

**EFFECT OF SUPPLEMENTATION OF FOXTAIL MILLET
(*Setaria Italica*) BISCUIT ON GLYCOLIPEMIC RESPONSE**

BY

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B.Sc. (Hons.) Home Science

**DEPARTMENT OF FOOD SCIENCE AND NUTRITION
COLLEGE OF COMMUNITY SCIENCE
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PARBHANI - 431 402 (M.S.) INDIA**

2019

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DISSERTATION

Submitted To

The Vasantao Naik Marathwada Krishi Vidayapeeth, Parbhani

In Partial Fulfillment of the Requirement

for the Degree of

MASTER OF SCIENCE

HOME SCIENCE

IN

(FOODS AND NUTRITION)

**DEPARTMENT OF FOOD SCIENCE AND NUTRITION
COLLEGE OF COMMUNITY SCIENCE
VASANTRAO NAIK MARATHWADA KRISHI VIDAYAPEETH
PARBHANI - 431 402 (M.S.) INDIA**

2019

CANDIDATE'S DECLARATION

I, hereby declare that this dissertation or part there of
has not been submitted by me to any
other University or Institute for a
degree or diploma

Place: Parbhani

Date: 31 / 05/ 2019

(Ankita Keshav Choudhari)

ACKNOWLEDGEMENT

I take this opportunity to look back on the path traversed during the course of Endeavour and to remember the guiding faces behind the task with a sense of gratitude. At this moment, I praise my God who was redeemed me and strengthened me to do all things.

First of all I express my deep sense of gratitude and high indebtedness to my dynamic, dedicated, kind hearted and enthusiastic guide Dr. T. Naheed Khan Professor (CAS), Dept. of Food science and Nutrition, College of Community Science, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, for her valuable guidance sympathetic approach to my personal being, sustained interest and constant encouragement till the final shaping of present investigation. I must admit that without her hand of co-operation and parentally guidance, it was not possible for me to work on this project. I am very much proud of her to be as my advisor.

My sincere thanks to Dr. Hemangini Sarambekar, Associate Dean and Principal, College of Community Science, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, for providing facilities in the college to carry out research work.

My sincere thanks to Dr. Vijaya Nalwade, Prof. and Head, Dept. of Foods Science and Nutrition, College of Community Science, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, for providing facilities in the department to carry out research work.

I am sincerely thankful to the advisory committee members; Dr. Asha Arya, Professor(CAS), Dept. of Food Science and Nutrition; Dr .Farzana Farooqui, Associate Professor, Dept. of Foods and Nutrition, College of

Community Science for their co-operation and valuable suggestions during the period of this project.

I would like to acknowledge my thanks to Dr. Vilas Patil, Associate Dean and Principal, College of Agriculture Vasantryao Naik Marathwada Krishi Vidyapeeth, Parbhani for their constant encouragement help, support and providing facilities in the college to carry out research work.

I shall remain extremely grateful to the subjects of my experiment. The study would have been difficult task without kind co-operation rendered by them throughout the study period.

I express my special thanks to Mrs.Jostna Nerlekar (RA) and Archana Bhoyar (SRF), for their valuable help, guidance and inspiration during the period of research work.

I am indebted for the inspiring words and aspiration of my beloved parents Mr. Keshav Choudhari and Mrs. Lata Choudhari and my beloved sister and brother Ambalika and Balaji whose contribution since the onset of my academic career can never be expressed. I humbly extend my hearty thanks to my family members for providing me psychological and moral encouragement during my research work.

My whole hearted thanks to my all friends Miss Sai, KIrti, Shivshakti and my all seniors and also beloved juniors for helping me in the completion of this study for the moral support extended to me till the completion of my dissertation work.

Thanks to all those well-wishers who helped me knowingly or unknowingly in this study.

*Place: Parbhani
Date: 31 / 50/ 2019*

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Reg.No.2017C-01M

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INTRODUCTION



CHAPTER-I

INTRODUCTION

In the last two to three decades, increasing attention has been paid to reduce the risk of chronic and degenerative disease like diabetes, cardiovascular disease etc. that plague the people of United States, many Western European countries and Asian Countries (Potter, 2003).

Diabetes Mellitus is the most common metabolic disorder affecting human kind and creating health hazards. It is a multifactorial disease increasing at an alarming rate in India as well as throughout the world. The prevalence of diabetes among Indians is estimated to touch 57.2 million by 2005 from the present 32 million (TOI, 2002). India leads the world with 40.9 million individuals with diabetes and this number is projected to rise to 69.9 millions by the year 2025 (Sicree *et al.*, 2006). In fact WHO has declared India as 'Diabetes Capital' of the world (TOI, 2003). Diabetes exists in all population sectors, with variations in prevalence between different ethnic groups and geographical areas. Though diabetes is associated with aging the recent hike can be attributed to change in life styles, poor dietary habits and stressful events affecting the younger generations of 25-40 years leading to premature deaths and disabling complications. Increased mortality in patients with type 2 diabetes is seen mainly among those with complications. Risk factors include proteinuria, retinal disease and the classical risk factors for heart disease. Hyperlipidaemia, hypertension and smoking each contribute disproportionately to death rates among those with type 2 diabetes (Steyn *et al.*, 2004).

There is a close relationship between the diabetes and the diet. The diabetes can be efficiently managed by the modifications in diet and physical activity pattern. A diet with hypoglycemic effect helps in controlling blood sugar level and considerably reduces the risk of long term complications hence; it becomes a great advantage for diabetic people (Tuomilehto *et al.*, 2001)

Dietetic management is the backbone of the control and management of diabetes mellitus, particularly of non-insulin-dependent diabetes mellitus (NIDDM), where the primary derangement is of carbohydrate metabolism, with secondary abnormalities involving lipids and proteins. Dietary regulation is a major component of the diabetes monitoring to avoid further complications. Dietary prescription should be individualized considering the dietary pattern, habitual diet and regional availability of the foods to achieve better meal adherence. At present, the recommended diabetic diet consists of high complex carbohydrate, high fiber and low fat because; it helps in minimizing the rise in post prandial hyperglycemia and serum cholesterol.

More than 80 per cent of diabetes deaths occur in low and middle income countries. The need for implementation of effective dietary strategies in diabetes prevention and management has been emphasized by the success of diet and lifestyle changes in preventing diabetes in high-risk patients (Knowler *et al.*, 2004). Reduction of postprandial glycemia is now considered a desirable goal for the treatment and management of diabetes. One dietary strