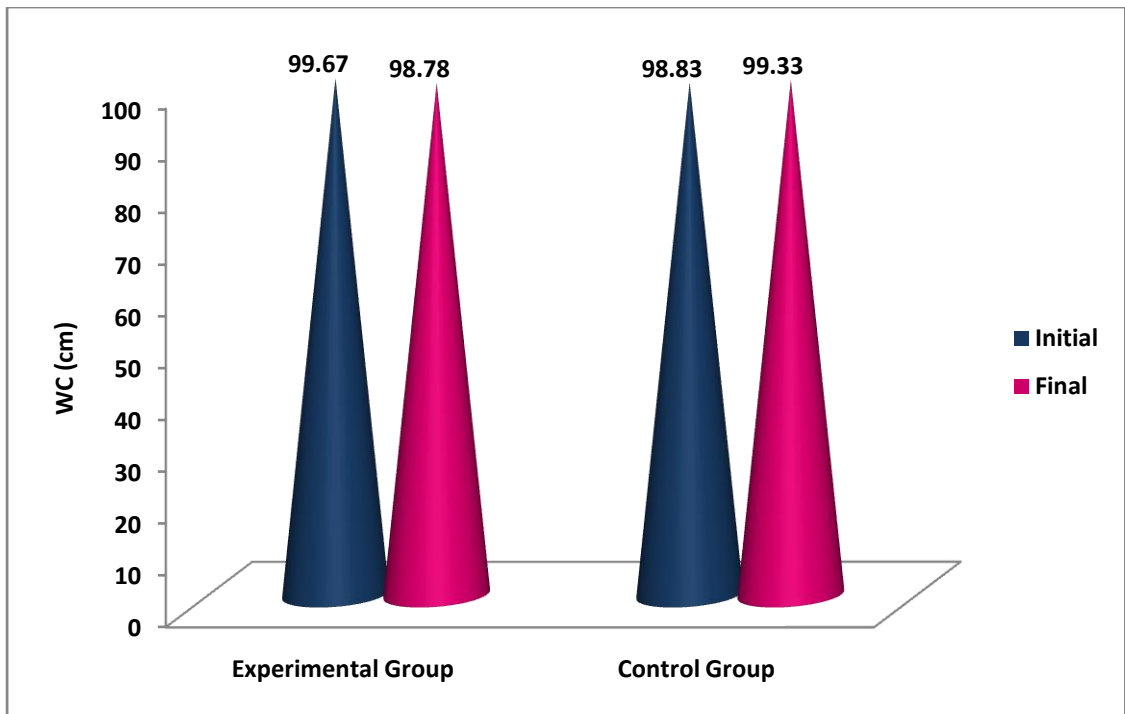


**Fig. 18 Waist Circumference of diabetic male subjects before and after supplementation**

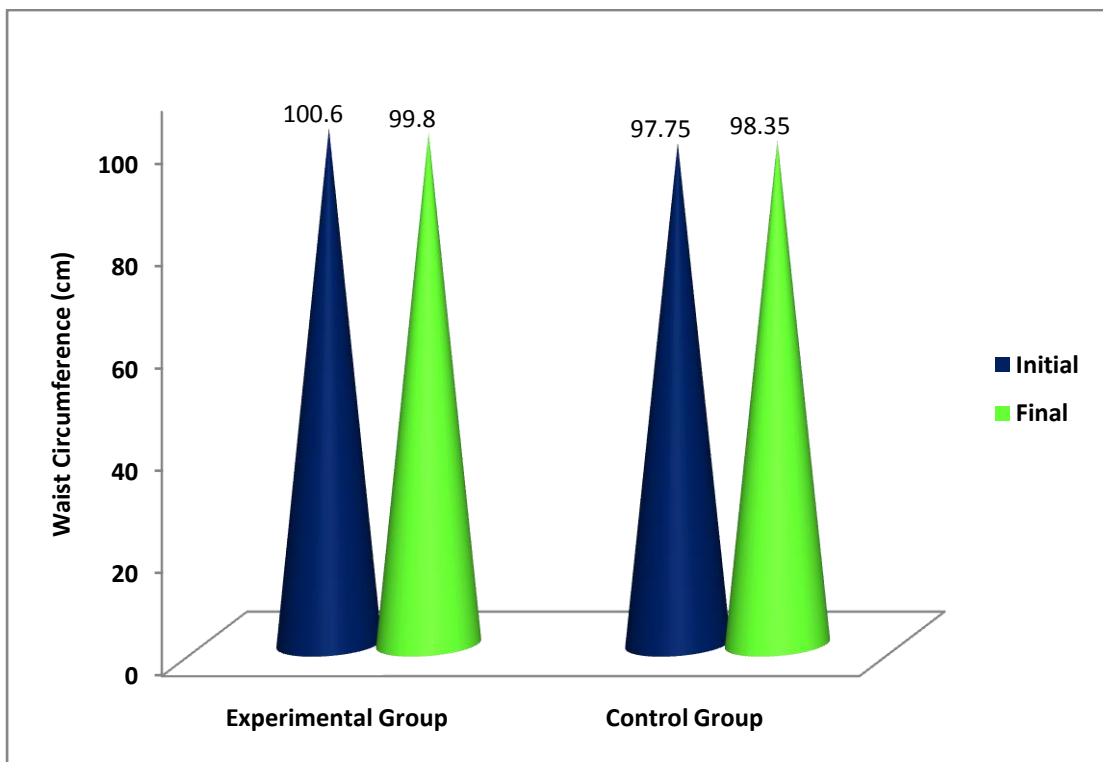


**Fig. 19 Waist circumference of diabetic female subjects before and after supplementation**

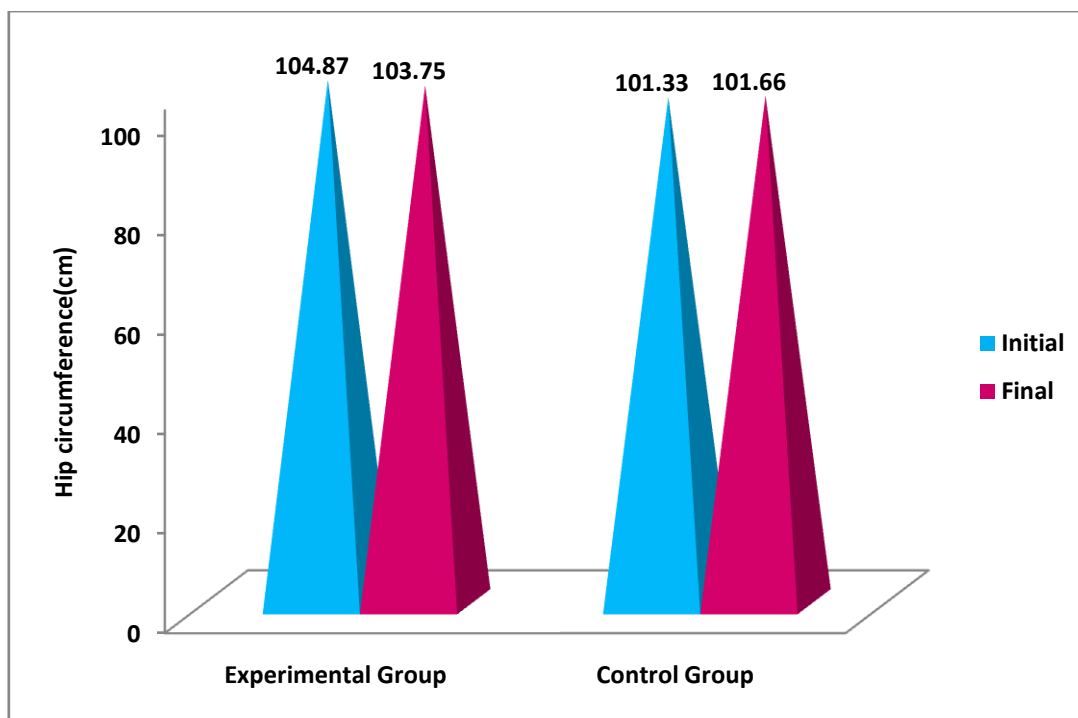


**Fig. 20 Hip circumference of diabetic female subjects before and after supplementation**

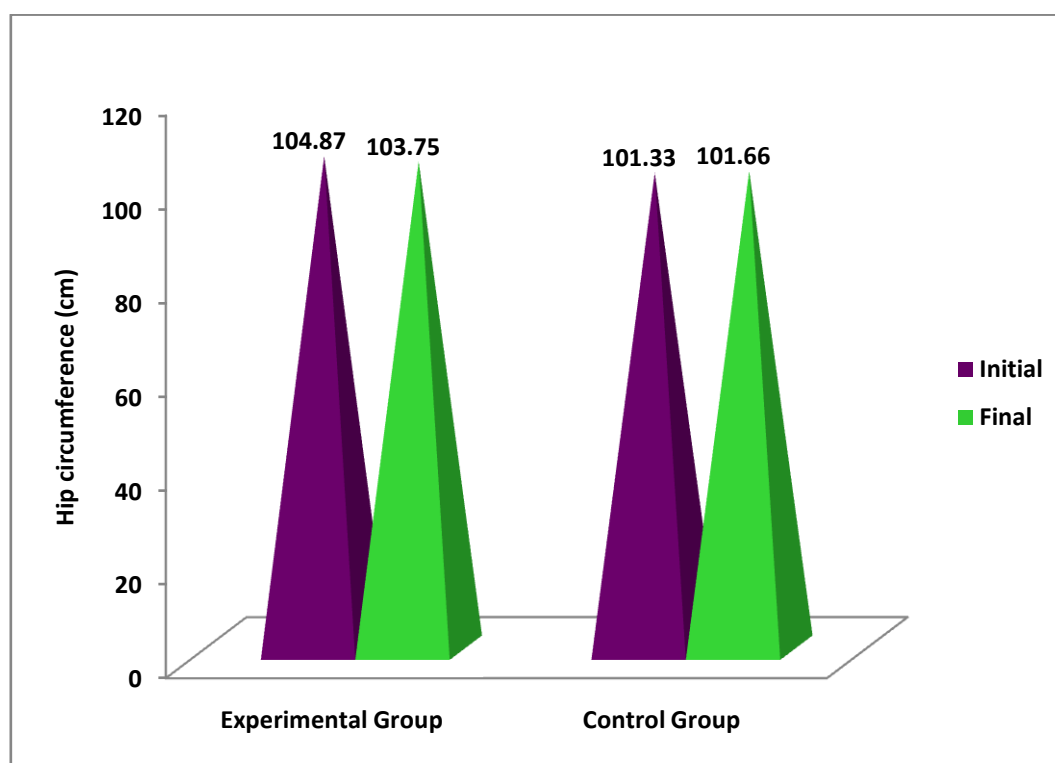


**Fig. 21 Hip circumference of diabetic female subjects before and after supplementation**

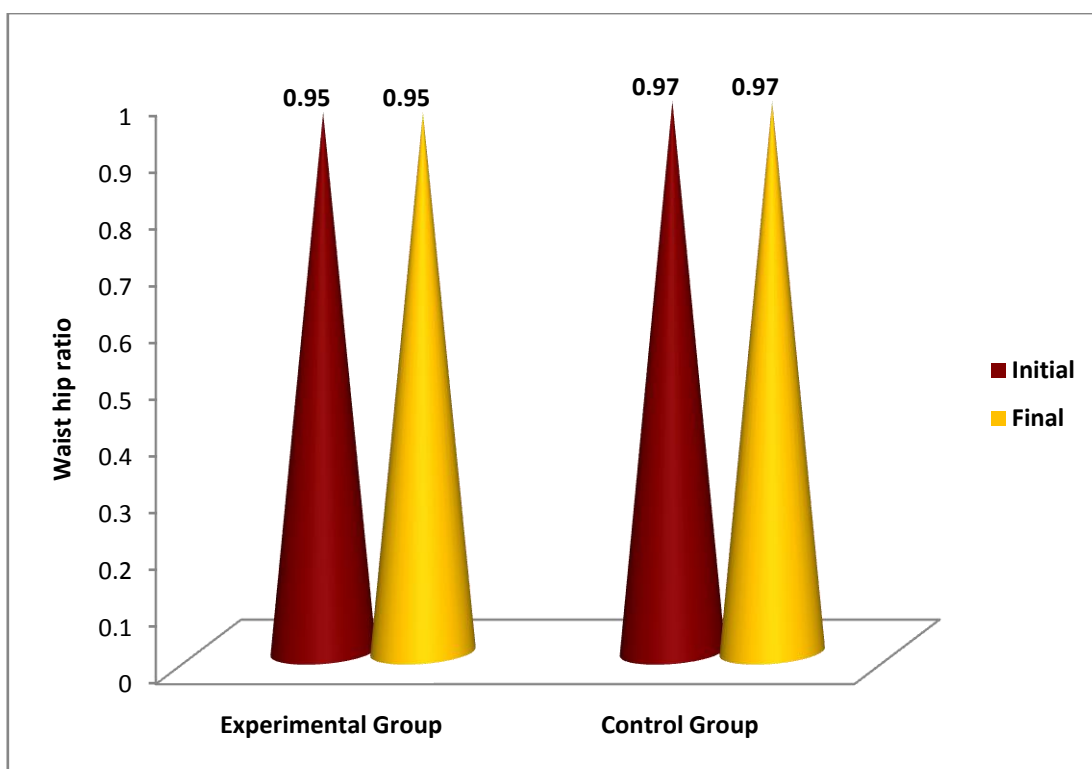


**Fig. 22** Waist hip ratio of diabetic male subjects before and after supplementation

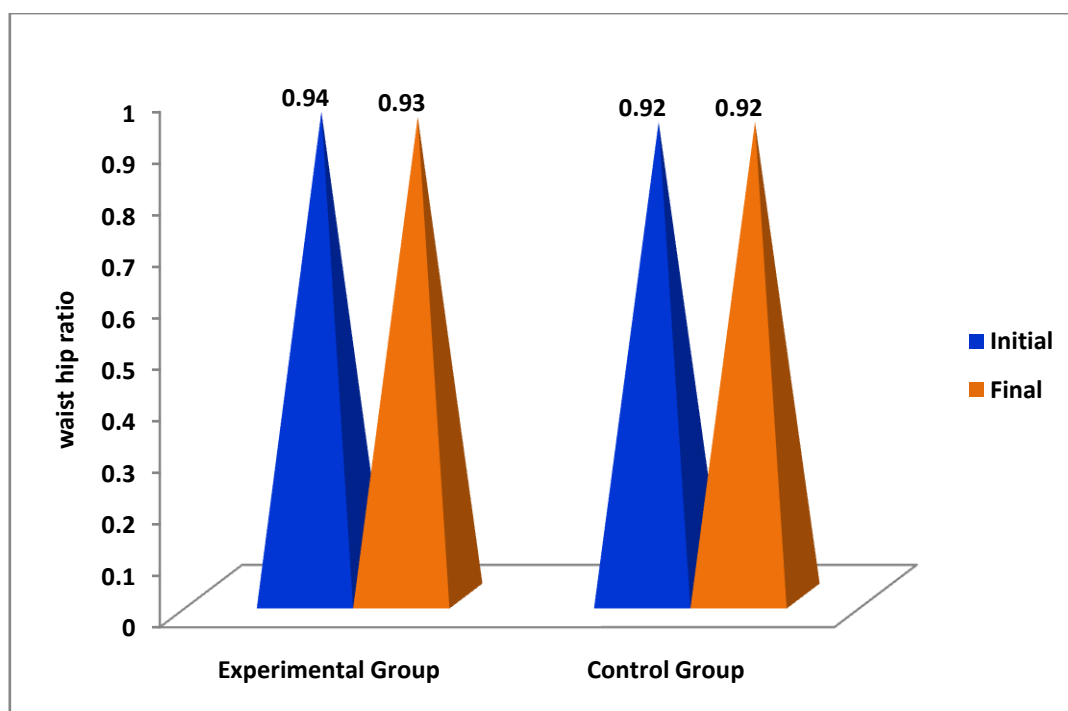


**Fig. 23** Waist hip ratio of diabetic female subjects before and after supplementation

**Table 29. Gender wise anthropometric measurements of selected hyperlipidemic subjects before and after supplementation (mean  $\pm$  SD)**

| <b>Anthropometric<br/>Measurements</b> | <b>Experimental Group men (n-10)</b> |                   |                    | <b>Control Group men (n-11)</b> |                   |                    | <b>Experimental Group women (n-5)</b> |                  |                    | <b>Control Group women (n-4)</b> |                    |                    |
|----------------------------------------|--------------------------------------|-------------------|--------------------|---------------------------------|-------------------|--------------------|---------------------------------------|------------------|--------------------|----------------------------------|--------------------|--------------------|
|                                        | <b>Initial</b>                       | <b>Final</b>      | <b>'t' Value</b>   | <b>Initial</b>                  | <b>Final</b>      | <b>'t' Value</b>   | <b>Initial</b>                        | <b>Final</b>     | <b>'t' Value</b>   | <b>Initial</b>                   | <b>Final</b>       | <b>'t' Value</b>   |
| <b>Weight (Kg)</b>                     | 75.62 $\pm$ 11.70                    | 74.12 $\pm$ 10.98 | 0.24 <sup>NS</sup> | 70.87 $\pm$ 6.93                | 70.72 $\pm$ 4.94  | 0.05 <sup>NS</sup> | 70.4 $\pm$ 9.83                       | 68.4 $\pm$ 8.87  | 0.33 <sup>NS</sup> | 65.25 $\pm$ 13.07                | 67.25 $\pm$ 11.87  | 0.22 <sup>NS</sup> |
| <b>Height (cm)</b>                     | 169.1 $\pm$ 6.02                     | 169.1 $\pm$ 6.02  | ---                | 170.7 $\pm$ 5.83                | 170.7 $\pm$ 5.83  | ---                | 156.8 $\pm$ 2.58                      | 156.8 $\pm$ 2.58 | ---                | 153.5 $\pm$ 4.50                 | 153.5 $\pm$ 4.50   | ---                |
| <b>BMI</b>                             | 26.5 $\pm$ 5.18                      | 25.99 $\pm$ 5.01  | 0.22 <sup>NS</sup> | 24.52 $\pm$ 8.26                | 24.90 $\pm$ 8.16  | 0.06 <sup>NS</sup> | 29.47 $\pm$ 4.73                      | 28.6 $\pm$ 4.33  | 0.29 <sup>NS</sup> | 27.60 $\pm$ 4.8                  | 28.47 $\pm$ 4.41   | 0.26 <sup>NS</sup> |
| <b>MUAC (cm)</b>                       | 31.5 $\pm$ 2.87                      | 31.25 $\pm$ 2.60  | 0.08 <sup>NS</sup> | 32.12 $\pm$ 2.85                | 32.37 $\pm$ 2.72  | 0.21 <sup>NS</sup> | 32.24 $\pm$ 4.07                      | 31.84 $\pm$ 4.07 | 0.15 <sup>NS</sup> | 29.75 $\pm$ 5.5                  | 29.25 $\pm$ 4.92   | 0.13 <sup>NS</sup> |
| <b>TSFT (mm)</b>                       | 28.25 $\pm$ 3.65                     | 28.12 $\pm$ 3.56  | 0.35 <sup>NS</sup> | 27.62 $\pm$ 4.53                | 27.37 $\pm$ 4.37  | 0.13 <sup>NS</sup> | 26.4 $\pm$ 4.03                       | 26.2 $\pm$ 4.08  | 0.07 <sup>NS</sup> | 27.25 $\pm$ 3.77                 | 26.75 $\pm$ 3.5    | 0.19 <sup>NS</sup> |
| <b>WC (cm)</b>                         | 100.75 $\pm$ 9.17                    | 99.37 $\pm$ 7.96  | 0.35 <sup>NS</sup> | 99.62 $\pm$ 4.03                | 100.12 $\pm$ 3.35 | 0.31 <sup>NS</sup> | 101.6 $\pm$ 7.23                      | 100.2 $\pm$ 5.31 | 0.34 <sup>NS</sup> | 103.25 $\pm$ 11.08               | 104.25 $\pm$ 10.11 | 0.13 <sup>NS</sup> |
| <b>HC (cm)</b>                         | 105.12 $\pm$ 9.9                     | 104.62 $\pm$ 9.0  | 0.11 <sup>NS</sup> | 105.87 $\pm$ 4.54               | 106.37 $\pm$ 3.92 | 0.27 <sup>NS</sup> | 108.2 $\pm$ 7.36                      | 107 $\pm$ 6.12   | 0.28 <sup>NS</sup> | 109.75 $\pm$ 6.07                | 110.5 $\pm$ 5.32   | 0.18 <sup>NS</sup> |
| <b>WHR</b>                             | 0.96 $\pm$ 0.11                      | 0.95 $\pm$ 0.09   | 0.22 <sup>NS</sup> | 0.94 $\pm$ 0.11                 | 0.94 $\pm$ 0.02   | ---                | 0.94 $\pm$ 0.13                       | 0.94 $\pm$ 0.10  | ---                | 0.94 $\pm$ 0.12                  | 0.93 $\pm$ 0.09    | 0.13 <sup>NS</sup> |

**MUAC- Mid upper arm circumference, TSFT -Triceps skin fold thickness, WC -Waist circumference, HC -Hip circumference and WHR -Waist hip ratio**

NS-Non Significant

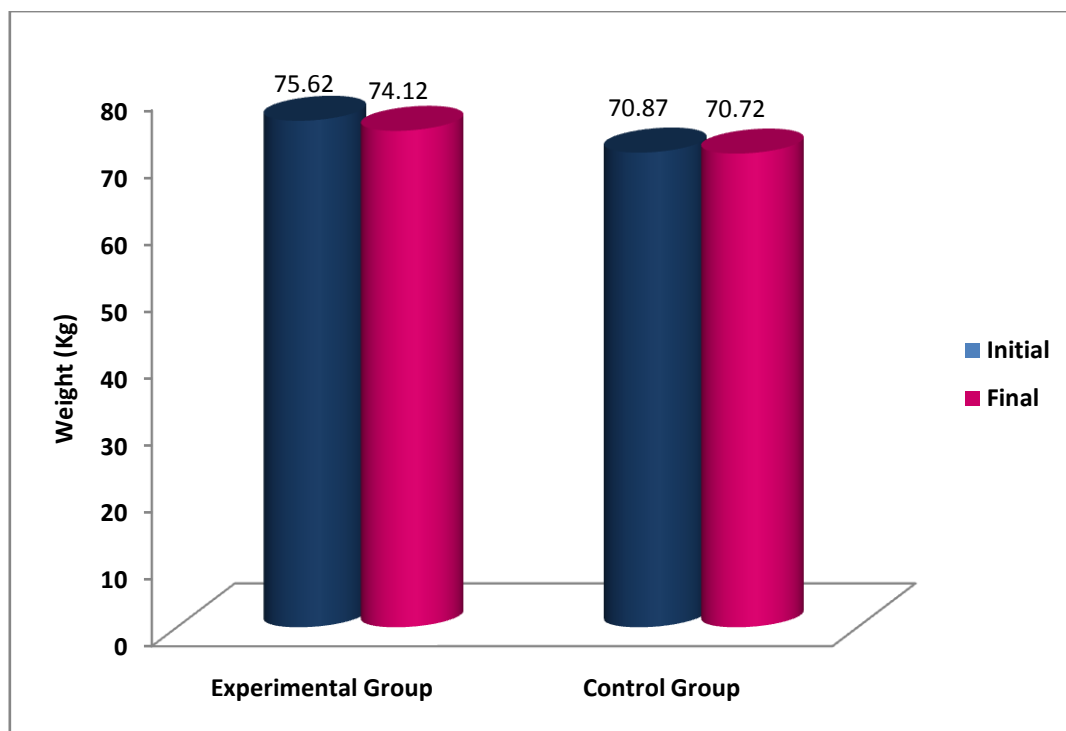


**Fig. 24 Weight of hyperlipidemic male subjects before and after supplementation**

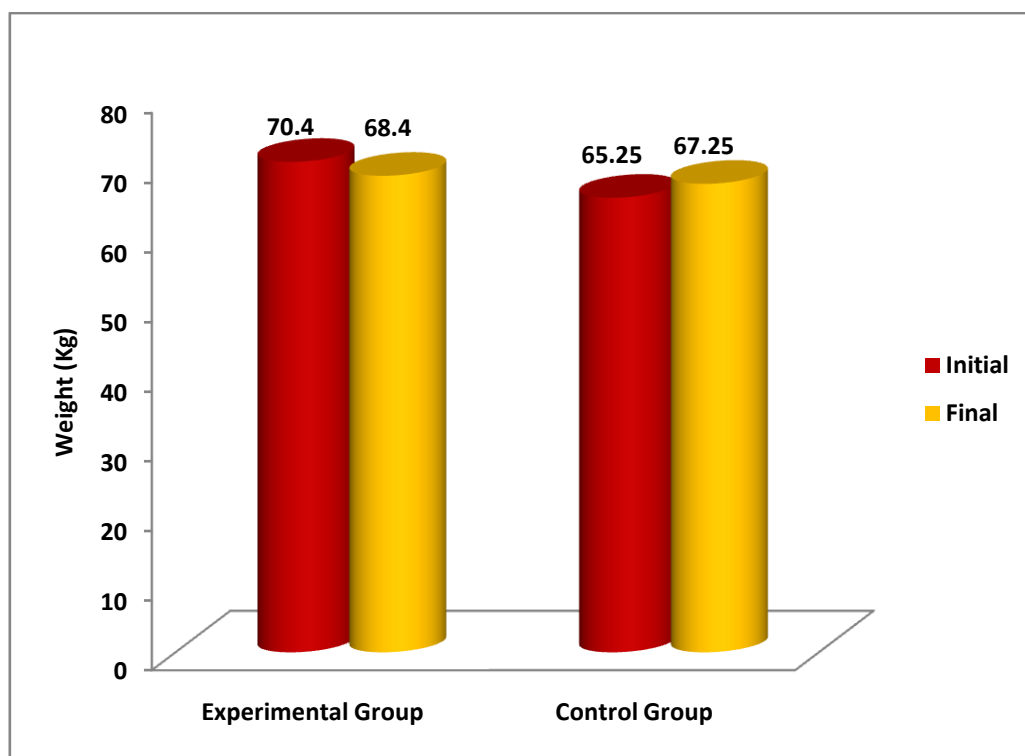


**Fig. 25 Weight of hyperlipidemic female subjects before and after supplementation**

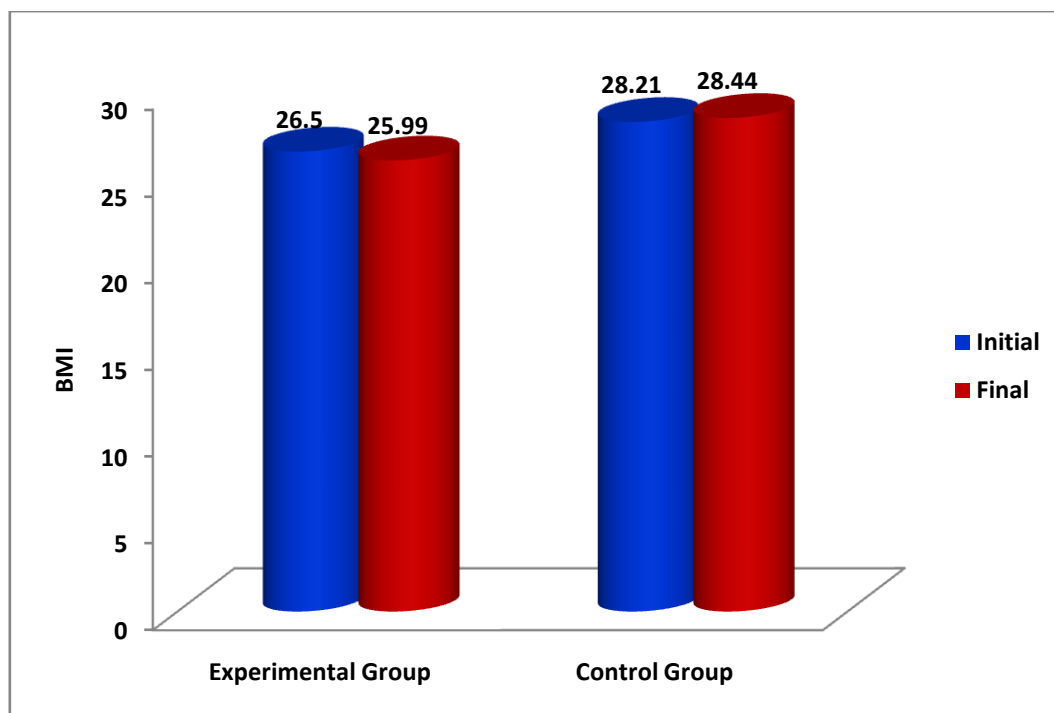


**Fig. 26 BMI of hyperlipidemic male subjects before and after supplementation**

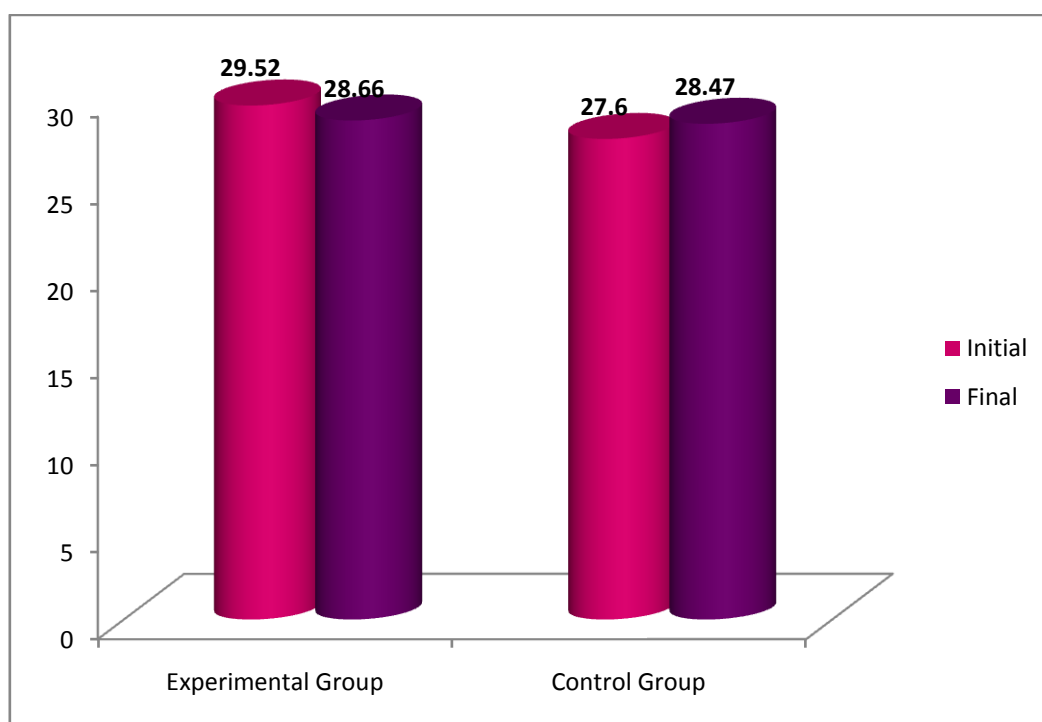


**Fig. 27 BMI of hyperlipidemic female subjects before and after supplementation**

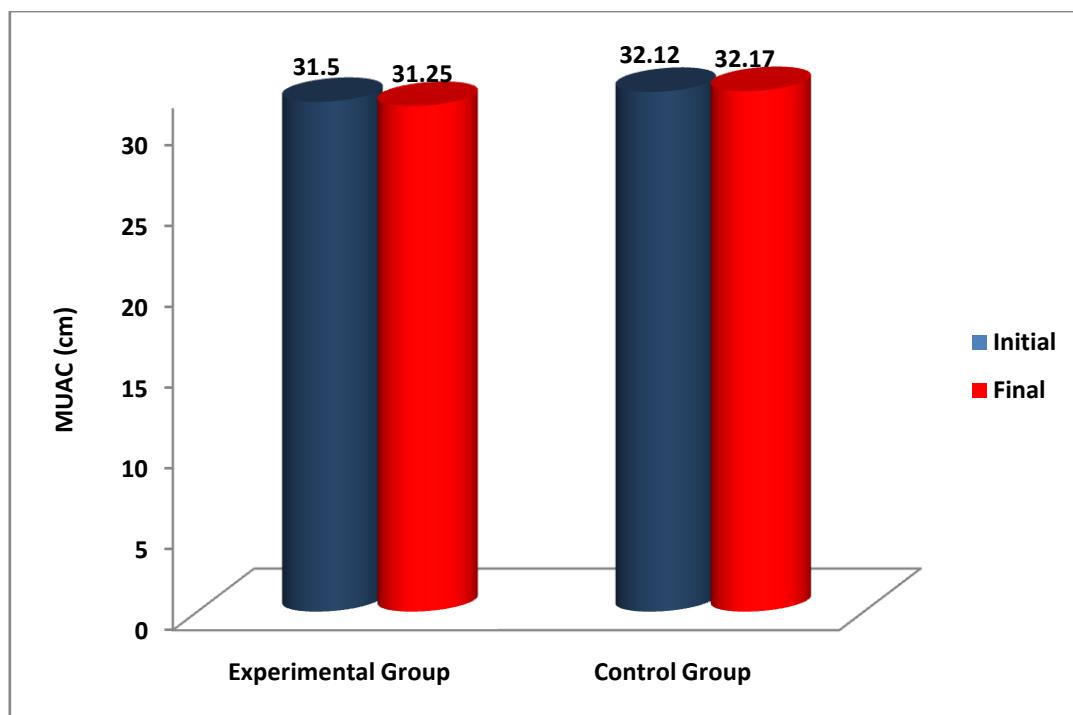


**Fig. 28 MUAC of hyperlipidemic male subjects before and after supplementation**

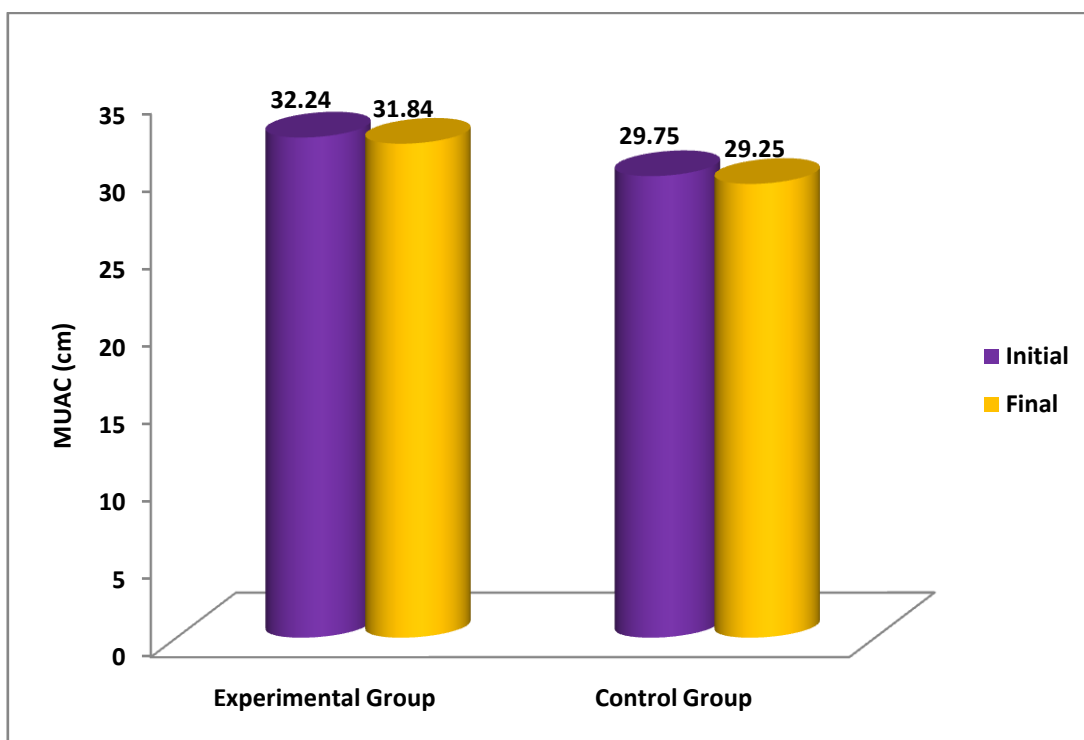


**Fig. 29 MUAC of hyperlipidemic female subjects before and after supplementation**

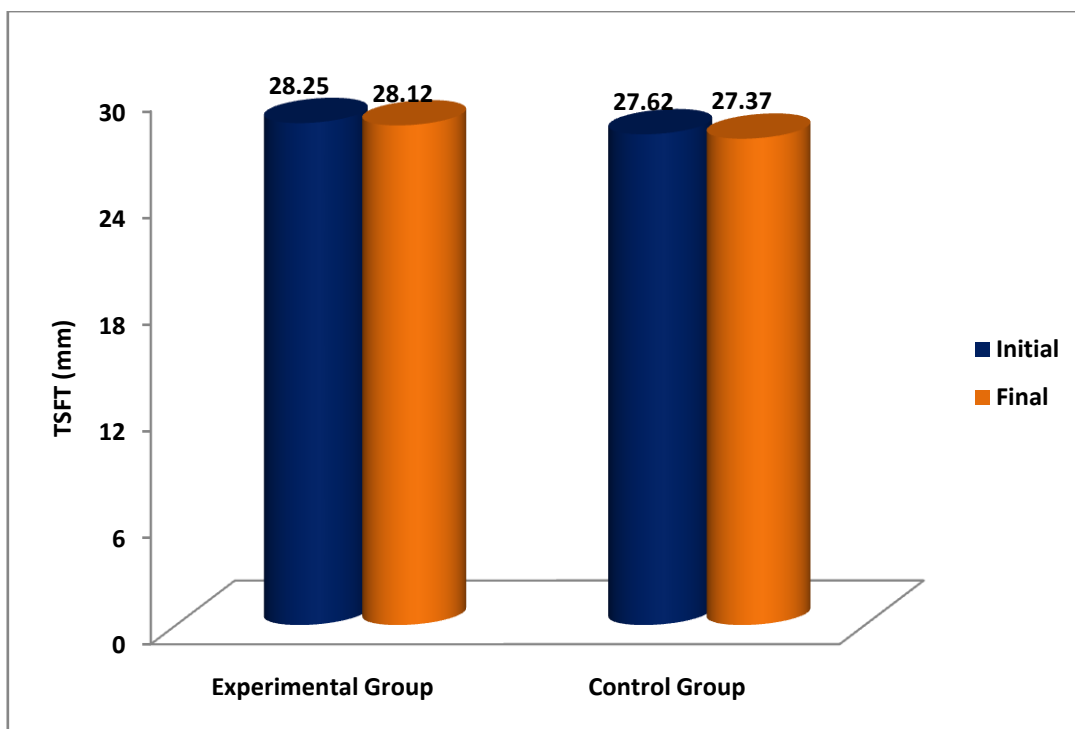


**Fig. 30 TSFT of hyperlipidemic male subjects before and after supplementation**

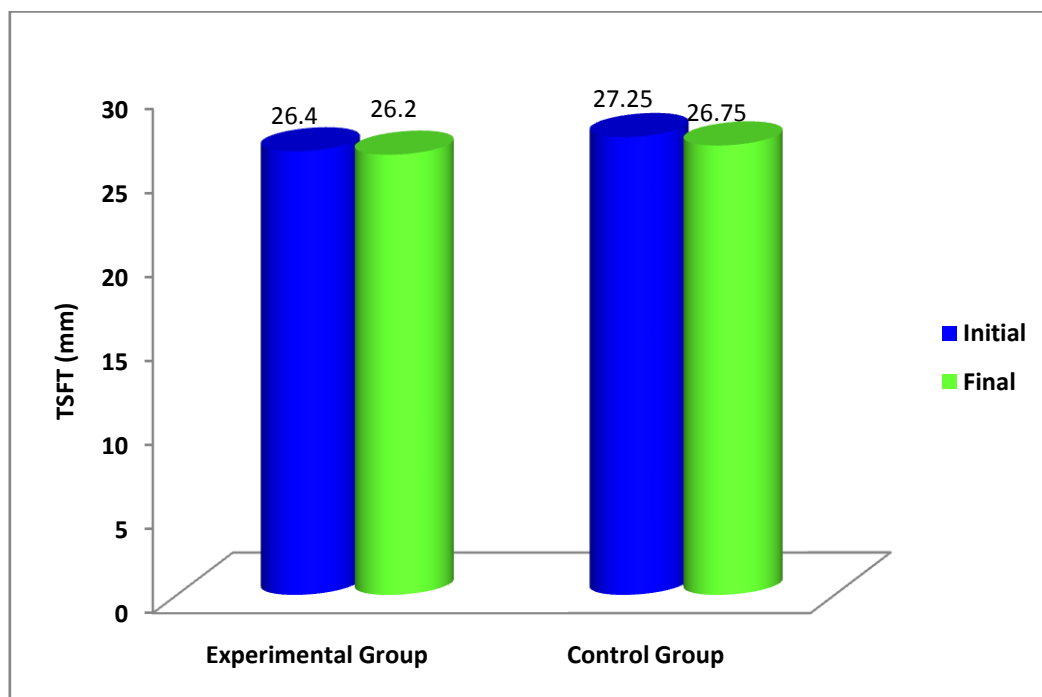


**Fig. 31 TSFT of hyperlipidemic female subjects before and after supplementation**

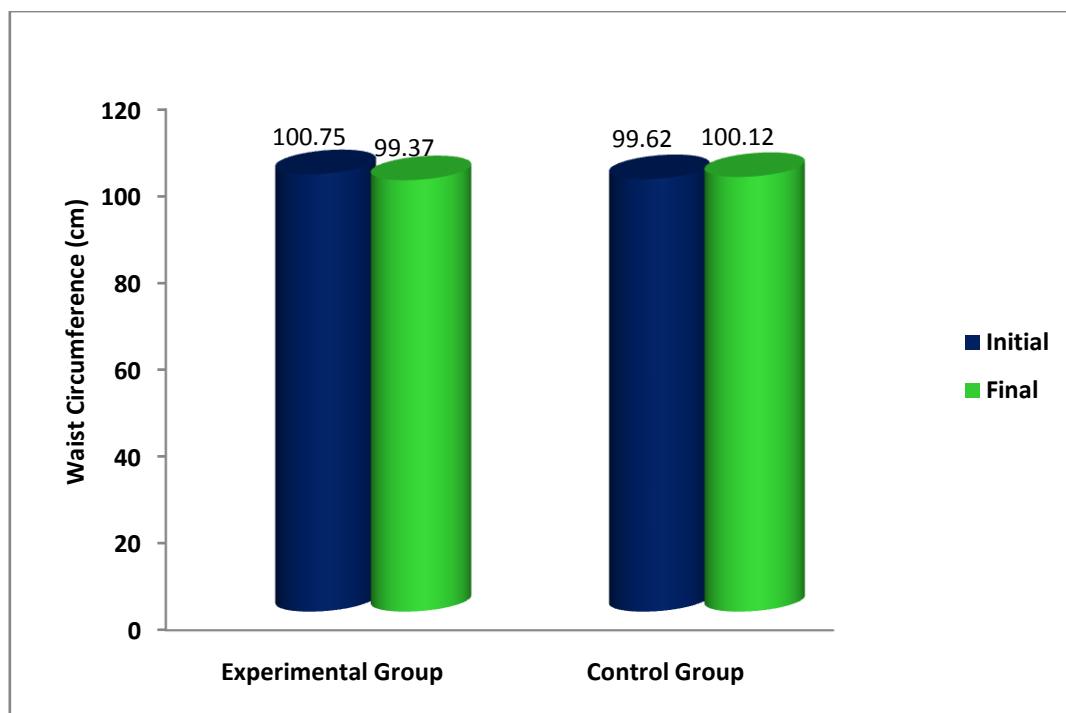


**Fig. 32** Waist circumference of hyperlipidemic male subjects before and after supplementation

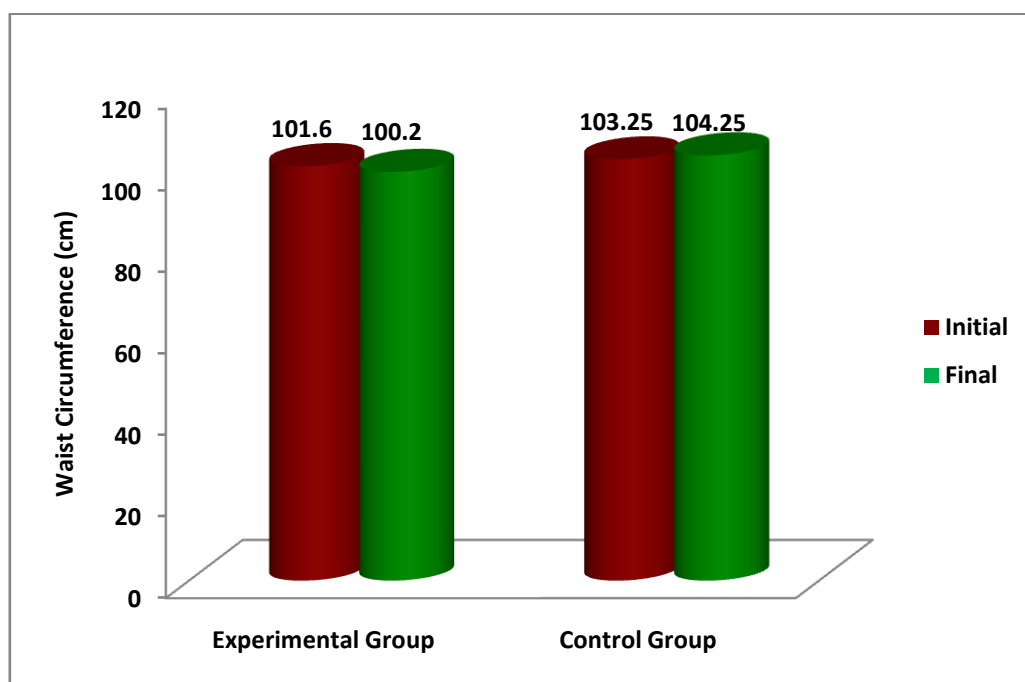


**Fig. 33** Waist circumference (cm) of hyperlipidemic female subjects before and after supplementation

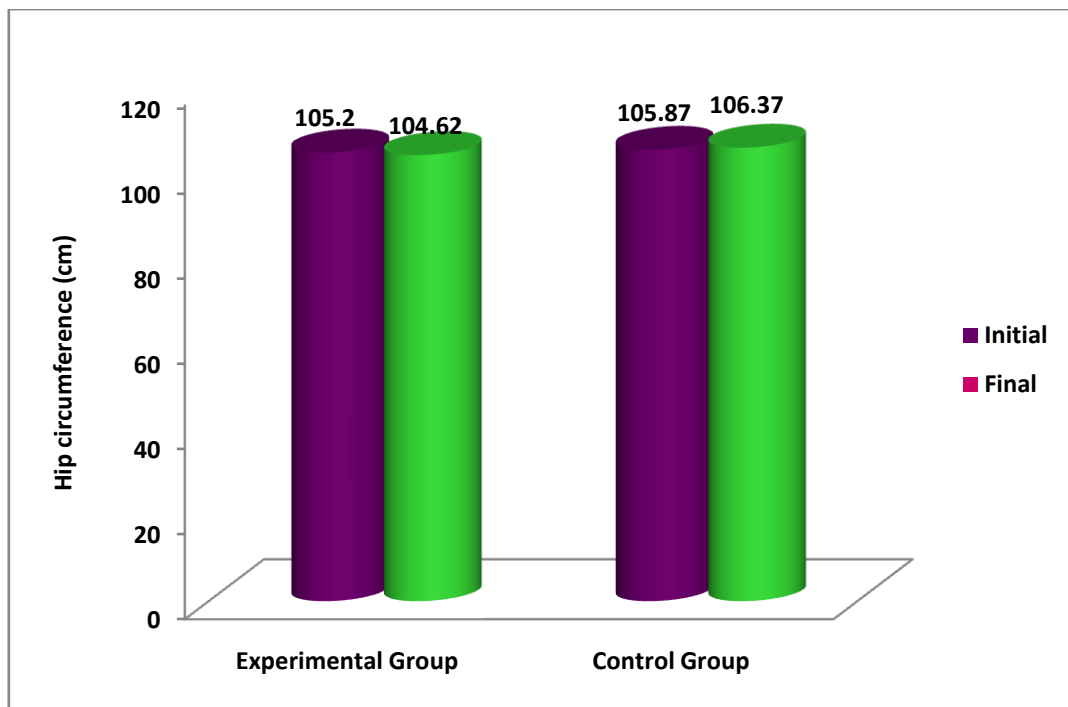


**Fig. 34 Hip circumference of hyperlipidemic male subjects before and after supplementation**

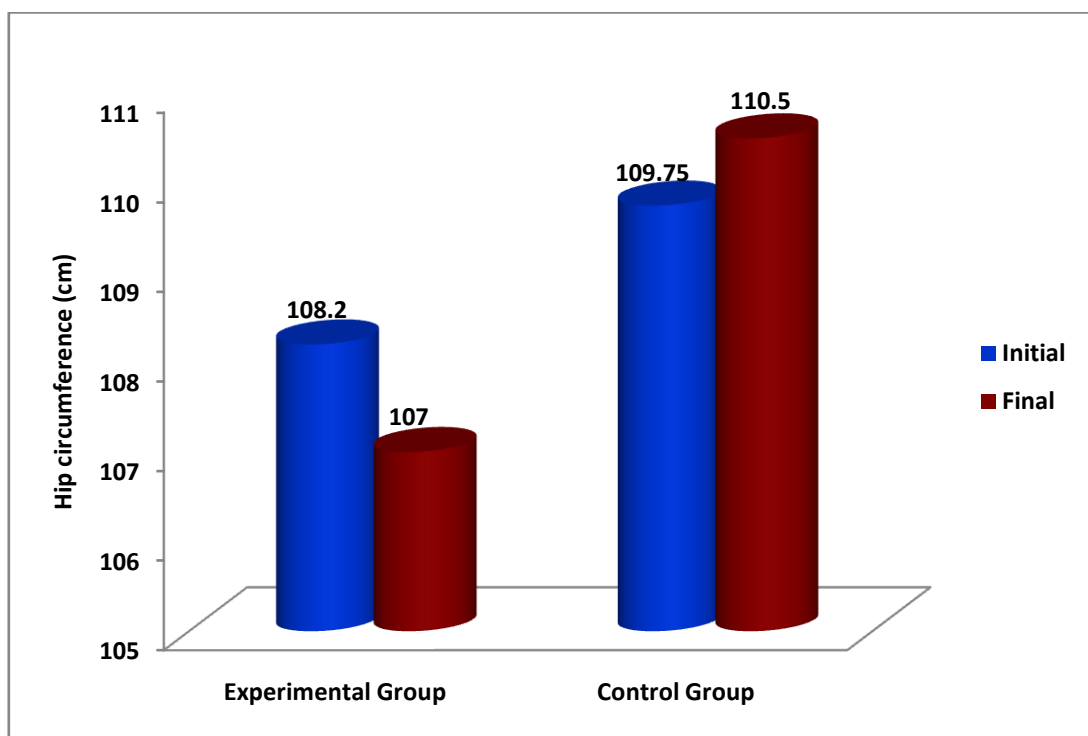


**Fig. 35 Hip circumference of hyperlipidemic female subjects before and after supplementation**

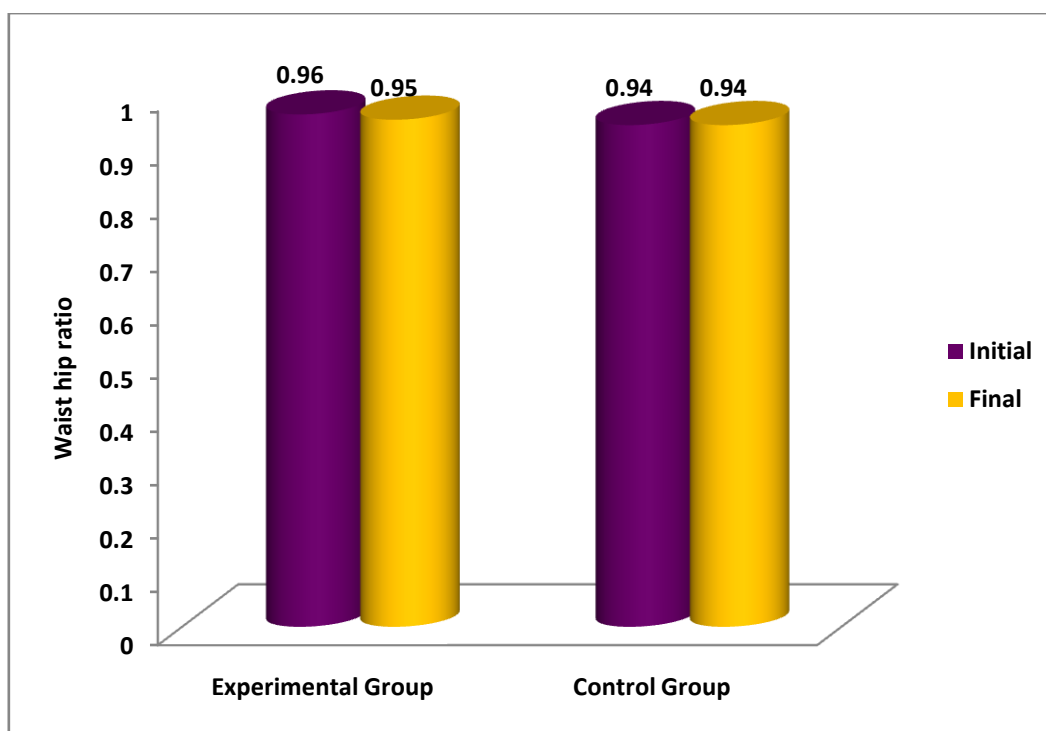


**Fig. 36** Waist hip ratio of hyperlipidemic male subjects before and after supplementation

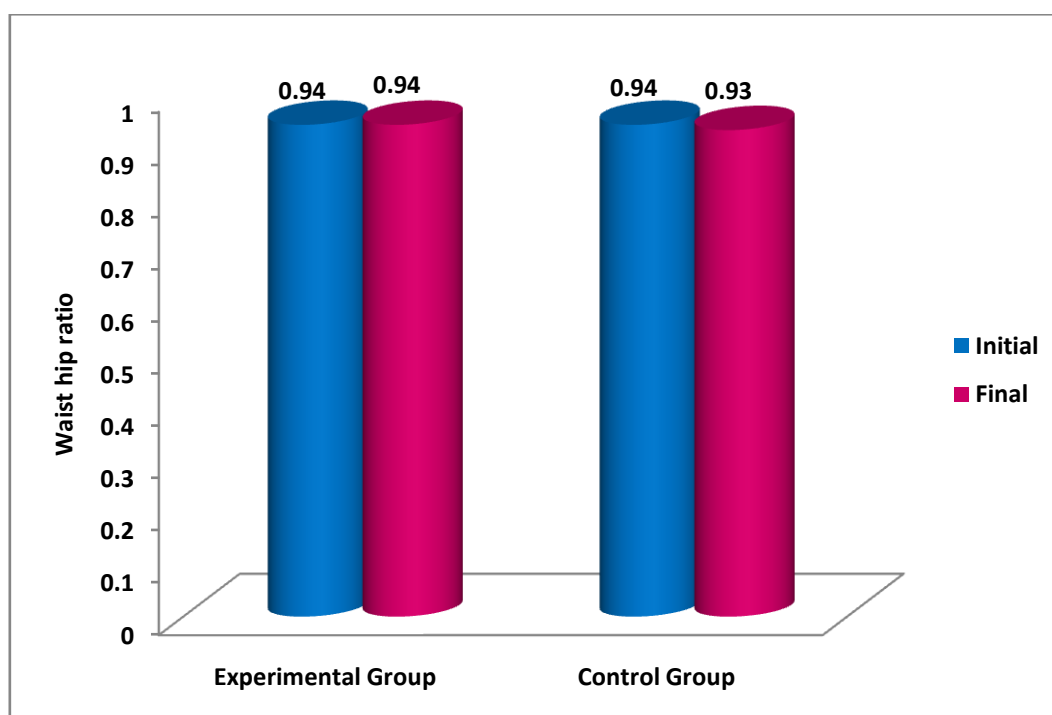


**Fig. 37** Waist hip ratio of hyperlipidemic female subjects before and after supplementation

#### 4.14 Blood Pressure Selected Subjects Before and After Intervention

Blood pressure is one of the best indicators of assessment of the health of heart and blood vessels. It is the pressure exerted by the flow of blood on the internal walls of the arteries. The normal blood pressure value is 120/80 mm/Hg (Systolic/Diastolic, American Heart Association, 2012). The rise above this limit is risk factor for development of heart diseases.

The blood pressure of the subjects enrolled for study was measured in the beginning of the experiment (Table 30). The recorded values were 131.93/90.73 for diabetic subjects and 144.33/ 96.73 mm/Hg for hyperlipidemic subjects. After feeding trials with *Heartdiabocare Snack* for two months the influence on blood pressure was assessed to judge the functionality of developed snack towards controlling the blood pressure. Hence, the mean blood pressure values were recorded at the end of the experiment which were 125.6/84.06 and 131.46/88.53 mm/Hg for diabetic and hyperlipidemic subjects respectively. The statistical comparison of blood pressure values inferred that there was significant reduction in the diastolic blood pressure of both diabetic and hyperlipidemic subjects and systolic blood pressure of hyperlipidemic subjects. Hence, it can be concluded that the developed functional snack is beneficial for maintaining normal blood pressure.

While expressing the characteristics of study population Patel *et al.*, (2012) reported the blood pressure values of type 2 diabetic subjects as 135.34/83.14 mm/Hg for male and 134.93/84.10mm/Hg for females. However the baseline values of type II diabetic patients were 142/81 mm/Hg. The findings are in line with the present investigation.

Several studies have demonstrated that systolic and diastolic pressures have a strong, continuous, graded and etiologically significant positive association with cardiovascular outcomes (Vasan *et al.*, 2001). Almost all

studied risk factors like age, age of onset, BMI, WHR, pulse rate, socioeconomic status, occupation and blood pressure phenotypes have higher correlation ( $p < 0.001$ ) with the occurrence of type 2 diabetes among both sexes. The multivariate regression analysis confirmed that age, BMI, WHR and socioeconomic status are significant predictor for the occurrence of type 2 diabetes among both sexes (Kaur, *et al.*, 2009).

**Table 30. Blood pressure of the selected subjects before and after supplementation**

| S<br>No. | Blood Pressure<br>(mm/Hg) | Diabetic subjects<br>(n=30) |                         | 't'<br>value       | Hyperlipidemic subjects<br>(n=30) |                         | 't' value |
|----------|---------------------------|-----------------------------|-------------------------|--------------------|-----------------------------------|-------------------------|-----------|
|          |                           | Before<br>Clinical trial    | After Clinical<br>trial |                    | Before Clinical<br>trial          | After Clinical<br>trial |           |
| 1.       | Systolic BP(mm/Hg)        | 131.93 ± 12.60              | 125.6 ± 8.50            | 1.61 <sup>NS</sup> | 144.33 ± 10.67                    | 131.46 ± 8.05           | 3.72*     |
| 2.       | Diastolic (mm/Hg)         | 90.73 ± 7.23                | 84.06 ± 4.71            | 2.93*              | 96.73 ± 5.44                      | 88.53 ± 4.25            | 4.60*     |

\* - Significant at 5per cent

NS - non significant

#### **4.15 Effect of Supplementation of *Heartdiabocare Snack* on Blood Glucose Level and Lipid Profile of the Selected Subjects**

All the subjects of experimental group i.e. diabetic (15) and hyperlipidemic (15) were given 60 gm *Heartdiabocare Snack* daily for 60 days (Plate 18 and 19).

##### **4.15.1 Effect of Supplementation of *Heartdiabocare Snack* on Blood Glucose Level of the Selected Diabetic Subjects**

Table 31 and Fig. 38 and 39 represent the effect of supplementation of *Heartdiabocare Snack* on fasting and post prandial blood glucose level of the selected diabetic subjects of experimental and control group before and after supplementation. The initial fasting blood glucose of experimental group subjects was  $186.53 \pm 32.21$  mg/dl while it was  $169.06 \pm 45.52$  mg/dl of the control group subjects. After 30 days supplementation the values of blood glucose were reduced to  $150.86 \pm 37.89$  mg/dl and it was  $171.06 \pm 39.51$  mg/dl in non-supplemented group. The mean fasting blood glucose values estimated after the completion of supplementation period were  $141.13 \pm 21.87$  mg/dl and  $170.2 \pm 27.74$  mg/dl among experimental and control group respectively. It can be observed from the data that in experimental subjects fasting blood glucose was reduced by 35.67 and 45.4 mg/dl after 30 and 60 days supplementation of *Heartdiabocare Snack* respectively while in case of control group it remained almost same at both the intervals of estimation. The statistical analysis of fasting blood glucose values inferred that within 30 days it was significantly reduced and the continuation of supplementation of *Heartdiabocare Snack* for 60 days resulted in significant decrease ( $P < 0.01$ ) in the serum glucose level. The data inferred that the supplementation of *Heartdiabocare Snack* is effective in reducing the fasting blood glucose significantly.

The data with regard to post prandial blood glucose level of the subjects showed that the initial post prandial blood glucose was  $261.4 \pm 78.42$  and  $264.56 \pm 67.65$  mg/dl of experimental and control group subjects respectively.



**Plate 18 Investigator is serving food supplements to the subjects**



**Plate 19 Investigator giving food supplement to the subject**

The initial value of post prandial blood glucose decreased to  $233.89 \pm 42.41$  mg/dl due to supplementation up to 30 days. The reduction in the value was by 28.51 mg/dl which was statistically not significant. Among control group such reduction in blood glucose level was not noticed as they did not receive the developed snack. On the contrary among them the value was slightly increased at the end of 30 days. Further continuation of supplementation of *Heartdiabocare Snack* for one more month resulted in reducing the post prandial blood glucose significantly ( $P < 0.01$ ) of experimental group subjects. After the 60 days intervention of *Heartdiabocare Snack* supplementation, the post prandial blood glucose value of experimental group subjects was declined by 50.14 mg/dl ( $211.26 \pm 36.71$  mg/dl). The post prandial blood glucose value among the control group subjects was raised to  $268.41 \pm 55.18$  mg/dl at the end of 2 months. The mean post prandial blood glucose level of the selected diabetic subjects of control group did not exhibit significant difference after 60 days period.

Hence, it can be concluded that supplementation of *Heartdiabocare Snack* to the diabetic subjects for 60 days found to be helpful in reducing blood glucose level significantly. A significant reduction of 22.80 mg/dl in fasting blood glucose was recorded by Haripriya and Premakumari (2010) in diabetic subjects supplemented with wheat bran.

The developed *Heartdiabocare Snack* is rich in dietary fiber especially soluble fiber and it is low in carbohydrates (Table 3). The sources of dietary fiber in the developed supplement are flaxseed, gum acacia, oats, wheat bran etc. (Table 1). It is proved by many researchers that dietary fibre plays a vital role in attenuation of blood glucose and cholesterol. Kapoor *et al.*, (2011) studied the effect of flaxseed on lowering the blood glucose and lipid profile among diabetic females and reported that flaxseed supplementation had significant effect in the improvement of blood glucose and lipid profile.

**Table 31. Effect of supplementation of *Heartdiabocare Snack* on fasting and post prandial blood glucose level (mg/dl) of the selected diabetic subjects (n=30)**

| Subjects                  | n         | Fasting blood glucose level (mean $\pm$ SD) |                    |                    |            | Post prandial blood glucose level (mean $\pm$ SD) |                    |                    |            |
|---------------------------|-----------|---------------------------------------------|--------------------|--------------------|------------|---------------------------------------------------|--------------------|--------------------|------------|
|                           |           | Initial                                     | 30 Days            | 60 Days            | Difference | Initial                                           | 30 Days            | 60 Days            | Difference |
| <b>Experimental group</b> | <b>15</b> | 186.53 $\pm$ 32.21                          | 150.86 $\pm$ 37.89 | 141.13 $\pm$ 21.87 | - 45.4     | 261.4 $\pm$ 78.42                                 | 232.89 $\pm$ 42.41 | 211.26 $\pm$ 36.71 | - 50.14    |
| <b>Control group</b>      | <b>15</b> | 169.06 $\pm$ 45.52                          | 171.06 $\pm$ 39.51 | 170.2 $\pm$ 27.74  | + 1.14     | 264.56 $\pm$ 67.65                                | 267.8 $\pm$ 70.26  | 268.41 $\pm$ 55.18 | + 3.85     |

**Statistical comparison of Data ('t' values)**

| Subjects                  | Fasting blood glucose level (mean $\pm$ SD) |                    |                    | Post prandial blood glucose level (mean $\pm$ SD) |                    |                    |
|---------------------------|---------------------------------------------|--------------------|--------------------|---------------------------------------------------|--------------------|--------------------|
|                           | 0Vs 30                                      | 30 Vs 60           | 0 Vs 60            | 0Vs 30                                            | 30 Vs 60           | 0 Vs 60            |
| <b>Experimental group</b> | 2.77**                                      | 0.86 <sup>NS</sup> | 4.51**             | 1.38 <sup>NS</sup>                                | 1.14 <sup>NS</sup> | 2.52**             |
| <b>Control group</b>      | 0.01 <sup>NS</sup>                          | 0.06 <sup>NS</sup> | 0.08 <sup>NS</sup> | 0.12 <sup>NS</sup>                                | 0.02 <sup>NS</sup> | 0.17 <sup>NS</sup> |

NS-Non Significant    \*\*- Significant at one per cent

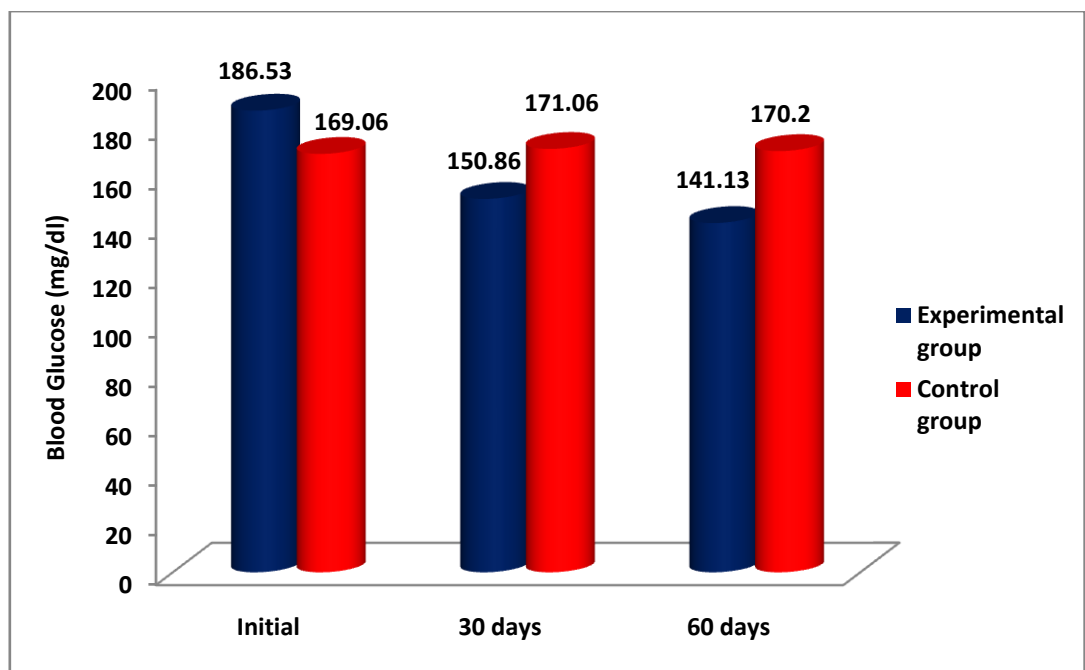


**Fig. 38 Mean fasting blood glucose level of the Diabetic subjects of experimental and control group before and after supplementation**

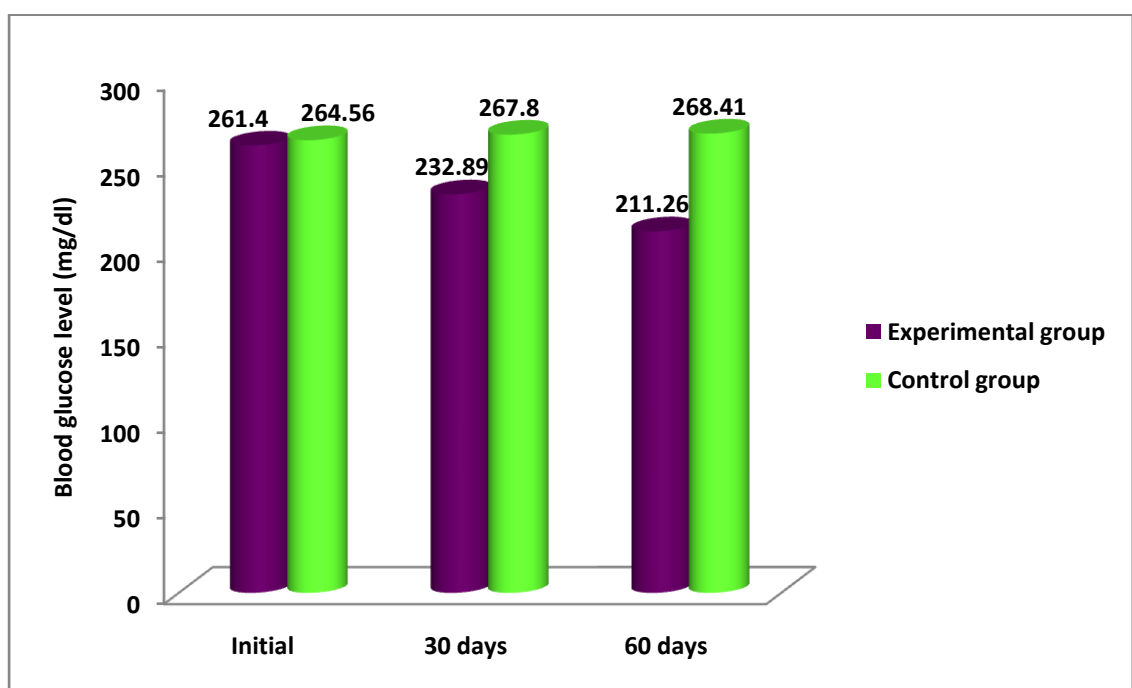


**Fig. 39 Mean post prandial blood glucose level of the Diabetic subjects of experimental and control group before and after supplementation**

#### **4.15.2 Effect of Supplementation of *Heartdiabocare Snack* on Lipid profile of the Selected Hyperlipidemic Subjects**

The data pertaining to the values of lipid profile as influenced by the supplementation of *Heartdiabocare Snack* in hyperlipidemic subjects is presented in Table 32 and Fig. 40 to 44.

The total cholesterol of supplemented group was  $225.2 \pm 77.60$  mg/dl, while it was  $214.66 \pm 57.16$  of control group subjects before initiation of intervention. The values of total cholesterol were decreased to  $171.6 \pm 34.73$  after the consumption of *Heartdiabocare Snack* for 30 days. This value of total cholesterol further slid down to  $156.3 \pm 33.65$  mg/dl in the experimental group subjects after the completion of supplementation. The reduction in the total cholesterol was 68.9 mg/dl due to consumption of *Heartdiabocare Snack* which was statistically significant. There was no significant difference in the total cholesterol content in the control group.

The triglyceride content of the blood of selected experimental group subjects and control group subjects was  $167.7 \pm 53.11$  and  $131.13 \pm 37.16$  mg/dl respectively in the beginning of the supplementation. After supplementation the value of triglycerides of the experimental group subjects was dropped from  $167.7 \pm 53.11$  to  $158.1 \pm 71.11$  mg/dl within 30 days and to  $129.1 \pm 44.78$  mg/dl after two months. The triglycerides content of control group was increased by 4.73 m/dl after the duration of 60 days. However, this increase was not significant. The reduction in the value of triglycerides was 38.6 mg/dl in supplemented group at the end of intervention which was statistically significant.

The initial HDL-cholesterol of the subjects from experimental group was  $37.91 \pm 5.83$  which was gradually increased to  $40.9 \pm 3.92$  within 30 days and  $43.7 \pm 9.4$  within 60 days. After supplementation there was slight increase (5.77 mg/dl) in HDL-cholesterol, but it was not significant statistically. The HDL cholesterol of control group subjects was  $41.4 \pm 9.4$  mg/dl which remained almost same after the completion of experiment.

There was a positive impact of supplementation of *Heartdiabocare Snack* on LDL cholesterol of supplemented groups which was exhibited by significant decrease in the initial value of  $140.37 \pm 45$  mg/dl to a final value of  $103.19 \pm 25.13$  mg/dl and slided down to  $90.19 \pm 25.31$  mg/dl. The initial and final values were compared statistically and it was noticed that the reduction in LDL cholesterol was significant ( $p < 0.01$ ). Such change was not noticed in the LDL cholesterol of control group subjects. VLDL cholesterol was 44.1 mg/dl initially and reduced slightly by 2.74 mg/dl at the end of the experiment. Supplementation did not show any significant effect on the VLDL cholesterol content of both experimental and control group subjects.

Sylvia *et al.*, (2001) assessed the effect of  $\beta$  glucan in incorporated foods on total and LDL cholesterol in 30 known hypercholesterolemic subjects. The results indicated that there was decline in the plasma cholesterol and LDL cholesterol. Katare and Saxena (2013) evaluated the effect of soybean and flaxseed supplementation on serum lipids of dyslipidemic subjects. It was reported that after a supplementation of 30 g flaxseed and 30 g soya nuts for 12 weeks resulted in significant drop in total cholesterol and triglycerides. The study conducted on cholesterol lowering benefits of soy and linseed enriched foods by Ridges *et al.*, (2009) demonstrated the feasibility of supplementing the diet with soy and linseed containing foods to achieve clinical reductions of total, LDL and non HDL cholesterol in hyperlipidemic women. From above discussed data it can be concluded that *Heartdiabocare Snack* is effective in reducing the blood glucose and lipid profile.

**Table 32. Effect of supplementation of *Heartdiabocare Snack* on lipid profile of the selected hyperlipidemic subjects (n=30)**

| Lipid profile                    | Mean $\pm$ SD      |                    |                    |
|----------------------------------|--------------------|--------------------|--------------------|
|                                  | Initial            | 30 Days            | 60 Days            |
| <b>Total Cholesterol (mg/dl)</b> |                    |                    |                    |
| Experimental                     | 225.2 $\pm$ 77.60  | 171.6 $\pm$ 34.73  | 156.3 $\pm$ 33.65  |
| Control                          | 214.66 $\pm$ 57.16 | 218.33 $\pm$ 50.77 | 216.8 $\pm$ 52.10  |
| <b>Triglycerides (mg/dl)</b>     |                    |                    |                    |
| Experimental                     | 167.7 $\pm$ 53.11  | 158.1 $\pm$ 71.11  | 129.1 $\pm$ 44.78  |
| Control                          | 131.13 $\pm$ 37.16 | 137.06 $\pm$ 56.67 | 135.86 $\pm$ 54.24 |
| <b>HDL- Cholesterol (mg/dl)</b>  |                    |                    |                    |
| Experimental                     | 37.91 $\pm$ 5.83   | 40.9 $\pm$ 3.92    | 43.7 $\pm$ 9.4     |
| Control                          | 41.4 $\pm$ 9.4     | 41.73 $\pm$ 11.84  | 41.6 $\pm$ 6.13    |
| <b>LDL- Cholesterol (mg/dl)</b>  |                    |                    |                    |
| Experimental                     | 140.37 $\pm$ 45    | 103.19 $\pm$ 25.13 | 90.19 $\pm$ 28.82  |
| Control                          | 145.73 $\pm$ 38.18 | 147.8 $\pm$ 53.07  | 137.68 $\pm$ 36.74 |
| <b>VLDL- Cholesterol (mg/dl)</b> |                    |                    |                    |
| Experimental                     | 140.37 $\pm$ 45    | 103.19 $\pm$ 25.13 | 90.19 $\pm$ 28.82  |
| Control                          | 145.73 $\pm$ 38.18 | 147.8 $\pm$ 53.07  | 137.68 $\pm$ 36.74 |

**Statistical comparison of Data ('t' values)**

| Subjects                  | Total Cholesterol (mg/dl) |                          |                          | Triglyceride (mg/dl)     |                             |                          | HDL Cholesterol (mg/dl)  |                             |                          | LDL cholesterol (mg/dl)  |                             |                          | VLDL Cholesterol(mg/dl)  |                             |                          |
|---------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|-----------------------------|--------------------------|
|                           | Initial<br>vs 30<br>days  | 30 Days<br>vs 60<br>days | Initial<br>vs 60<br>Days | Initial<br>vs 30<br>days | 30<br>Days<br>vs 60<br>days | Initial<br>vs 60<br>Days | Initial<br>vs 30<br>days | 30<br>Days<br>vs 60<br>days | Initial<br>vs 60<br>Days | Initial<br>vs 30<br>days | 30<br>Days<br>vs 60<br>days | Initial<br>vs 60<br>Days | Initial<br>vs 30<br>days | 30<br>Days<br>vs 60<br>days | Initial<br>vs 60<br>Days |
| <b>Experimental Group</b> | 5.63**                    | 1.22 <sup>NS</sup>       | 6.34**                   | 2.41**                   | 1.33 <sup>NS</sup>          | 3.48**                   | 1.64 <sup>NS</sup>       | 1.06 <sup>NS</sup>          | 2.02 <sup>NS</sup>       | 1.78 <sup>NS</sup>       | 1.21 <sup>NS</sup>          | 3.68**                   | 0.41 <sup>NS</sup>       | 0.22 <sup>NS</sup>          | 0.63 <sup>NS</sup>       |
| <b>Control Group</b>      | 0.31 <sup>NS</sup>        | 0.45 <sup>NS</sup>       | 0.31 <sup>NS</sup>       | 0.50 <sup>NS</sup>       | 1.50 <sup>NS</sup>          | 1.91 <sup>NS</sup>       | 0.08 <sup>NS</sup>       | 0.03 <sup>NS</sup>          | 0.06 <sup>NS</sup>       | 0.71 <sup>NS</sup>       | 0.60 <sup>NS</sup>          | 0.14 <sup>NS</sup>       | 1.25 <sup>NS</sup>       | 0.74 <sup>NS</sup>          | 1.56 <sup>NS</sup>       |

\*\* - Significant at 1per cent

NS - non significant

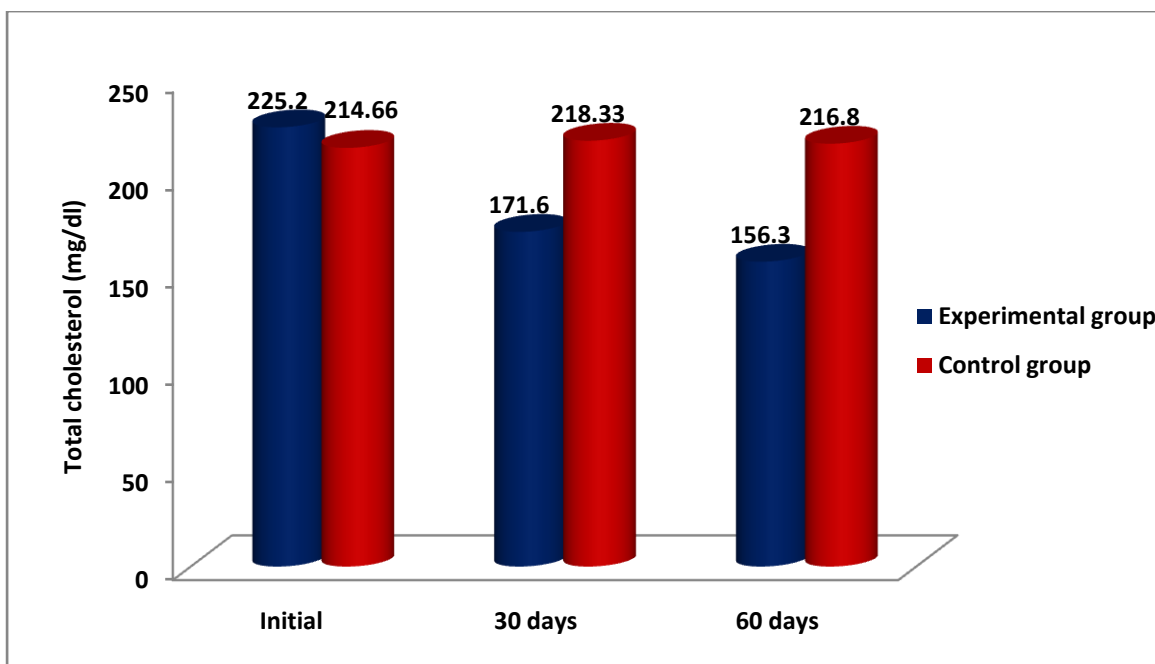


**Fig. 40 Total cholesterol of hyperlipidemic subjects of experimental and control group before and after supplementation**

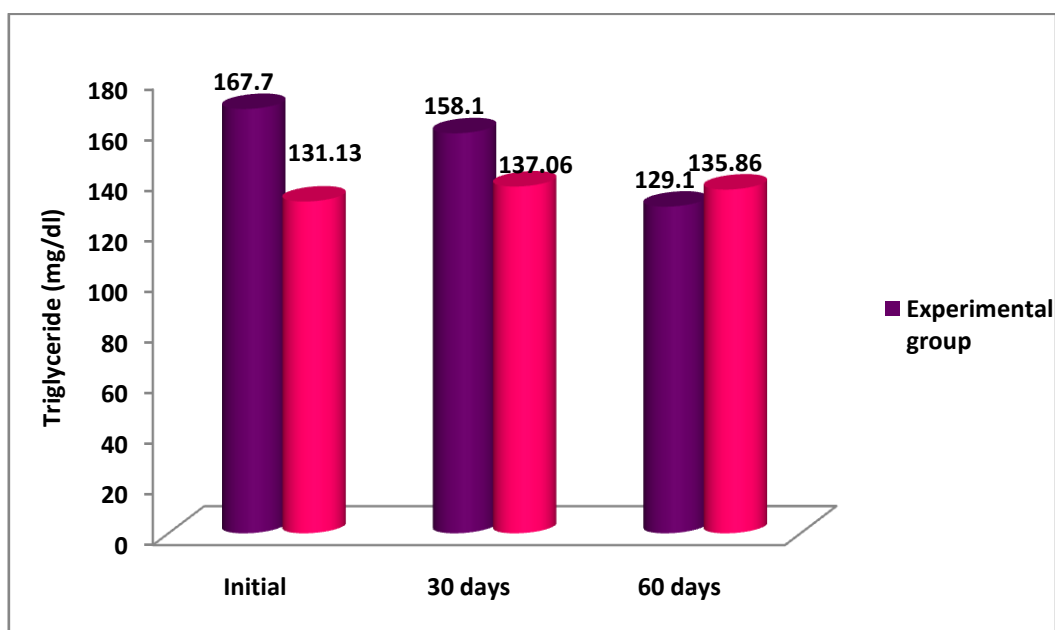


**Fig. 41 Triglyceride of hyperlipidemic subjects of experimental and control group before and after supplementation**

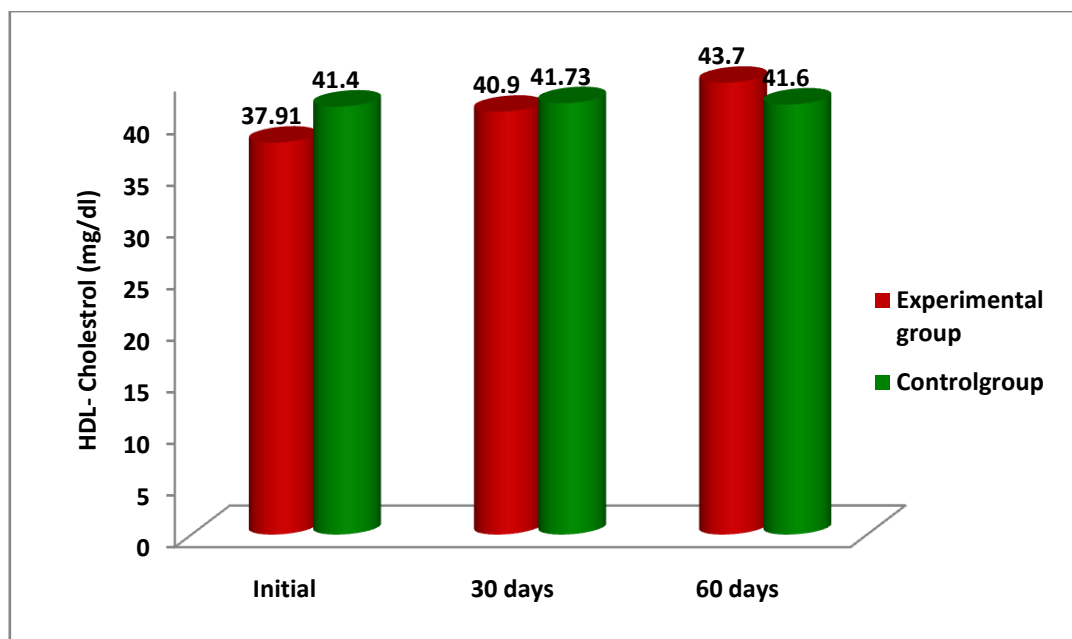


**Fig. 42 HDL Cholesterol of hyperlipidemic subjects of experimental and control group before and after supplementation**

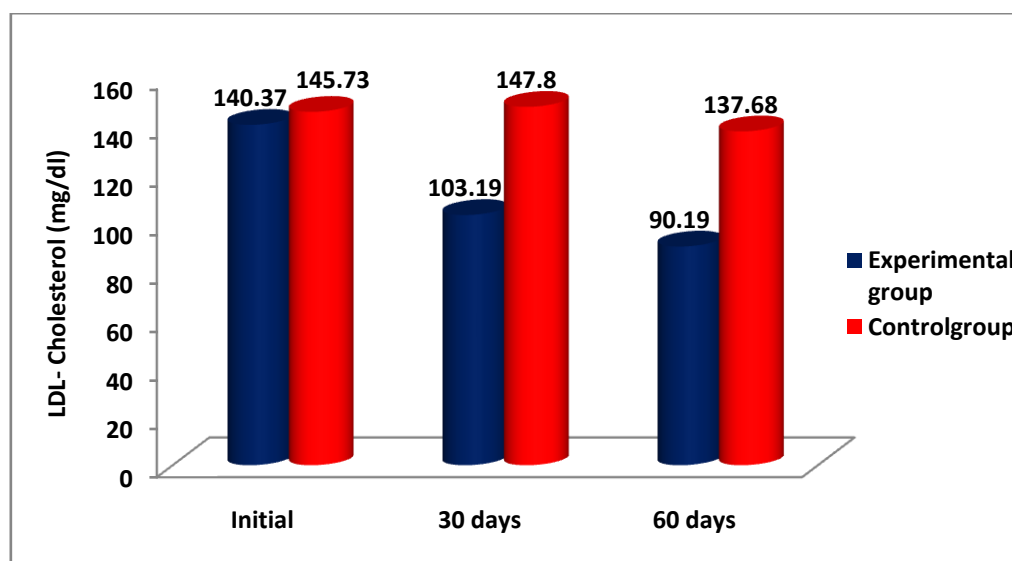


**Fig. 43 LDL Cholesterol of hyperlipidemic subjects of experimental and control group before and after supplementation**

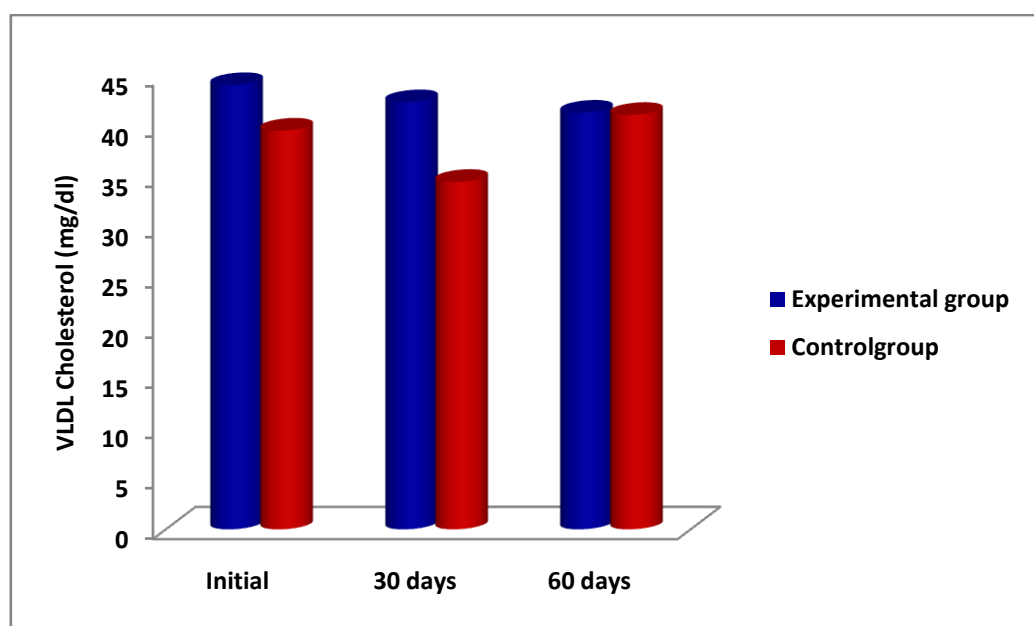


**Fig. 44 VLDL Cholesterol of hyperlipidemic subjects of experimental and control group before and after supplementation**



# Summary and Conclusion

## CHAPTER-V

### SUMMARY AND CONCLUSIONS

In view of the increased prevalence of non communicable diseases interests of population in the health benefits of food have been sparked. Therefore, the present investigation **“Formulation of Functional Snack and its Effect on Blood Sugar and Lipid Profile”** was carried out in two phases - development of functional snack and effect of supplementation of functional snack on selected diabetic and hyperlipidemic subjects. The methods used and results emerged out of experiments are presented and discussed in previous chapters and are summarized below.

For development of functional snack forty two variations were tried by changing the composition of ingredients to finalize one composition of functional snack. Variation 40 i.e. cardamom flavoured functional snack recorded highest scores in case of all sensory characters. The functional snack prepared by using in percent wheat flour 20, flax seed powder 5, niger seed powder 5, wheat bran 10, skim milk powder 20, soya chunk powder 5, oat flour 5, jowar flour 4, sugar powder 5, baking powder 3, fat 5, salt 1 and cardamom powder 2 per cent received an overall acceptability score of 8.97 and was liked by the sensory panel members. The cardamom flavoured functional snack recorded highest scores in case of all sensory characters viz. and over all acceptability (8.97). Hence, it was selected for further study and the developed functional snack was named as *Heartdibocare* snack.

The functional properties of the flour were studied. It was evidenced from the data that the water absorption capacity and oil absorption capacity were recorded as 2.26 and 1.98 ml/g respectively and least gelation concentration was 4 per cent.

Physical properties of developed functional snack indicated that the baking temperature was maintained while preparing functional snack was 150<sup>0</sup>C and the baking time was about 20 minutes. Number of pieces (functional

bar) obtained from 100g were seven. The weight of each piece was 15g. The length and width of the snack was 11cm and 3 cm respectively. The thickness of the sample was 0.6 cm. Volume of the snack was 30 ml Bulk density was 1.23 g/ml and the hardness (texture) of the snack was 3.08 N. The colour of functional snack was recorded as values of L, a, b as 48.28, 6.94 and 22.85 respectively.

The nutrient evaluation of *Heartdibocare* snack evidenced that moisture, protein and fat content of functional snack were 2.33 per cent, 17.11 per cent and 12.08 per cent respectively. Dietary fiber content of functional snack was 22.28 per cent. The soluble and insoluble dietary fibre was 3.86 and 18.42 percent respectively. The estimated micronutrients were calcium 296.56 mg, iron 7.5 mg, zinc 1.48 mg, copper 0.397 mg and manganese 1.65mg per 100 g. Invitro protein digestibility of developed functional snack was 82 per cent. The developed functional snack had 43.97 per cent carbohydrates, can supply 349 Kcal energy per 100g while the values of thiamine, riboflavin and niacin were 0.225, 1.031 and 1.85 mg/100g of snack.

The *Heartdiabocare Snack* was packed in low density polyethylene pouch (LDPE) & laminated aluminium packages and it was stored for 90 days. Biochemical parameters and microbial population were assessed in the beginning and at the end of the storage.

Results indicated that the non significant increase was observed in moisture content, peroxide value and free fatty acids of the *Heartdiabocare Snack* during storage in both the packaging materials after 3 months storage.

Initially the microbial population of functional snack was found to be nil or below the detectable level (BDL). Both the packed samples had low microbial population after storage and hence were fit for consumption.

Cost of ingredients used for development of functional snack was 155Rs. /Kg.

GI of the heartdiabocare snack was estimated to check its suitability to feed to the diabetic subjects. Glycemic index of developed *Heartdiabocare* functional snack was 26.77 which is categorized as low glycemic index  $< 55$  (Wolver and Jenkins, 1986).

It was observed that both diabetic and hyperlipidemic subjects were more from 50-60 years age group. Sex wise data indicated that more number of male were sufferers of diabetes (53.33%) and hyperlipidemia (70%). Educational status of subjects revealed that there was no specific trend observed according to educational status for both the disorders. Diabetes and hyperlipidemia was observed more among the subjects who were engaged in the service (36.66 % each). The income wise distribution indicated that there was increase in the number of subjects as the income was increased.

The data with regard to prevalence of symptoms among the studied diabetic subjects indicated that the symptom experienced by maximum (56.66%) subjects was getting tired even after a small activity, followed by polyuria (50%), polyphagia (50 %), polydypsia(40 %), nocturia (36.66 %) and weight loss (33.33 %). There were only 10 per cent subjects having the eye and feet problem each. The symptoms experienced by the respondents under study are very common among the diabetic patients.

Among the total selected diabetic subjects majority of them (40%) were suffering from more than five years and 33.33 per cent subjects were suffering from 3-5 years. While, twenty per cent (6) of respondents were from 1-3 years and only two subjects (6.66%) were suffering from less than one year from diabetes. With regard to hyperlipidemia it was noticed that maximum (43.33%) subjects were suffering since one year followed by 36.66 per cent subjects had hyperlipidemia from 1- 3 years. There were 13.33 per cent and 6.66 per cent subjects who had impaired lipid profile from 3-5 years and  $> 5$  years duration.

Majority of the diabetic subjects (50%) were not having diabetic history from either of the parent side while 40 per cent were having from maternal side and only three (10%) diabetic subjects were having diabetic history from

paternal side. The hyperlipidemic subjects having family history of disorder were 60 per cent, out of which 33.33 per cent reported it from maternal side and 26.66 per cent from paternal side. There were 40 per cent subjects who did not have family history of hyperlipidemia.

The food consumption pattern of selected subjects revealed that most of the diabetic patients were vegetarian on the contrary majority of the hyperlipidemics were non vegetarians. There were 66.66 percent each vegetarian diabetics and non vegetarian hyperlipidemic subjects. Non vegetarian diabetics were 6.66 per cent while vegetarian hyperlipidemic respondents were 26.66 per cent. Ova vegetarians were 26.66 and 6.66 per cent respectively from diabetic and hyperlipidemic group.

Nuts and oilseeds were consumed by all 100 per cent selected subjects. Oilseeds were consumed daily by 26.66 per cent diabetics and 60 per cent hyperlipidemic respondents. Snacking was followed by selected subjects. Sixty and seventy per cent among them respectively were consuming more than 100 g snack. The frequency of snack consumption was daily in 60 per cent respondents in both the groups. The remaining respondents consumed snacks 2-4 times a week (16.66%), weekly (6.66 and 10%) and occasionally (6.66%).

Among the diabetic subjects, all subjects consumed garlic, tomatoes and citrus fruits. While 80 to 93.33 per cent subjects consumed fermented foods, flaxseed and soybean. The functional foods were found to be consumed by 6.66 to 30 per cent subjects. Green tea and omega 3 fatty acids capsules consumption was reported to be lowest (by 6.66 per cent subjects).

Among the various factors responsible for purchasing of functional food it was noticed that cost was the most influenceable factor in purchasing of these foods followed by good taste, as it availability in the market in both type of subjects. It was observed that in general diabetic subjects were more aware regarding the purpose of functional food purchase or its biological role than the hyperlipidemic subjects.

Seventy percent diabetic subjects and 40 per cent hyperlipidemic subjects do exercise while rest of the subjects were not performing the exercise. In respect of type of exercise 70 per cent diabetic subjects go for walking while 23.33 hyperlipidemic subjects opted walking as an exercise. It was reported from data that 100 per cent diabetic and hyperlipidemic subject spent their time in watching TV, chit chatting with Family and friends, where as 86.66 per cent diabetic subjects and 83.33 per cent hyperlipidemic subjects spent their time in reading and watching TV.

All the selected 16 diabetic and 21 hyperlipidemic men had some or other undesirable habit. There were 31.25 per cent diabetic and 38.09 per cent hyperlipidemic subjects who were drinking alcoholic beverages.

The results clearly show that protein, energy, iron and fiber intake was lower than the RDA among both these subjects. While fat consumption exceeded than RDA given by ICMR.

The observed deficit intake of protein and excess intake of fats and carbohydrates among both male and female diabetic individuals is not recommended. Intake of all the food groups among the male and female diabetic subjects studied in present investigation clearly shows that except fat and oils intake of all foods were deficient.

In present investigation weight, height, mid upper arm circumference, triceps skinfold thickness, waist circumference, and hip circumference were measured. The BMI were calculated and WHR was calculated before and after giving the supplementation of developed heartdiabocare snack.

Gender wise anthropometric measurements of selected diabetic subjects showed that there was no significant difference in recorded anthropometric measurements of experimental and control group men and women before and after supplementation of *Heartdiabocare Snack*. All the selected subjects were categorized as obese as they had more than 25 BMI. The similar trend of observations with respect to gender wise anthropometric measurements of selected hyperlipidemic subjects was noticed.

The blood pressure values were recorded in beginning and at the end of the experiment which were 125.6/84.06 and 131.46/88.53 mm/Hg. The statistical comparison of blood pressure values inferred that there was significant reduction in the diastolic blood pressure of both diabetic and hyperlipidemic subjects and systolic blood pressure of hyperlipidemic subjects was reduced to normal.

The impact of developed functional snack on blood glucose level of diabetic and lipid profile of hyperlipidemic subjects was assessed by conducting a clinical study.

It can be observed from the data that in experimental subjects fasting blood glucose was reduced by 45.4 mg/dl after 60 days supplementation of *Heartdiabocare Snack* while in case of control group it remained almost same. The data inferred that the supplementation of *Heartdiabocare Snack* could reduce the fasting blood glucose significantly.

After the 60 days intervention of *Heartdiabocare Snack* supplementation, the post prandial blood glucose value of experimental group subjects was declined by 50.14 mg/dl. The statistical analysis of post prandial blood glucose data indicated that mean post prandial blood glucose of experimental subjects was decreased significantly after 60 days of intervention. On the other hand mean post prandial blood glucose level of the selected diabetic subjects of control group did not exhibit significant difference after 60 days period.

Hence, it can be concluded that supplementation of *Heartdiabocare Snack* to the diabetic subjects for 60 days found to be helpful in reducing blood glucose level significantly.

The reduction in the total cholesterol was 68.9 mg/dl due to two months consumption of *Heartdiabocare Snack* which was statistically significant. There was no significant difference in the total cholesterol content of the control group after two months interval.

After supplementation the value of triglycerides of the experimental group subjects was dropped from  $167.7 \pm 53.11$  to  $129.1 \pm 44.78$  mg/dl. The triglycerides content of control group was increased by 4.73 m/dl after the duration of 60 days.

There was slight increase (5.77 mg/dl) in HDL-cholesterol, after interventions but it was not significant statistically. The HDL cholesterol of control group subjects remained almost same after the completion of experiment.

There was a positive impact of supplementation of *Heartdiabocare Snack* on LDL cholesterol which was exhibited by significant decrease in the such change was not noticed in the LDL cholesterol of control group subjects.

Supplementation did not show any significant effect on the VLDL cholesterol content of both experimental and control group subjects.

Hence, it can be concluded from the above findings that the cardamom flavoured functional snack was most accepted by panel members.

From the present investigation the following conclusions are drawn

## Conclusions

- Very well accepted functional snack can be developed by using ingredients such as wheat flour, flax seed, niger seed, oats, jowar, milk powder, gum acasia and soya chunks.
- The developed *Heartdiabocare* functional snack is rich in protein (17.11%), dietary fibre (22.28 %), iron (7.5 mg/100g) and calcium (298.56 mg/100g).
- In vitro protein digestibility of *Heartdiabocare* functional snack is 82 per cent.
- The *Heartdiabocare* functional snack has low Glycemic index (26.77) hence it is suitable for diabetic persons.
- The developed functional snack is fit for consumption on 90<sup>th</sup> day of storage.
- Cost of ingredients used for functional snack is 115 Rs. / Kg which is for less than the snack available in market.
- All the selected subjects were categorized as obese as they had more than 25 BMI.
- The protein, energy, iron and fiber intake of the selected subjects was lower than the RDAs of ICMR, while fat consumption exceeded significantly than RDAs in both groups of subjects.
- Supplementation of *Heartdiabocare Snack* to the diabetic and hyperlipidemic subjects is helpful to control blood pressure in both the groups.
- Supplementation of *Heartdiabocare Snack* to the diabetic subjects for 60 days found to be helpful in reducing fasting and post prandial blood glucose level.
- Supplementation of *Heartdiabocare Snack* to the hyperlipidemic subjects for 60 days found to be effective in reducing the total cholesterol, triglyceride and LDL cholesterol level.



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**Web addresses**

<http://www.justicegovt.in>

Innovation centre of U. S. Dairy 2010.<http://www.u.sdairy.com>

[www. healthyeating.sfgate.com](http://www.healthyeating.sfgate.com)

European Heart Network Website. <http://www.ehnheart.org>



# Appendix

## ANNEXURE- I

### *Organoleptic Evaluation Score Card*

**Name of the evaluator** : -----

**Date** : -----

You are requested to evaluate the given samples and score the qualities of the given samples. Express the acceptability numerically according to given score point.

| <b>Score Point</b> | <b>Reaction</b>          |
|--------------------|--------------------------|
| 9                  | Like extremely           |
| 8                  | Like very much           |
| 7                  | Like moderately          |
| 6                  | Like slightly            |
| 5                  | Neither like nor dislike |
| 4                  | Dislike slightly         |
| 3                  | Dislike moderately       |
| 2                  | Dislike very much        |
| 1                  | Dislike extremely        |

| <b>Sample no.</b> | <b>Colour</b> | <b>Flavour</b> | <b>Taste</b> | <b>Texture</b> | <b>Overall Acceptability</b> |
|-------------------|---------------|----------------|--------------|----------------|------------------------------|
|                   |               |                |              |                |                              |
|                   |               |                |              |                |                              |
|                   |               |                |              |                |                              |
|                   |               |                |              |                |                              |

**Sign of the evaluator**

## **ANNEXURE-II**

### **Analysis of developed functional snack**

#### **Determination of Moisture Content**

Moisture content of the developed functional snack as well as all products prepared from functional snack were determined by oven drying method of (A.O.A. C., 2005).

#### **Procedure**

All samples taken in triplicate set were accurately weighed in an amount of 5.0 g each in weighing bottle (previously heated at 90° to 100°C and cooled in desicator). The bottles were loosely covered with lids which contain sample kept in hot air oven for 3 hours at 105°C. After 3 hours bottles were removed from oven and cool in desicator and weighed accurately. Then again bottles were returned to oven for 1 hour and weighed. This procedure was repeated until the constant weight was observed.

Moisture content of the sample was calculated by the formula is as,

$$\text{Moisture content of the sample (\%)} = \frac{W1 - W2}{\text{Weight of the sample}} \times 100$$

Where,

W1 = Initial weight of bottle with sample before drying.

W2 = Final weight of bottle with sample after drying.

#### **1. Determination of Total Protein Content**

Total protein content of the developed functional snack as well as all products prepared from developed functional snack were estimated by determining total nitrogen content of the using macro-Kjeldhal method (N. I. N., 1983). Total protein content was calculated by multiplying the estimated total nitrogen content with a factor 6.25.

## **Preparation of reagents**

### **a) Catalyst mixture**

It was prepared by grinding together 98 parts of potassium sulphate ( $K_2SO_4$ ) and 2 parts copper sulphate ( $CuSO_4$ ).

### **b) 40 per cent Sodium Hydroxide Solution**

An amount of 40g of sodium hydroxide pellets were dissolved in distilled water and diluted up to 100ml.

### **c) Methyl Red Indicator**

### **d) 2 per cent Boric acid solution**

A accurately weighed 2g of boric acid was dissolved in distilled water and the volume was made up to 100ml.

### **e) 0.1 N Sulphuric acid**

A measured quantity of 27.8ml of concentrated sulphuric acid was dissolved in distilled water and the volume was made up to 1000ml. This solution gives 1 N sulphuric acid. Then 100ml aliquot of 1 N sulphuric acid was dissolved up to 1000ml with distilled water.

## **Procedure**

One gram of defatted powdered sample of each product were weighed on butter paper, in triplicate and placed in each separate 300ml Kjeldhal flask. An amount 5.0g of catalyst mixture, 20ml of concentrated sulphuric acid and 1-3 glass bids were added into each flask. Similarly blank was also prepared using other reagents except sample. The contents in the flask were digested by heating for about 8 hours until the digested material was clear. The contents were allowed to cool and diluted by rinsing down the neck of the flask with distilled water. The contents were then transferred to a 100ml volumetric flask and the volume was made up to the mark with distilled water.

10ml of boric acid solution was delivered in to a 100ml conical flask and two drops of methyl red indicator were added and mixed well. The flask was then placed under the condenser with the tip of condenser extending below

the surface of boric acid solution; 5ml of digested sample was delivered into the distillation apparatus. Then 10ml of 40 per cent NaOH was added and the funnel was washed with 2 to 3ml of distilled water. Steam distillation was carried out and it was continued for 10 to 15 min, until about 40ml of distillate collected in boric acid solution. The tip of the condenser was washed with distilled water and the flask was removed. The ammonia collected in boric acid was titrated against the standard 0.1 N sulphuric acid solution. The end point of the titration was noted when 0.1 N sulphuric acid produced a light pink colour. Then the volume of 0.1 sulphuric acid required to neutralize the sample was noted.

Total protein content of sample was calculated by the formula,

$$\text{Nitrogen (\%)} = \frac{(\text{Titre. Volume of sample}) - (\text{Titre. Volume of blank}) \times \text{Normality of H}_2\text{SO}_4 \times 14 \times 100 \times \text{Dilution factor}}{\text{Weight of the sample (mg)}}$$

$$\text{Protein (\%)} = \text{Nitrogen (\%)} \times 6.25$$

## 2. Determination of Total Fat Content

The total fat content of functional snack samples was estimated by the soxhlet method of A. O. A. C. (2005).

### Procedure

Three soxhlet flask of 250ml capacity were cleaned and dried in an oven to a constant weight. Then triplicate samples in an amount of 5.0g were accurately weighed on a filter paper from each product. Each weighed sample was placed in thimbles and plugged with fat free cotton. Then the thimbles with the weighed sample were placed in the siphon portion of soxhlet apparatus. The volume of 160ml of analytical grade petroleum ether and diethyl ether mixture (1:1) was placed in each round bottom flask of the soxhlet apparatus and it was connected to the soxhlet siphon and condenser. The condenser was plugged with moistened cotton. It was refluxed for 5-7

times at 60°C. Then ether was distilled off and flask were placed on hot plate for 3 hours at 105°C for drying, cooled in a desicator and weighed.

Fat content of samples was calculated by the formula,

$$\text{Fat content (\%)} = \frac{W2 - W1}{X} \times 100$$

Where,

W1= Weight of empty round bottom flask

W2 = Weight of round bottom flask.

X = Weight of sample.

### **3. Estimation of Total Minerals**

The total minerals of sample were determined by the ashing method of A. O. A. C. (2005).

#### **Preparation of Mineral Solution**

The triple acid digestion method of Sahrawat *et al.* (2002) was employed. The sample (2.0 g) was weighed into a Micro-Kjeldahl digestion flask to which 24 ml of mixture of concentrated HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> and 60 per cent HClO<sub>4</sub> (9:2:1 v/v) were added. The sample was digested to a clear solution and diluted to 50 ml with distilled water. The solution was used for determination of mineral elements; calcium, magnesium, potassium and iron.

#### **Minerals Analysis using Atomic Absorption Spectrometry (AAS)**

Calcium, magnesium, manganese, potassium, iron and zinc were analyzed using atomic absorption spectrometry (AAS). The method gives a good precision and accuracy (Ojeka and Ayodele, 1995). The principle of the method is based on nebulising a sample solution into an air acetylene flame where it is vaporized. Elemental ions were then atomized and the atoms then absorb radiation of a characteristic wavelength from a hollow-cathode lamp. The absorbance measured, is proportional to the amount of analyte in the

sample solution. As mentioned already, the level of each element in the sample solution was determined by reference to a calibration curve.

## **6. Determination of Crude Fiber Content**

Crude fiber content of functional snack products was determined by the method of A.O.A. C (1990).

### **a) Preparation of reagents**

#### **b) 0.225 N sulphuric acid solution**

A measured quantity of 1.25ml of concentrated sulphuric acid was dissolved in glass distilled water and volume was made up to 100ml.

#### **c) 0.313 N Sodium hydroxide solution**

A weighed amount of 1.25g of sodium hydroxide was dissolved in glass distilled water and the volume was made up to 100ml.

## **Procedure**

Exactly 2.0g of moisture, fat free sample was weighed in triplicate in 500ml beaker. Then 200ml of 0.225 N sulphuric acid solution was added in to each beaker and mixture was allowed to boil for 30 min keeping the volume constant by addition of water at frequent intervals, glass rod was used to stir the solution which helped for smooth boiling. Then the mixture was filtered through a muslin cloth and residue was washed with hot water to make it free from acid. The material was then transferred to the same beaker carefully; 200ml of boiling 0.313 N sodium hydroxide was add and boiled for 30 min keeping the volume constant by using the distilled water. The mixture was again filtered through a muslin cloth and residue was washed with hot water to make it free from alkali and alcohol. Then residue was transferred to crucible which was dried in an oven overnight at 80°C and weighed accurately (W1). The crucible was heated in muffle furnace at 600°C for 2-3 hours, cooled in a desicator and weighed again accurately (W2). The difference between the two weights (W1- W2) was considered as the weight of crude fiber in the moisture

and fat free sample. The crude fiber in sample was calculated by using following formula,

$$\text{Crude fiber content} = \frac{(W1-W2)}{\text{Weight of sample}} \times 100.$$

(g/100g)

## **7. Dietary fibre**

### **7.1 Insoluble Fiber (AOAC; 1995)**

Defatted foods are gelatinized and proteins and starch are removed by enzymatic digestion. The residue is filtered and washed. The residue is quantified gravimetrically.

#### **Reagents:-**

- a) 95% Ethanol
- b) 78% Ethanol
- c) 0.08 M Phosphate buffer, PH 6.0
- d) 0.275 N NaOH
- e) 0.325 N HCL or 0.205 M Phosphoric acid
- f) L amylase heat stable solution
- g) Protease solution – Suspend 50 mg Protease in 1 ml of Phosphate buffer PH 6.0
- h) Amyloglucosidase solution

#### **Sample Preparation:**

Homogenize sample and dry overnight in hot air oven at 105 °C, cool in desiccator and dry mill portion of sample to 0.3 – 0.5 mm mesh. If sample cannot be heated, freeze dry before milling.

Wash in duplicate 1 g of sample, accurate to 0.1 mg into 500 ml beaker. Sample weight should not differ 20 mg. add 50 ml of phosphate buffer and adjust the PH to 6.0, of necessary. Add 0.1 ml heat stable alpha amylase solution. Cover the beakers reach 100 °C and incubate for 15 mts at this temperature. Total of 30 min in water bath should be sufficient; cool the solution to room temperature and adjust PH to 7.5 with NaOH solution.

Add 1 ml of Protease solution to each beaker. Cover beaker with aluminium foil and incubate for 30 min at 60 °C with continuous agitation. Cool, and adjust Ph to 4.0-4.6 add 0.3 ml amylolucosidase and incubate for 30 mts at 60°C with continuous agitation.

Weigh crucible with fitted disc containing 1 g celite to constant weight. The celite in the crucible is made into a bed by using a stream of 78 % ethanol and applying suction.

Maintain suction and quantitatively transfer precipitate from enzyme digest to crucible using filtration module.

Wash residue successfully with 3 times 20 ml portions of 78% ethanol, two 10 ml portions of 95 % ethanol and two 10 ml portions of acetone. Dry crucible containing residue overnight at 100 °C in hot air oven. Cool in dessicator and weigh to nearest 0.1mg. Subtract crucible and celite weight from the above to obtain the insoluble dietary fibre residue (IDF residue).

Analyze residue from one sample of set of duplicates for protein and subtract from the IDA residue value.

Incinerate second residue sample of duplicate for 5 lt at 525°C. Cool in dessicator and weigh to nearest 0.1 mg and subtract from the IDF residue value.

Insoluble Dietary Fibre= IDF residue-(Protein + Ash)

## 7.2 Soluble dietary fibre: (AOAC; 1995)

### Principle:

The soluble fibre is estimated in the filtrate obtained after enzymatic digestion of protein and carbohydrate of defatted food. The soluble fibre is precipitated and estimated gravimetrically. Reagents are the same as that of insoluble fibre sample preparation is the same of insoluble fibre.

### Determination:

Follow the steps of digestion with  $\alpha$  amylase, protease and amyloglucosidase and quantitative transfer the digest and cool the filtrate. Add 4 volumes of pre-heated (60°C) 95% ethanol. Allow the precipitation to complete for 60 min. filter through an accurately weighed crucible with celiate follow the procedure given under insoluble fibre, to obtain soluble dietary fibre (SDF) residue. Duplicate samples run similarly are analyzed for protein and ash.

$$\text{Soluble dietary fibre} = \text{weight of SDF residue} - (\text{Protein} + \text{Ash})$$

## 7.3 Total dietary fibre: (AOAC; 1995)

This is the sum of insoluble and soluble dietary fibre.

Blank (%) =  $\frac{\text{Wt. of the blank residue} - (\text{Protein (g) in the blank residue} + \text{Ash (g) in blank residue})}{\text{Weight of the sample (g)}} \times 100$

$$\text{IDF(\%)} = \frac{\text{Wt. of the SDF residue (g)} - (\text{Protein (g) in IDF} + \text{Ash (g) in IDF residue})}{\text{Weight of the sample (g)}} \times 100$$

$$\text{SDF(\%)} = \frac{\text{Wt. of the SDF residue} - (\text{Protein (g) in SDF residue} + \text{Ash (g) in SDF residue})}{\text{Weight of the sample (g)}} \times 100$$

$$\text{TDF} = \text{SDF} + \text{IDF value}$$

(Subtract blank value from IDF and SDF values to get actual TDF content of food sample)

## **8. Calculation of Carbohydrate Content (NIN, 1984)**

The content of carbohydrate in the selected samples was obtained by subtracting from 100, the sum of values of moisture, protein, fat, ash and total fiber content per 100g of the sample.

$$\text{Carbohydrate} = 100 - (\text{Moisture} + \text{Protein} + \text{Fat} + \text{Ash} + \text{Total Fiber}).$$

## **9. Determination of Calcium**

The calcium content of the products was determined by EDTA method.

### **Reagents**

#### **a) 4 N sodium hydroxide**

It was prepared by dissolving 160g of sodium hydroxide in glass distilled water and then volume made up to 100ml.

Ammonium purpurate indicator :

5g of ammonium purpurate was thoroughly mixed with 100g of powdered potassium sulphate.

#### **b) Ethylene diamine tetra acetic acid (versenate) solution(0.01)**

2.0g of disodium dihydrogen ethylene diamine tetra acetate and 0.05g of magnesium chloride hexahydrate were dissolved in water and volume was made up to 100ml.

### **Procedure for wet digestion**

5g of oven dried sample was taken in 250ml conical flask in triplicate, 10ml nitric acid was added to each flask and it was kept for one night. Next day 5ml of  $\text{H}_2\text{SO}_4$  was added to each flask and heated on hot plate until 2 to 1ml solution remained in conical flask. Then contents were allowed to cool and diluted by rinsing down the neck of flask with distilled water. The contents were transferred to 100ml volumetric flask and volume was made up to 100ml and filtered through whatman No. 40 filter paper.

## Procedure

5ml of aliquot of digested sample was taken into beaker and 5ml of water was added. Then (0.25ml) 5 drops of 4N sodium hydroxide and approximately 50mg of ammonium purpurate indicator was added. The mixture was filtered against 0.01N EDTA. The end point of titration was noted when 0.01N EDTA produces a colour change from orange red to lavender to purple. The volume of 0.01N EDTA solution required to neutralize the sample was calculated by formula,

$$\text{Ca (mg/lit) (a)} = \frac{\text{R x Normality of EDTA x 1000 x 5}}{\text{Aliquot (ml) taken}}$$

## 10. Determination of trace elements

Trace element viz., iron (fe), copper (Cu), Manganese (Mn) and Zinc (Zn) content of the developed samples was determined by atomic absorption spectrophotometer (A.A.S.). The aliquot of wet digested sample was used for estimation. Trace element content was calculated by using formula,

$$\text{Trace element in ppm} = \frac{\text{R x 100}}{\text{Weight of sample}}$$

Where,

R = Reading on atomic absorption spectrophotometer

ppm = mg/1000mg.

## 11. Calculation of energy content

The energy content of developed products was computed by summing up the values obtained by multiplying the values with Atwater constants for carbohydrates, crude fat and protein with the 4, 9 and 4 respectively (NIN, 1983).

## 12. Determination of *in-vitro* protein digestibility

*In vitro* protein digestibility of sample was carried out using enzymatic method of Mouliswar *et al.* (1993). Sample containing 100mg of protein was

treated with 12.5 mg of pepsin (1:2500) in 50 ml of 0.1 N HCl at 37°C for 3h. After neutralisation with 0.5 N NaOH, 6mg of pancreatin dissolved in 25 ml of phosphate buffer (pH 8.0) was added and the digestion continued for 24h at 37°C. The volume was then made up to 100ml and a 50ml aliquot was treated with three ml of 10% TCA overnight to precipitate the proteins. The suspensions were centrifuged at 6000rpm. The undigested material was assayed for protein by micro kjeldahl method and protein digestibility was calculated.

$$\text{Digested protein} = \frac{\text{Total protein} - \text{Undigested protein}}{\text{Total protein}} \times 100$$

Thus obtained values of digested protein were expressed in percentage.

### **Estimation of free fatty acid**

The amount of free fatty acid present gives an indication of age and quality of fat in foods. The FFA is expressed as oleic acid equivalents. It was estimated by titrating the samples against potassium hydroxide in presence of phenolphthalein indicator (Anon., 1983)

### **Reagents**

1. Neutral alcohol
2. N/100 Potassium hydroxide (KOH) solution 3.1% phenolphthalein

### **Procedure**

Fat extract of 25ml in a conical flask was added with 50ml of hot neutral alcohol and 3-4 drops of phenolphthalein indicator. The content was titrated against 0.01N KOH solution, until a pink colour which persisted for 15 sec, or more. A blank was run simultaneously.

Free fatty acid content of the sample was determined using the formula

$$\text{Free fatty acid (0\% Oleic acid)} = \frac{\text{Titre. value} \times \text{Normality of KOH} \times 28.2}{\text{Weight of fat (g)}}$$

## Estimation of Peroxide Value

### Reagents

- a) Solvent mixture of glacial acetic acid and chloroform (2:1).
- b) 5% potassium iodide solution.
- c) N/500 sodium thiosulphate solution.
- d) 1% starch solution.

### Procedure:

Extract fat by using chloroform and methanol mixture (2:10) by filtration and evaporation. Weigh 1g of oil into dry clean boiling tube and add 1g of powdered KI and 20ml solvent mixture. Place the tube in boiling water so that the liquid boils within 30 seconds and allow to boil vigorously for not more than 30 seconds. Transfer the contents quickly to a conical flask containing 20ml of potassium iodide solution and collect the washing of the flask. Titrate against N/500 sodium thiosulphate solution until pale yellow colour disappears. Add 0.5ml of starch solution, shake vigorously and titrate carefully till the blue colour disappears. Repeat with blank.

$$\text{Peroxide level (meq/kg of fat)} = \frac{S \times N \times 1000}{\text{Weight of sample (g)}} \times 100$$

Where, S - ml of sodium thiosulphate solution (test - blank)

N - Normality of sodium thiosulphate solution

### **Annexure III**

#### **Estimation of Fatty acid Profile of developed functional snack**

The profile of fatty acids in developed functional snack sample was estimated according to the method described in AOCS (1998). The fat extracted from each sample was used to estimate the fatty acids profile. The fatty acids were converted to their respective methyl esters prior to analysis through Gas Chromatograph (Agilent Technologies, 6890N). The oil sample (50  $\mu$ l) was methylated in 4 ml KOH for 1 hour at room temperature. The resultant esters were extracted with HPLC grade hexane and analyzed by GC using fused capillary column (Silica 30m x 0.25), flame ionization detector (FID) and nitrogen gas as a carrier (3.5 ml/ min). Operating conditions were maintained as split ratio 50%; injector and detector temperature 260 °C and column oven temperature was 222 °C for 7.5 minutes. The fatty acids were identified by retention time comparing them with the fatty acids run for different standards provided by Sigma.

## Annexure IV

### Microbial Analysis of Functional Snacks

#### Enumeration (counting) of bacteria by plate count or serial dilution agar plate technique

The plate count technique is one of the most routinely used procedure because of the enumeration of viable cells by this method. This method is based on the principle that when material containing bacteria are cultured, every viable bacterium develops into a visible colony on a nutrient agar medium. The number of colonies, therefore, is the same as the number of organisms contained in the sample. In this procedure a small measured volume (or weight) is mixed with a large volume of sterile water or saline called the diluents or dilution blank. Dilutions are usually made in multiple of ten. A single dilution is called as follows:

$$\text{Dilution} = \frac{\text{Volume of the sample}}{\text{Total volume of the sample and the diluents}}$$

Serial dilutions are later prepared by transferring a known volume of the dilution to second dilution blank and so on. Once diluted the specified volume of the dilution sample (1ml or 0.1ml) from various dilutions is added to sterile petri plates (in triplicate for each dilution) to which molten and cooled (45- 50<sup>0</sup>C) suitable agar medium is added. The colonies are counted on a Quebec colony counter. The number of organisms developed on the plates after an incubation period of 24-48 hours per ml is obtained by multiplying the number of colonies obtained per plate by the dilution factor, which is the reciprocal of the dilution. To facilitate calculations, the dilution is written in exponential notation. For example 1:1000 dilutions would be written as 10<sup>-3</sup>.

$$\text{Number of cells/ml} = \frac{\text{Number of colonies}}{\text{Amount plated} \times \text{Dilution}}$$

## Requirements

1. Sample or bacterial suspension
2. 9ml dilution blank (7)
3. Sterile petri plates (12)
4. Sterile 1ml pippets (7)
5. Nutrient agar medium (200ml)
6. Colony counter (Quebee colony counter)

## Procedure

1. Label the dilution blank as  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$ ,  $10^{-5}$ ,  $10^{-6}$  and  $10^{-7}$ .
2. Prepare the initial dilution by adding 1ml or 1g of the sample into a 9 ml dilution blank labeled  $10^{-1}$  thus diluting the original sample 10 times ( $1/1+9=1/10$  and is written as 1:10 or  $10^{-1}$  ).
3. Mix the contents by rolling the tubes back and forth between hands to obtain uniform distribution of organisms (cells).
4. From the first dilution, transfer 1ml of the suspension while in motion, to the dilution blank  $10^{-2}$  with a sterile and fresh 1ml pipette diluting the original specimen/suspension to 100 times ( $1/10 \times 1/10 = 1/100$  or  $10^{-2}$  ).
5. From the  $10^{-2}$  suspension, transfer 1ml of suspension to  $10^{-3}$  dilution blank with a fresh sterile pipettes, thus diluting the original sample to 1000 times (1:1000 or  $10^{-3}$  ).
6. Repeat this procedure till the original sample has been diluted 10,000,000 n ( $10^{-7}$  ) times using every time sterile pipette.
7. From the appropriate dilutions ( $10^{-5}$  or  $10^{-6}$  ) transfer 1ml of 0.1ml of suspension while in motion, with the suspension pipettes, to sterile petri dishes. Three petri plates are to be used for each dilution (if 0.1ml is plated; the dilution is increased 10 times).
8. Add approximately 15ml of the nutrient medium, melted and cooled to

45<sup>0</sup> C, to each petri plate containing the diluted sample. Mix the contents of each plate by rotating gently to distribute the cells throughout the medium.

9. Allow the plates to solidify.

10. Incubate these plates in an inverted position for 24-48 hours at 37<sup>0</sup>C.

### Observations

1. Observe all the plates for the appearance of bacterial colonies.
2. Count the number of colonies in the plates that have colonies in the 30-300 range, by placing each plate one by one on the platform of a Quebec colony counter.

Calculate the number of bacteria per ml of the original suspension/sample as follow:

$$\text{Organisms per milliliter/gram of the sample Amount} = \frac{\text{Number of colonies (average of 3 replicates)}}{\text{plated x dilution.}}$$

### Estimation of Yeast and Mold count

The yeast and mold count of functional snack was determined by using potato dextrose agar (PDA) and the pour plate technique was used for the enumeration of yeast and mold. The dilutions of sample were made up to 10<sup>-4</sup>. 1ml of dilution was taken into sterile petri plates with the help of micropipette and 10-12ml PCA media was poured into the plates and swirled gently clockwise, anti-clockwise direction. The media was allowed to set. Further the plates were inverted and incubated at 35<sup>0</sup> C for 48 hours. Then the colonies were counted and final count was taken in CFU/g. The yeast and mold count of accepted sour cream sample was examined for 0, 8, 16, 32 days of storage period.

## **Annexure V**

### **Consent of the respondents to Participate in the Experiment on Estimation of Glycaemic Index**

**Name:**

**Age:**

**Sex:**

**Place:**

**Education:**

**Occupation:**

**Food habits:**

The detail procedure of the experiment (Glycemic Index) has been explained by the researcher, so we are to participate in the above said experiment.

Signature

Date:

Place

## ANNEXURE –VI (i)

### Written concent of subjects in local language for participating in clinical study

#### संमति पत्र

(मधुमेह)

संशोधनाचा विषय : “नाशत्यासाठीचा क्रि यात्मक पदार्थ विकसित करणे आणि मधुमेहावर व उच्च वाढीव रक्त स्निग्धांशवर होणा-या परिणामांचा अभ्यास करणे”

संमति संदर्भातिल आजार - मधुमेह

संशोधनाबदल :

मधुमेह : मधुमेह ही भारतातील एक मोठी जन आरोग्य समस्या आहे. मधुमेह हा चयापचयाचा विकार आहे. इन्सुलिन हे द्रव्य रक्तातील साखरेचे प्रमाण कमी करण्यास मदत करते. जर शरीरात इन्सुलिन पुरेशा प्रमाणात तयार होत नसेल किंवा तयार झालेले इन्सुलिन व्यवस्थित काम करत नसेल तर रक्तातील साखरेचे प्रमाण वाढते यालाच मधुमेह म्हणतात.

नाशत्यासाठीचा क्रि यात्मक पदार्थ : फंक्शनल स्नॅक तयार करण्यासाठी गव्हाचे पीठ, जवसाचे व कारळाचे पीठ, गव्हाचा कोंडा, डिक, ओटस्, तूप, साखर, दुध पावडर, विलायची आणि मीठ हे अन्न पदार्थ वापरण्यात आले. विकसित फंक्शनल स्नॅक मध्ये प्रथिने, तंतूमय पदार्थ, लोह, कॅल्शियम भरपूर प्रमाणात आहे. व त्याचा ग्लायसेमिक इंडेक्स कमी आहे. म्हणून विकसित नाशत्यासाठीचा क्रि यात्मक पदार्थ दररोज २५ ग्रॅम प्रमाणे मधुमेही व्यक्तींना सलग दोन महिने देऊ न त्यांच्या रक्तातील साखरेच्या प्रमाणावर होणारा परिणाम तपासणे हा या अभ्यासाचा विषय आहे.

संशोधनातील समाविष्ट मानके आणि तुमचा सहभाग :

तुमच्या रक्तातील साखरेची पातळी तपासण्यासाठी तुमच्या बोटातून थोडासा रक्त नमूना (०.०२ ते २ मि.ली. ) घेवून त्यातील साखरेचे प्रमाण तपासले जाईल. त्यासोबतच लाभार्थीची वजन व उंची याविषयी नोंद ठेवली जाईल. या अभ्यासा दरम्यान वेळोवेळी केलेल्या तपासण्यांच्या निष्कर्षांची नोंद ठेवली जाईल. आणि नाशत्यासाठी दिलेला पदार्थाचा रक्तातील साखरेच्या प्रमाणावर होणारा परिणाम पडताळून बघण्यात येईल. म्हणून यासाठी तुमचा सहभाग आवश्यक आहे.

धोका : रक्ताचा नमुना घेताना तुम्हाला टोचल्या सारखे जाणवेल आणि हे दुखणार नाही. तसेच प्रत्येक लाभार्थीसाठी नवि सुई वापरण्यात येईल त्यामुळे कोणताही धोका संभवणार नाही.

संशोधनाचे फायदे : तुमची रक्त तपासणी मोफत केली जाईल. रक्त तपासणीमुळे तुम्हाला तुमच्या रक्तातील साखरेच्या पातळीचा अचूक अंदाज येईल जेणेकरून तुम्ही तुमच्या आहार-विहारात बदल करून रक्तशर्करा नियंत्रित ठेवू शकता.

गुप्तता : आम्ही जमा केलेली माहिती आणि तुमची ओळख ही गुप्त ठेवली जाईल. जर तुम्हाला प्रकल्प सोडायचा असेल तर तुम्ही स्वेच्छेने कोणत्याही वेळी प्रकल्प सोडू शकता.

तुमच्या शंका : जर तुम्हाला या अभ्यासाबद्दल कुठलीही शंका असेल तर मोकळेपणाने संशोधक विद्यार्थीनी कु. रुपाली शिंदे, गृहविज्ञान महाविद्यालय, वनामकृवि, परभणी यांना संपर्क करू शकता आणि शंकेचे निरसन करू शकता.

सहभागाबद्दल संमति : मला या संशोधनाबद्दल माहिती मिळालेली आहे. मला या संशोधनाबाबत कसलीही शंका नाही. मी या संशोधनाचा लाभार्थी म्हणून माझ्या कडून काय अपेक्षा आहे याची मला माहिती देण्यात आलेली आहे. माझी या संशोधनात सहभागी होण्यासाठी संमति आहे.

सहभागी लाभार्थीचे नाव : -----

सहभागी लाभार्थी स्वाक्षरी

दिनांक :     /     /२०१६

संशोधकाची स्वाक्षरी

दिनांक :     /     /२०१६

## ANNEXURE –VI (ii)

### संमति पत्र

(वाढीव रक्त स्निग्धांश)

### (Hyperlipidemia)

संशोधनाचा विषय : “नाशत्यासाठीचा क्रि यात्मक पदार्थ विकसित करणे आणि मधुमेहावर व उच्च वाढीव रक्त स्निग्धांशवर होणा-या परिणामांचा अभ्यास करणे”

संमति संदर्भातिल आजार -वाढीव रक्त स्निग्धांश

संशोधनाबद्दल :

वाढीव रक्त स्निग्धांश : चुकीचा आहार, व्यायामाचा आभाव, बैठी जीवनशैली यामुळे लठठपणा, मधुमेह, उच्च रक्तदाब इत्यादी तसेच हृदय विकाराचे प्रमाण वाढीस लागलेले आहे. हृदय विकारा संदर्भात महत्वाचे परिक्षण म्हणजे रक्तातील स्निग्धांश पातळी तपासणी हे आहे. कारण वाढील रक्त स्निग्धांश पातळी रक्तवाहिन्यांच्या आतील बाजूस स्निग्धांचे आवरण वाढवत जाते. व विविध हृदय रोगांना यामुळे आमंत्रण मिळते. रक्त स्निग्धांश पातळी तपासणी हे विविध हृदय विकारा संदर्भात एक महत्वाचे संकेतांक आहे.

नाशत्यासाठीचा क्रि यात्मक पदार्थ : फंक्शनल स्नॅक तयार करण्यासाठी गव्हाचे पीठ, जवसाचे व कारळाचे पीठ, गव्हाचा कोंडा, डिक, ओट्स, तूप, साखर, दुध पावडर, विलायची आणि मीठ हे अन्न पदार्थ वापरण्यात आले. विकसित फंक्शनल स्नॅक मध्ये प्रथिने, तंतूमय पदार्थ, कॅल्शियम भरपूर प्रमाणात आहे. व त्याचा ग्लायसेमिक इंडेक्स कमी आहे. म्हणून विकसित नाशत्यासाठीचा क्रि यात्मक पदार्थ दररोज २५ ग्रॅम प्रमाणे वाढीव रक्त स्निग्धांश पातळी असणा-या व्यक्तींना दोन महिने देऊ न त्यांच्या रक्तातील साखरेच्या प्रमाणावर होणारा परिणाम तपासणे हा या अभ्यासाचा विषय आहे.

संशोधनातील समाविष्ट मानके आणि तुमचा सहभाग :

तुमच्या रक्तातील स्निग्धांश पातळी तपासण्यासाठी तुमच्या हाताच्या शिरेतून थोडासा रक्त नमूना घेवून त्यातील स्निग्धांचे प्रमाण तपासले जाईल. त्यासोबतच लाभार्थीची वजन व उंची याविषयी नोंद ठेवली जाईल. या अभ्यास कालावधीमध्ये वेळोवेळी होणा-या मापांच्या नोंदी साठी तुमचा सहभाग आवश्यक आहे.

धोका : रक्ताचा नमुना घेताना तुम्हाला टोचल्या सारखे जाणवेल आणि हे दुखणार नाही. तसेच प्रत्येक लाभार्थीसाठी नवि सुई वापरण्यात येईल त्यामुळे कोणताही धोका संभवणार नाही.

संशोधनाचे फायदे : तुमची रक्त तपासणी मोफत केली जाईल. रक्त तपासणीमुळे तुम्हाला तुमच्या रक्तातील साखरेच्या पातळीचा अचूक अंदाज येईल जेणेकरून तुम्ही तुमच्या आहार-विहारात बदल करून रक्तशर्करा नियंत्रित ठेवू शकता.

गुप्तता : आम्ही जमा केलेली माहिती आणि तुमची ओळख ही गुप्त ठेवली जाईल. जर तुम्हाला प्रकल्प सोडायचा असेल तर तुम्ही स्वेच्छेने कोणत्याही वेळी प्रकल्प सोडू शकता.

तुमच्या शंका : जर तुम्हाला या अभ्यासाबद्दल कुठलीही शंका असेल तर मोकळेपणाने संशोधक विद्यार्थीनी कु. रुपाली शिंदे, गृहविज्ञान महाविद्यालय, वनामकृषि, परभणी यांना संपर्क करू शकता आणि शंकेचे निरसन करू शकता.

सहभागाबद्दल संमति : मला या संशोधनाबद्दल माहिती मिळालेली आहे. मला या संशोधनाबाबत कसलीही शंका नाही. मी या संशोधनाचा लाभार्थी म्हणून माझ्या कडून काय अपेक्षा आहे याची मला माहिती देण्यात आलेली आहे. माझी या संशोधनात सहभागी होण्यासाठी संमति आहे.

सहभागी लाभार्थीचे नाव : -----

सहभागी लाभार्थी स्वाक्षरी

दिनांक :     /     /२०१६

संशोधकाची स्वाक्षरी

दिनांक :     /     /२०१६

**ANNEXURE- VII (i)**

**COLLEGE OF HOME SCIENCE VNMKV, PARBHANI**

**DEPT. OF FOODS AND NUTRITION**

**QUESTIONNAIRE TO STUDY THE SOCIOECONOMIC STATUS,  
FOOD CONSUMPTION PATTERN AND DISEASE HISTORY OF  
DIABETIC SUBJECTS**

**1] General information:**

1. Name:\_\_\_\_\_
2. Age:\_\_\_ yrs.                      Gender:                      F:                      M:
3. Address:\_\_\_\_\_
4. Phone: Home (\_\_\_\_)\_\_\_\_\_ Mobile: (\_\_\_\_)\_\_\_\_\_
5. Ethnic Background:
6. What is your language preference:  
1] Marathi      2] Hindi      3] English      4] Any other

**7. Education:**

|                                   |   |  |
|-----------------------------------|---|--|
| Profession or Honors'             | 7 |  |
| Graduate or post graduate         | 6 |  |
| Intermediate/ high school diploma | 5 |  |
| High school certificate           | 4 |  |
| Middle school certificate         | 3 |  |
| Primary school certificate        | 2 |  |
| Illiterate                        | 1 |  |

**8. Occupation:**

|                              |    |  |
|------------------------------|----|--|
| Profession                   | 10 |  |
| Semi profession              | 6  |  |
| Clerical, shop owner, farmer | 5  |  |
| Skilled worker               | 4  |  |
| Semi skilled worker          | 3  |  |
| Unskilled worker             | 2  |  |
| Unemployed                   | 1  |  |

#### 4] Monthly Income (RS.)

|              |    |  |
|--------------|----|--|
| $\geq 32050$ | 12 |  |
| 16020-32049  | 10 |  |
| 12020-16019  | 6  |  |
| 8010-12019   | 4  |  |
| 4810-8009    | 3  |  |
| 1601-4809    | 2  |  |
| $\leq 1600$  | 1  |  |

#### 5. Family background:

I] Type of family: 1] Nuclear                      2] Joint                      3] Extended

II] Size:                      1] Small                      2] Medium                      3] Large

III] No. of people    1] 2-4                      2] 5-7                      3]  $\geq 8$

#### 6. Anthropometric measurements:

| Measurements                    | Visit 1 | Visit 2 | Visit3 |
|---------------------------------|---------|---------|--------|
| Height (cm)                     |         |         |        |
| Weight (kg)                     |         |         |        |
| BMI                             |         |         |        |
| Waist circumference (cm)        |         |         |        |
| Hip circumference (cm)          |         |         |        |
| Waist hip ratio                 |         |         |        |
| MUAC (cm)                       |         |         |        |
| Triceps skinfold thickness (mm) |         |         |        |

#### 7] Diabetes History

1. Year/Age of Diabetes Diagnosis: \_\_\_\_\_/\_\_\_\_\_

2. What type of diabetes you have:

1]Type 1            2]Type 2            3]Pre-diabetes    4] Gestational diabetes

5] Stress Diabetes                      6] Don't Know

3. Diabetes history: 1] Maternal side                      2] Paternal side

4. List relatives with  
diabetes:\_\_\_\_\_

**8] Did you ever have any of the following symptoms?**

1. Increased thirst.....☐ No ☐ Yes ☐  
Don't know
2. Dry mouth.....☐ No ☐ Yes ☐  
Don't know
3. Decreased appetite .....☐ No ☐ Yes ☐  
Don't know
4. Nausea or vomiting ..... ☐ No ☐ Yes ☐  
Don't know
5. Abdominal pain.....☐ No ☐ Yes ☐  
Don't know
6. Frequent urination at night ☐ No ☐ Yes ☐  
Don't know
7. Morning headaches.....☐ No ☐ Yes ☐  
Don't know
8. Night sweats.....☐ No ☐ Yes ☐  
Don't know
9. Shakiness or weakness.....☐ No ☐ Yes ☐  
Don't know
10. Intense hunger.....☐ No ☐ Yes ☐  
Don't know
11. Did you faint any time? ..... ☐ No ☐ Yes ☐  
Don't know consciousness, even for a short time?

**9] Checking Blood Glucose**

1. Do you check your blood sugars: 1]Yes      2]No
2. Blood sugar range: \_\_\_\_\_ to \_\_\_\_\_
3. 1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

4. Very high blood sugar- 1]was recorded 2]not recorded  
Very low blood sugar – 1] was recorded 2] not recorded
5. If yes how many times \_\_\_\_\_
6. How often:  
1] Once a day 2] 2 or more times/day 3] Once a Week  
4] Occasionally
7. Do you check your blood sugar? : 1] Yes 2]No  
If yes how many times  
1] Before breakfast 2] 2 hours after meal 3] Before bedtime
8. How do you treat low blood sugar?  
\_\_\_\_\_

### **10] Dietary Pattern**

1. Food pattern: 1] Vegetarian 2] Non vegetarian 3] Ova vegetarian
2. Did your physician suggested any plan for you: 1]Yes 2]No  
If yes do you follow it \_\_\_\_\_
3. About how often do you use this meal plan?  
1] Never 2] Seldom 3] Sometimes 4] Usually 5] Always
4. Do you read and use food labels as a dietary guide: 1]Yes 2]No
5. Do you have any dietary restrictions: 1]Salt 2]Fat 3]Fluid 4]None  
5]Other
6. Which oil you use for daily food preparation? 1] Sunflower 2] Soybean  
3] Groundnut 4] 5] Mustard seed 6] combination of 2 oil 7] any other ----  
-----
7. Do you take salad in your diet? 1] Yes 2] No  
If yes which food  
\_\_\_\_\_
8. Do you take fruits? 1]Yes 2] No

If yes then list

| Sr. no. | Fruits         | Amount | Frequency            |
|---------|----------------|--------|----------------------|
| 1       | Apple          |        | Daily                |
| 2       | Banana         |        | 2- 4 times in a week |
| 3       | Sapota (Chiku) |        | Once in a Weekly     |
| 4       | Orange         |        | Occasionally         |
| 5       | Pomogranate    |        | Never                |
| 6       | Mango          |        |                      |
| 7       | Grapes         |        |                      |
| 8       | Papaya         |        |                      |

9. Snacking Pattern : 1] Yes 2]No

**10. Snacking Frequency:**

| Sr no. | Name of snack   | Amount | Frequency            |
|--------|-----------------|--------|----------------------|
| 1      | Puff            |        | Daily                |
| 2      | Pastry          |        | 2- 4 times in a week |
| 3      | Chips           |        | Weekly               |
| 4      | Sandwich        |        | Occasionally         |
| 5      | Vadapav         |        | Never                |
| 6      | Bread           |        |                      |
| 7      | Biscuits        |        |                      |
| 8      | Bakery products |        |                      |
| 9      | Chakli          |        |                      |
| 10     | Chiwada         |        |                      |
| 11     | Shev            |        |                      |
| 12     | Sonpapdi        |        |                      |
| 13     | Panipuri        |        |                      |
| 14     | Bhel            |        |                      |
| 15     | Burger          |        |                      |
| 16     | Pizza           |        |                      |
| 17     | Chinese noodles |        |                      |
| 18     | Maggi           |        |                      |
| 19     | Pavbhaji        |        |                      |
| 20     | Kurkure         |        |                      |
| 21     | Manchurian      |        |                      |
| 22     | Chinese food    |        |                      |

7 Do you take snacks while watching T.V. ?

Yes

☐☐

No

If yes ,

| Sr. No. | Type of food | Home prepared /<br>bought from outside /<br>both | Quantity<br>consumed | How many<br>times in<br>week |
|---------|--------------|--------------------------------------------------|----------------------|------------------------------|
| 1       |              |                                                  |                      |                              |
| 2       |              |                                                  |                      |                              |
| 3       |              |                                                  |                      |                              |
| 4       |              |                                                  |                      |                              |

8 Do you take fast ?1] Yes 2] No

If yes how many times in a week\_\_\_\_\_days

9. Do you eat sweets 1] Yes 2] No

If yes list them\_\_\_\_\_

Amount\_\_\_\_\_

11. Food purposely included

\_\_\_\_\_

12. Foods purposely avoided

\_\_\_\_\_

13. Which type of meal pattern do you follow?

14. 1] 2 meal 2] 3 meal 3] 4 meal 4] 5 meal 5]  $\geq 6$

### 15. Dietary pattern: 24hr recall method

| Time | Meal pattern  | Menu | Amount |
|------|---------------|------|--------|
|      | Early morning |      |        |
|      | Breakfast     |      |        |
|      | Mid afternoon |      |        |
|      | Lunch         |      |        |
|      | Evening snack |      |        |
|      | Dinner        |      |        |
|      | Bed time      |      |        |

### 11. Functional foods:

1. Do you know about functional foods? 1] Yes 2] No

9. What Reasons for buying functional food?

1] To solve my consciences 2] To do myself good 3] Recommended by medical doctor or nutritional consultant 4] Interest, curiosity 5] Good taste 6] To avoid medical treatments 7] For my children 8] To retard aging 9] To stay attractive 10] To stay healthy

3. What are the reasons for refusing of functional foods?

1] concerns about novel food 2] Bad Taste 3] I prefer organic food 4] I focus more upon present than future 5] I do not feel ill 6] Fear of side effects 7] Fear of artificial additives 8] To retard aging 9] Not effective 10] Too expensive

4. Who is responsible for the food purchase in your household?

1] Myself 2] Partner 3] parents 4] children 5] other person

| Sr. No. | Functional food                      | Frequency of consumption |        |         |        | Amount |
|---------|--------------------------------------|--------------------------|--------|---------|--------|--------|
|         |                                      | Daily                    | Weekly | Monthly | Rarely |        |
| 1       | Flaxseed                             |                          |        |         |        |        |
| 2       | Soybean                              |                          |        |         |        |        |
| 3       | Italian Millet                       |                          |        |         |        |        |
| 4       | Flaxseed oil                         |                          |        |         |        |        |
| 5       | Garden cress seed                    |                          |        |         |        |        |
| 6       | Oats                                 |                          |        |         |        |        |
| 7       | Multigrain cereal                    |                          |        |         |        |        |
| 8       | Garlic                               |                          |        |         |        |        |
| 9       | Tomatoes                             |                          |        |         |        |        |
| 10      | Fermented dairy products             |                          |        |         |        |        |
| 11      | Cruciferous vegetables               |                          |        |         |        |        |
| 12      | Green Tea                            |                          |        |         |        |        |
| 13      | Wheat bran                           |                          |        |         |        |        |
| 14      | Citrus fruits                        |                          |        |         |        |        |
| 15      | Omega 3 Fatty Acids foods (DHA/ EPA) |                          |        |         |        |        |
| 16.     | Oil with essentials fatty acids      |                          |        |         |        |        |
| 17.     | High fiber cereals                   |                          |        |         |        |        |
| 18.     | Anti diabetic tea                    |                          |        |         |        |        |
| 19.     | Low cholesterol margarine            |                          |        |         |        |        |

5. What do you know about functional foods?

1] No definition 2] Prevent Diseases 3] Promote good health 4] Prevent diseases and promotes health

6. What are the current sources of information of functional foods?

1] Food labels 2] Printed Materials 3] Family / Friends 4] Television/ radio 5] Physician 6] Other

7. Do you aware about the functional components of food? 1] Yes 2] No  
If yes a] Calcium b] omega 3 fatty acids c] Probiotics d] Dietary fibre
8. Do you aware about the desired health benefits of functional foods?

| <b>Sr. no.</b> | <b>Health benefits</b>             |  |
|----------------|------------------------------------|--|
| 1.             | Reduced the risk of heart diseases |  |
| 2.             | Reduced the risk of hypertension   |  |
| 3.             | Gain Satisfaction                  |  |
| 4.             | Improved Performance               |  |
| 5.             | Reduced the risk of diabetes       |  |
| 6.             | Reduced the risk of cancer         |  |

9. Factors reported to increase the functional food consumption

| <b>Sr. no.</b> | <b>Factors</b>                |  |
|----------------|-------------------------------|--|
| 1.             | Awareness/ Knowledge          |  |
| 2.             | Health Professional influence |  |
| 3.             | Availability                  |  |
| 4.             | Taste                         |  |
| 5.             | Cost/ Price                   |  |
| 6.             | Family/ friends influence     |  |
| 7.             | Advertisement                 |  |

10. Nutrients mentioned in nutrient content claim that would increase the participants functional food consumption : 1] salt / sodium 2] Dietary fibre 3] Omega 3 fatty acids 4] Sugar 5] Trans fatty acids 6] Fat 7] Cholesterol 8] Saturated fatty acid 9] Energy

11. Functions or biological roles mentioned in nutrient function claims that would increase functional food consumption-

| Sr.No. | Function or biological role                                | Percent of participants |
|--------|------------------------------------------------------------|-------------------------|
| 1.     | Helps lower cholesterol                                    |                         |
| 2.     | Factor in the formation and maintenance of bones and teeth |                         |
| 3.     | Dietary antioxidant                                        |                         |
| 4.     | Factor in the maintenance of good health                   |                         |
| 5.     | Helps build antibodies                                     |                         |
| 6.     | Promotes regularity                                        |                         |
| 7.     | Helps build and repair body tissues                        |                         |
| 8.     | Aids in maintaining the health of skin and membranes       |                         |
| 9.     | Aids in red blood cell formation                           |                         |

**12. Do you like Nuts & Oil Seeds, Dry Fruits to eat?**

Yes ☐ No ☐

If yes how many times you eat in a week?

| Nuts & Oil Seeds, Dry Fruits | How often in Week | How Much |
|------------------------------|-------------------|----------|
| Till (Gingelly seeds)        |                   |          |
| Groundnut                    |                   |          |
| Coconut dry                  |                   |          |
| Almond (Badam)               |                   |          |
| Cashewnet (Kaju)             |                   |          |
| Garden Cress Seeds (Ahliv)   |                   |          |
| Linseed (Jawas)              |                   |          |
| Niger Seeds (Caral)          |                   |          |
| Pista                        |                   |          |
| Akhrod                       |                   |          |

13. Do you: do your own food shopping? 1]Yes 2]No

14. Do you cook different meals for you? 1]Yes 2]No

**15 How do you spend your leisure / free time?**

| Type of activity              | √/X | Duration<br>in Day | How Many<br>times in Week |
|-------------------------------|-----|--------------------|---------------------------|
| i) Watching T.V.              |     |                    |                           |
| ii) Reading and writing       |     |                    |                           |
| iii) Chitchatting with family |     |                    |                           |
| iv) Members / friend          |     |                    |                           |
| v) Any other                  |     |                    |                           |

**16 How many hours you sleep in the night? .....**

Do you sleep at afternoon? .....

How many hours? .....

**17 Do you watch T.V. regularly?**

Yes ☐ No ☐

**18. Awareness of Diabetes:**

1. Do you know how to take care of your diabetes? 1]Yes 2]No

If yes, specify care to be taken \_\_\_\_\_

2. Do you know what is diabetes? 1] Yes 2] No

If yes explain in your words

\_\_\_\_\_

3. Do you have any cultural or religious practices or beliefs that influence how you care for your diabetes? 1]Yes 2]No

if yes please describe \_\_\_\_\_

4. Did you know about hemoglobin A1c? 1] Yes \_\_\_\_\_

2]Don't know

5. Do you have any food allergies? 1]Yes 2]No

6. Do you drink alcohol? 1]Yes 2]No

1] Daily 2] per week 3] occasionally

7. Do you use tobacco? 1]Yes 2]No

8. Do you use cigarette? 1]Yes 2]No

### 19] Physical Activity

1. Do you exercise regularly? 1]Yes 2]No

Type of exercise:

\_\_\_\_\_

Time\_\_\_\_\_ hrs.

2. How often\_\_\_\_\_

### 20] Health

1. Are you aware of the impact of diabetes on pregnancy/ in your health?

1]Yes 2] No

If yes what is

\_\_\_\_\_

2. Do you get support to carry on healthy life? 1]Yes 2]No

If yes 1] Family member 2] Co-Workers 3] Healthcare providers

4] Friend 6] other

3. In the last 3 months have you admitted to a hospital? 1]Yes 2]No

If yes then for treatment of diabetes\_\_\_\_\_

or any other\_\_\_\_\_

4. Any weight changes (increase or decrease)? 1]Yes 2]No

5. What is the hardest thing for you in caring for your diabetes?

\_\_\_\_\_

6. Do you have any of the following health complications :

1]Yes 2] No

1] Eye problems 2]Kidney problems 3]Numbness/tingling in feet

4]Dental problems 5]High blood pressure 6]High cholesterol

7] Sexual problems 8]Depression

7. Did you check any of the following test?1] Yes 2] No

1] Dilated eye exam 2] Urine test for protein 3]foot exam—self

4] Foot exam—healthcare professional 5] Dental exam 6]Blood pressure

7] Cholesterol 8]HgbA1c

8. Do you take diabetes medications daily : 1]Yes 2]No

If yes in which form 1] Diabetes Pills      2]Insulin injections

3]Combination of pills and injections

9. Do you miss taking your medicines 1]Yes      2]No

If yes, about how often do you miss taking your medications as prescribed? \_\_\_\_\_

10. Do you have any medication allergies? 1] Yes      2]No

11. If yes, please

list \_\_\_\_\_

12. Do you take other medications? 1]Yes      2]No

13. Please list other

medications \_\_\_\_\_

14. Do you take any other the counter medications, vitamins, or supplements?

1] Yes

2] No

Please list \_\_\_\_\_

## **21] History of Foot Problems**

1. Have you ever had a sore or cut on your foot or leg that took more than

two weeks to heal?

☐ Yes    ☐ No

2. Have you ever had a foot ulcer?

☐ Yes    ☐ No

3. Have you ever had an amputation of a toe, foot, or leg?

☐ Yes    ☐ No

4. (If yes, date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_).

## **22] Current Foot or Leg Problems**

1. Do you have an ulcer, sore, or blister on your feet at this time? 1]Yes

2]No

2. Do you have blood or discharge on your socks? 1]Yes      2]No

3. Do you have any calluses on your feet? 1]Yes      2]No

4. Do you have any numbness, tingling, pins and needles, or itching sensation in your feet?

1] Yes    2] No

### **23] Foot Care**

1. Can you reach and **see** the bottoms of your feet? 1]Yes    2]No
2. Do you examine your feet? (If yes, how often?) 1]Yes    2]No  
Every day    ☐ 2-6 times a week    once a week or less    ☐ When I  
have a problem
3. Do you wash your feet every day? 1]Yes    2]No
4. Do you dry well between the toes? 1]Yes    2]No
5. Do you use a moisturizing cream on your feet? 1]Yes    2]No
6. Do you cut your own toenails? (If no, who does this for you?) 1]Yes  
2]No  
☐ Family member ☐ Caregiver ☐ Foot care nurse    ☐ Podiatrist

### **24] Foot ware**

1. What kind of shoes do you wear? (Check all that apply.)  
☐ pointed toes                      ☐ broad, round toes  
☐ high heels sandals              ☐ flip flops/thongs  
☐ shoes with adjustable laces, buckles or velcroathletic /sneakers  
/runners shoes made of leather or canvas  
☐ special/custom shoes    ☐ slippers
2. What kind of socks do you wear? (Check all that apply.) cotton ☐ wool ☐  
acrylic/synthetic knee highs ☐ elastic-free tops ☐ seamless socks☐  
nylons/pantyhose ☐ “diabetes” socks ☐ prescription/compression

### **25] Safety and Prevention**

1. Do you ever soak your feet? 1] Yes    2] No
2. Do you always test water temperature before putting your foot  
1] Yes    2] No
3. Do you put moisturizing creams or lotions between your toes?  
1] Yes    2] No
4. Do you ever wear shoes without wearing any socks? 1] Yes    2] No
5. Do you always inspect your shoes for foreign objects or torn  
a. 1] Yes    2] No
6. Do you sit with your legs crossed? 1] Yes    2] No

7. Do you smoke? 1] Yes 2] No

## **26] Foot Care Education**

1. Have you ever attended a class on how to care for your feet?
2. Have you ever read any handouts on foot care?
3. Have you ever read any handouts on proper footwear?
4. Would you like a handout on how to care for your feet?

## **27]:Skin care**

- 1] Did your physician tell you about diabetes related complications of skin?  
1] Yes 2] No 3] Don't remember
- 2] Is a diabetic person more prone to skin diseases  
1] Yes 2] No 3] Don't know
- 3] In case of skin disease what should be done?  
1] Consult Doctor 2] Consult Traditional Healer 3] Self  
Remedy  
4] Consult family elders 5] Ignore it 6] Don't  
Know what to do
- 4] As a diabetic, do you know how to take care of your skin?  
1] Yes 2] No
- 5] Do you check skin daily for change in skin colour, pigmentation, texture,  
turgor, cuts, blisters, and red spots or swelling?  
Often 2] sometimes 3] Never

## **28] Diabetes and oral health**

- 1] Do you know about how to take care of oral health in diabetes? 1] Yes 2]  
No
- 2] Is a diabetic person more prone to dental problems? 1] Yes 2] No
- 3] Does diabetes cause dental caries? 1] Yes 2] No 3] May be
- 4] Does diabetes affect gingiva? 1] Yes 2] No
- 5] Did you have dry mouth sensation? 1] Yes 2] No
- 6] Do you have burning mouth sensation? 1] Yes 2] No
- 7] Do you brush your teeth? 1] Yes 2] No

8] The frequency of tooth brushing 1] Once a day 2] Two times a day 3] Ones a week

9] Bleeding during brushing? 1] Yes 2] No

10] Do you want to get any education about oral health and diabetes? 1] Yes

2] No 3] Not sure

**29] Needs/Education Plan:**

1] Diabetes disease process 2] Nutrition Management 3] Physical Activity

4] Using medications 5] Monitoring 6] Preventing

7] Acute Complications 8] Preventing Chronic Complications

9] Behaviour Change Strategies 10] Risk Reduction Strategies

11] psychosocial adjustment

**Signature:**\_\_\_\_\_

**Date:**\_\_\_\_\_

**Thank you for your help!**

## APPENDIX- VII (b)

COLLEGE OF HOME SCIENCE VNMKV, PARBHANI

DEPARTMENT OF FOODS AND NUTRITION

### QUESTIONNAIRE TO STUDY THE SOCIOECONOMIC STATUS, FOOD CONSUMPTION PATTERN AND DISEASE HISTORY OF HYPERLIPEDEMIC SUBJECTS

#### 1] General information:

1. Name: \_\_\_\_\_
2. Age :\_\_\_\_ Gender: F M:
3. Address: \_\_\_\_\_
4. **Phone:** Home (\_\_\_\_) \_\_\_\_\_ Mobile: (\_\_\_\_) \_\_\_\_\_
5. **Ethnic Background:**
6. What is your language preference: 1] Marathi 2] Hindi 3]English

#### 2. Education:

|                                   |   |  |
|-----------------------------------|---|--|
| Profession or Honors?             | 7 |  |
| Graduate or post graduate         | 6 |  |
| Intermediate/ high school diploma | 5 |  |
| High school certificate           | 4 |  |
| Middle school certificate         | 3 |  |
| Primary school certificate        | 2 |  |
| Illiterate                        | 1 |  |

#### 3. Occupation:

|                              |    |  |
|------------------------------|----|--|
| Profession                   | 10 |  |
| Semi profession              | 6  |  |
| Clerical, shop owner, farmer | 5  |  |
| Skilled worker               | 4  |  |
| Semi skilled worker          | 3  |  |
| Unskilled worker             | 2  |  |
| Unemployed                   | 1  |  |

#### 4] Monthly Income (₹ )

|             |    |  |
|-------------|----|--|
| ≥ 32050     | 12 |  |
| 16020-32049 | 10 |  |
| 12020-16019 | 6  |  |
| 8010-12019  | 4  |  |
| 4810-8009   | 3  |  |
| 1601-4809   | 2  |  |
| ≤ 1600      | 1  |  |

## 5. Family background:

- I] Type of family: 1] Nuclear                      2] Joint                      3] Extended
- II] Size:              1] Small                      2] Medium                      3] Large
- III] No. of people    1] 2-4                      2] 5-7                      3]  $\geq 8$

## 6. Anthropometric measurements:

| Measurements                    | Visit 1 | Visit 2 | Visit3 |
|---------------------------------|---------|---------|--------|
| Height (cm)                     |         |         |        |
| Weight (kg)                     |         |         |        |
| BMI                             |         |         |        |
| Waist circumference (cm)        |         |         |        |
| Hip circumference (cm)          |         |         |        |
| Waist hip ratio                 |         |         |        |
| MUAC (cm)                       |         |         |        |
| Triceps skinfold thickness (mm) |         |         |        |

## 7] Family History:

1. Year/Age of disease Diagnosis: \_\_\_\_\_/\_\_\_\_\_
2. Disease history:      1] Maternal side                      2] Paternal side
3. Have you had previous instruction on how to take care of your hyperlipidemia?  
1] Yes      2]No
4. If yes, How long ago? \_\_\_\_\_
5. Any weight changes (up or down)? 1]Yes    2]No

## 8] In the PAST WEEK, did you ever have any of the following symptoms -

- 1] High B.P. 2] Acidity 3] heavy sweating

## 9] Checking Blood Pressure

1. Do you check your blood Pressure: 1]Yes                      2]No
2. Blood pressure range: \_\_\_\_\_ to \_\_\_\_\_
3. Visit 1 \_\_\_\_\_ visit 2 \_\_\_\_\_ visit  
3 \_\_\_\_\_
4. How often: 1] Always                      4]Occasionally

## 10] Dietary Pattern

16. Food pattern: 1] Vegetarian 2] Non vegetarian 3] Ovo vegetarian

17. Did your physician suggested any plan for you: 1]Yes 2]No If yes do you follow it

18. About how often do you use this meal plan? 1]Never 2]Seldom  
3]Sometimes 4]Usually 5]Always

19. Do you read and use food labels as a dietary guide: 1]Yes 2]No

20. Do you have any dietary restrictions: 1]Salt 2]Fat 3]Fluid 4]None  
5]Other

| Sr no. | Name of snack   | Amount | Frequency            |
|--------|-----------------|--------|----------------------|
| 1      | Puff            |        | Daily                |
| 2      | Pastry          |        | 2- 4 times in a week |
| 3      | Chips           |        | Weekly               |
| 4      | Sandwich        |        | Occasionally         |
| 5      | Vadapav         |        | Never                |
| 6      | Bread           |        |                      |
| 7      | Biscuits        |        |                      |
| 8      | Bakery products |        |                      |
| 9      | Chakli          |        |                      |
| 10     | Chiwada         |        |                      |
| 1      | Shev            |        |                      |
| 12     | Sonpapdi        |        |                      |
| 13     | Panipuri        |        |                      |
| 14     | Bhel            |        |                      |
| 15     | Burger          |        |                      |
| 16     | Pizza           |        |                      |
| 17     | Chinese noodles |        |                      |
| 18     | Maggi           |        |                      |
| 19     | Pavbhaji        |        |                      |
| 20     | Kurkure         |        |                      |
| 21     | Manchurian      |        |                      |
| 22     | Chinese food    |        |                      |

6. Which oil you use for daily food preparation?

- 1] Sunflower 2] Soybean 3] Groundnut 4] Mustard seed  
5] combination of 2 oil 7] any other -----

7. Do you take salad in your diet? 1] Yes 2] No

If yes which food \_\_\_\_\_

7. Do you take fruits? 1] Yes 2] No

If yes then list

| Sr. no. | Fruits         | Amount | Frequency            |
|---------|----------------|--------|----------------------|
| 1       | Apple          |        | Daily                |
| 2       | Banana         |        | 2- 4 times in a week |
| 3       | Sapota (Chiku) |        | Once in a Weekly     |
| 4       | Orange         |        | Occasionally         |
| 5       | Pomogranate    |        | Never                |
| 6       | Mango          |        |                      |
| 7       | Grapes         |        |                      |
| 8       | Papaya         |        |                      |

#### 11. Snacking pattern

1. Snacking Pattern: 1] Yes 2] No

2. Do you take snacks while watching T.V.?

Yes ☐

No ☐

If yes,

| Sr. No. | Type of food | Home prepared /<br>bought from outside /<br>both | Quantity consumed | How many times in week |
|---------|--------------|--------------------------------------------------|-------------------|------------------------|
| 1       |              |                                                  |                   |                        |
| 2       |              |                                                  |                   |                        |
| 3       |              |                                                  |                   |                        |
| 4       |              |                                                  |                   |                        |

12. Do you take fast ? 1] Yes 2] No If yes how many times in a week \_\_\_\_\_ days

13. Do you eat sweets 1] Yes 2] No

If yes list them\_\_\_\_\_

Amount\_\_\_\_\_

14. Food purposely included

\_\_\_\_\_

15. Foods purposely

avoided\_\_\_\_\_

16. Which type of meal pattern do you follow? 1] 2 meal 2] 3 meal 3] 4 meal  
4] 5 meal 5]  $\geq 6$

17. **Dietary pattern: 24hr recall method**

| Time | Meal pattern  | Menu | Amount |
|------|---------------|------|--------|
|      | Early morning |      |        |
|      | Breakfast     |      |        |
|      | Mid afternoon |      |        |
|      | Lunch         |      |        |
|      | Evening snack |      |        |
|      | Dinner        |      |        |
|      | Bed time      |      |        |

### 18. Functional foods:

1. Do you know about functional foods? 1] Yes 2] No
1. What Reasons for buying functional food?
  - 1] To solve my consciences 2] To do myself good 3] Recommended by medical doctor or nutritional consultant 4] Interest, curiosity 5] Good taste 6] To avoid medical treatments 7] For my children 8] To retard aging 9] To stay attractive 10] To stay healthy
3. What are the reasons for refusing of functional foods?
  - 1] concerns about novel food 2] Bad Taste 3] I prefer organic food 4] I focus more upon present than future 5] I do not feel ill 6] Fear of side effects 7] Fear of artificial additives 8] To retard aging 9] Not effective 10] Too expensive
4. Who is responsible for the food purchase in your household?
  - 1] Myself 2] Partner 3] parents 4] children 5] other person
5. What do you know about functional foods?
  - 1] No definition 2] Prevent Diseases 3] Promote good health 4] Prevent diseases and promotes health
6. What are the current sources of information of functional foods?
  - 1] Food labels 2] Printed Materials 3] Family / Friends 4] Television/ radio 5] Physician 6] other
7. Do you aware about the functional components of food? 1] Yes 2] No  
If yes a] Calcium b] omega 3 fatty acids c] Probiotics d] Dietary fibre

| Sr. No. | Functional food   | Frequency of consumption |        |         |        | Amount |
|---------|-------------------|--------------------------|--------|---------|--------|--------|
|         |                   | Daily                    | Weekly | Monthly | Rarely |        |
| 1       | Flaxseed          |                          |        |         |        |        |
| 2       | Soybean           |                          |        |         |        |        |
| 3       | Italian Millet    |                          |        |         |        |        |
| 4       | Flaxseed oil      |                          |        |         |        |        |
| 5       | Garden cress seed |                          |        |         |        |        |
| 6       | Oats              |                          |        |         |        |        |
| 7       | Multigrain cereal |                          |        |         |        |        |
| 8       | Garlic            |                          |        |         |        |        |
| 9       | Tomatoes          |                          |        |         |        |        |
| 10      | Fermented dairy   |                          |        |         |        |        |

|     |                                      |  |  |  |  |  |
|-----|--------------------------------------|--|--|--|--|--|
|     | products                             |  |  |  |  |  |
| 11  | Cruciferous vegetables               |  |  |  |  |  |
| 12  | Green Tea                            |  |  |  |  |  |
| 13  | Wheat bran                           |  |  |  |  |  |
| 14  | Citrus fruits                        |  |  |  |  |  |
| 15  | Omega 3 Fatty Acids foods (DHA/ EPA) |  |  |  |  |  |
| 16. | Oil with essentials fatty acids      |  |  |  |  |  |
| 17. | High fiber cereals                   |  |  |  |  |  |
| 18. | Anti diabetic tea                    |  |  |  |  |  |
| 19. | Low cholesterol margarine            |  |  |  |  |  |

8. Do you aware about the desired health benefits of functional foods?

| <b>Sr. no.</b> | <b>Health benefits</b>             |  |
|----------------|------------------------------------|--|
| 1.             | Reduced the risk of heart diseases |  |
| 2.             | Reduced the risk of hypertension   |  |
| 3.             | Gain Satisfaction                  |  |
| 4.             | Improved Performance               |  |
| 5.             | Reduced the risk of diabetes       |  |
| 6.             | Reduced the risk of cancer         |  |

9. Factors reported to increase the functional food consumption

| <b>Sr. no.</b> | <b>Factors</b>                |  |
|----------------|-------------------------------|--|
| 1.             | Awareness/ Knowledge          |  |
| 2.             | Health Professional influence |  |
| 3.             | Availability                  |  |
| 4.             | Taste                         |  |
| 5.             | Cost/ Price                   |  |
| 6.             | Family/ friends influence     |  |
| 7.             | Advertisement                 |  |

10. Nutrients mentioned in nutrient content claim that would increase the participants functional food consumption : 1] salt / sodium 2] Dietary fibre 3] Omega 3 fatty acids 4] Sugar 5 ]Trans fatty acids 6] Fat 7] Cholesterol 8] Saturated fatty acid 9] Energy

11. Functions or biological roles mentioned in nutrient function claims that would increase functional food consumption-

| Sr.No. | Function or biological role                                | Percent of participants |
|--------|------------------------------------------------------------|-------------------------|
| 1.     | Helps lower cholesterol                                    |                         |
| 2.     | Factor in the formation and maintenance of bones and teeth |                         |
| 3.     | Dietary antioxidant                                        |                         |
| 4.     | Factor in the maintenance of good health                   |                         |
| 5.     | Helps build antibodies                                     |                         |
| 6.     | Promotes regularity                                        |                         |
| 7.     | Helps build and repair body tissues                        |                         |
| 8.     | Aids in maintaining the health of skin and membranes       |                         |
| 9.     | Aids in red blood cell formation                           |                         |

19. Do you like Nuts & Oil Seeds, Dry Fruits to eat? Yes ☐ No ☐

If yes how many times you eat in a week?

| Nuts & Oil Seeds, Dry Fruits | How often in Week | How Much |
|------------------------------|-------------------|----------|
| Till (Gingelly seeds)        |                   |          |
| Groundnut                    |                   |          |
| Coconut dry                  |                   |          |
| Almond (Badam)               |                   |          |
| Cashewnut (Kaju)             |                   |          |
| Garden Cress Seeds (Ahliv)   |                   |          |
| Linseed (Jawas)              |                   |          |
| Niger Seeds (Caral)          |                   |          |
| Pista                        |                   |          |
| Akhrod                       |                   |          |

15. Do you: do your own food shopping? 1]Yes 2]No

16. Do you cook different meals for you? 1]Yes 2]No

## 20] Meal Plan

17. Do you have a meal plan for your cholesterol levels: 1]Yes 2]No

18. About how often do you use this meal plan? 1]Never 2]Seldom

3]Sometimes 4]Usually 5]Always

19. Do you read and use food labels as a dietary guide: 1]Yes 2]No

20. Do you have any dietary restrictions: 1]Salt 2]Fat 3]Fluid 4]None  
5]Other

21. Snacking Pattern : 1] Yes 2]No

22. Do you: do your own food shopping? 1]Yes 2]No

23. Cook your different meals for you ? 1]Yes 2]No

24. Do you have any food allergies? 1]Yes 2]No

**21. How do you spend your leisure / free time?**

| Type of activity               | √/X | Duration<br>in Day | How Many<br>times in Week |
|--------------------------------|-----|--------------------|---------------------------|
| vi) Watching T.V.              |     |                    |                           |
| vii) Reading and writing       |     |                    |                           |
| viii) Chitchatting with family |     |                    |                           |
| ix) Members / friend           |     |                    |                           |
| x) Any other                   |     |                    |                           |

**22. How many hours you sleeping the night? .....**

Do you sleep at afternoon? .....

How many hours? .....

**23. Do you watch T.V. regularly?**

Yes ☐ No ☐

**24. Physical Activity**

1. Do you exercise regularly? 1]Yes 2]No

Type:

1] Walking \_\_\_\_\_ 2] Yoga \_\_\_\_\_ 3] other \_\_\_\_\_

2. How often \_\_\_\_\_

Time \_\_\_\_\_

3. My exercise routine is:

1] Easy 2] Moderately 3] Intense 4]Very intense

**25] Sick Days/Complications**

1. Have you been given sick day guidelines? 1]Yes 2]No

2. Do you drink alcohol? 1]Yes 2]No

1] Daily 2] per week 3] Occasionally

3. Do you use tobacco? 1]Yes 2]No  
1] Cigarette 2] Other 3] None 4]Quit
4. In the last 3 months have you admitted to a hospital? 1]Yes 2]No
5. Have you admitted in hospital CVD related? 1] Yes 2]No

**26] Other Medical Concerns**

1. Do you know what is hyperlipidemia : 1]Yes 2]No
2. From whom you get information about this: 1] Physician 2] Friend 3] Relative 4] Media
3. Do you have any of the following:  
1] Heart problems 2] Kidney problems 3]Dental problems  
4]High blood pressure

**27] Medications**

1. Do you take your medications daily : 1]Yes 2]No
2. Do you have any medication allergies?1] Yes 2]No
- 3.If yes, please  
list\_\_\_\_\_
4. Do you take other medications? 1]Yes 2]No
5. Please list other  
medications\_\_\_\_\_
6. Do you take any other the counter medications, vitamins, or  
supplements?  
1] Yes 2] NoPlease list\_\_\_\_\_

**28] What are you most interested in learning from these nutrition session(s)?**

- 
- Needs/Education Plan:** 1] Nutrition Management 2] Physical Activity  
3] Using medications 4] Monitoring 5]Preventing Acute  
Complications 6]Preventing Chronic Complications

Signature:\_\_\_\_\_

Date:\_\_\_\_\_

**Thank you for your help!**

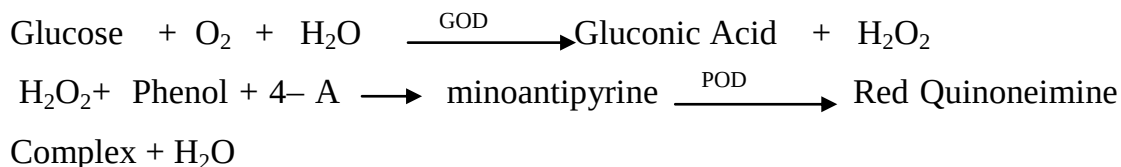
## Annexure VIII

### Estimation of Blood Fasting Glucose Level By GOD-POD Method

Fasting and Post prandial blood sugar is estimated by GOD-POD method of **Raobdo *et al.*, (1960)**.

#### Principle

Glucose is oxidized to gluconic acid and hydrogen peroxide in the presence of glucose oxidase. Hydrogen peroxide further reacts with phenol and 4-aminoantipyrine by the catalytic action of Peroxidase to form a red colored Quinoneimine dye complex. Intensity of the color formed is directly proportional to the amount of glucose present in the sample



#### Procedure

|                   | Sample | Standard | Blank |
|-------------------|--------|----------|-------|
| Serum or plasma   | 10 µl  | -        | -     |
| Standard          | -      | 10 µl    | -     |
| Reaction solution | 1 ml   | 1 ml     | 1 ml  |

The contents were vortexed and incubated for 15 mins at room temperature.

Absorbance was taken at 505 nm against the buffer as blank.

#### Calculation

$$\text{Blood Glucose} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 100 \text{ mg/dl}$$

$$\begin{aligned} \text{A (test sample)} &= \text{O.D. of sample} \\ \text{A (standard)} &= \text{O.D. of standard} \\ \text{Conc. Std.} &= \text{Standard concentration (100 mg/dl)} \end{aligned}$$

## Annexure IX

### Analytical Techniques for the Estimation of Lipid Profile

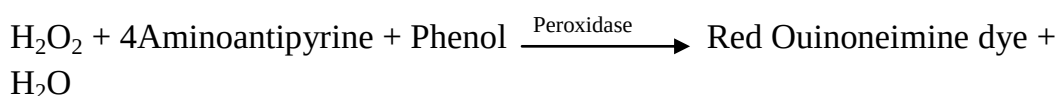
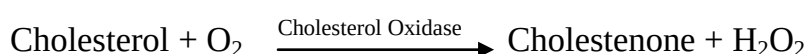
About two ml of blood was taken from antecubital vein of each subject with the help of trained personnel around 8.00 am. The collected blood samples were analyzed to find the fasting serum lipid profile following the standard methods. The collected blood was allowed to clot then serum was separated from the blood clot as rapidly as possible by centrifugation. The serum thus obtained was used as a sample for the estimation of lipid profile.

#### Estimation of cholesterol in serum by CHOD-PAP method –

Stockbridge *et al.*, (1989).

#### Principle

Cholesterol esterase hydrolyses esterified cholesterols to free cholesterol. The free cholesterol is oxidised to form hydrogen peroxide which further reacts with phenol and 4-aminoantipyrine by the catalytic action of peroxidase to form a red colour edquinoneimine dye complex. Intensity of the colour formed is directly proportional to the amount of cholesterol present in sample.



#### Procedure

|                   | Sample | Standard | Blank |
|-------------------|--------|----------|-------|
| Serum or plasma   | 10 µl  | -        | -     |
| Standard          | -      | 10 µl    | -     |
| Reaction solution | 1 ml   | 1 ml     | 1 ml  |

The contents were vortexed and incubated for 10 min at 20 to 25°C. Then the absorbance was taken against the cholesterol working reagent as blank and measured at 546 nm.

### Calculation

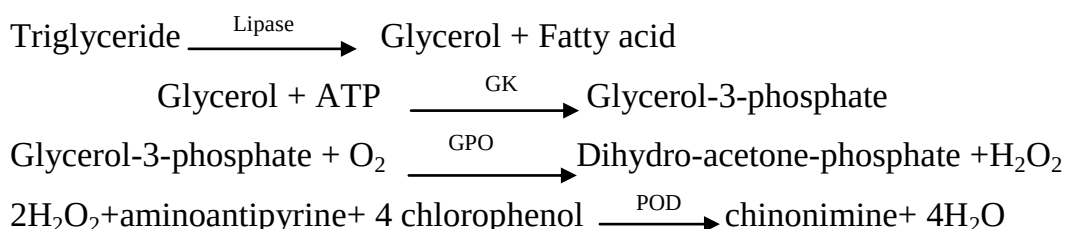
$$\text{Total Cholesterol} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 200 \text{ mg/dl}$$

### Estimation of Triglycerides

This parameter is estimated by the method GPO-POD Method of Schettler *et al.*, (1975).

### Principle

Triglyceride (a form of lipid), by the action of Lipase, hydrolyze to glycerol and fatty acid. Glycerol by the enzymatic reaction of Glycerol Kinase (GK) gets convert to Glycerol-3-phosphate. In the subsequent enzymatic oxidation by Glycerol-3-phosphate oxidation (GPO), H<sub>2</sub>O<sub>2</sub> is formed. This is converted into colored chinonimine in a reaction with aminoantipyrine and chlorophenol catalyzed by peroxidase.



### Procedure

|                   | Sample | Standard | Blank |
|-------------------|--------|----------|-------|
| Serum or plasma   | 10 µl  | -        | -     |
| Standard          | -      | 10 µl    | -     |
| Reaction solution | 1 ml   | 1 ml     | 1 ml  |

|                  | Standard | Sample | Blank |
|------------------|----------|--------|-------|
| Standard         | 100µl    | -      | -     |
| Sample           | -        | 100µl  | -     |
| Reagent Solution | 1ml      | 1ml    | 1ml   |

The contents were vortexed and incubated for 15 mins at room temperature. Absorbance was taken at 546 nm using reagent as blank.

### Calculation

$$\text{Triglycerides} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 200 \text{ mg/dl}$$

### Estimation of HDL-Cholesterol

This parameter is estimated by CHOP-PAP method of Stockbridge *et al.*, (1989).

### Principle

Chylomicrons, VLDL (very low density lipoproteins), and LDL (low-density lipoproteins) in serum or plasma are separated from HDL by precipitating with Phosphotungstic acid and Magnesium chloride. After centrifugation, the cholesterol in the HDL fraction, which remains in the supernatant, is assayed with enzymatic cholesterol method, using Cholesterol Esterase, Cholesterol Oxidase-Peroxidase and the Chromogen 4-Aminoantipyrine/Phenol.

### Procedure

The contents were mixed well and incubated for 10 minutes at room temperature. The tubes were then centrifuged for 10 minutes at 4000 rpm. After centrifugation, the clear layer (supernatant) was separated and used as a sample and the cholesterol content was determined by the CHOD – PAP method. The standard was prepared by diluting the cholesterol standard (100µl) with 250µl of normal saline.

|             |        |
|-------------|--------|
|             | Sample |
| Sample      | 200 µl |
| Precipitant | 200 µl |

All the contents were mixed well and incubated for 20 minutes at room temperature. The absorbance was measured at 546nm against cholesterol reagent as blank.

### **Calculation**

$$\text{HDL Cholesterol} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 100 \text{ mg/dl}$$

### **VLDL Cholesterol**

This parameter is calculated from total cholesterol, HDL-cholesterol & Triglyceride by Friedwald's formula and the Risk ratio (ratio of total cholesterol & HDL Cholesterol) will be calculated.

$$\text{VLDL Cholesterol} = \frac{\text{Triglycerides}}{5}$$

### **LDL-Cholesterol**

$$\text{LDL Cholesterol} = \text{Total cholesterol} - (\text{VLDL} + \text{HDL})$$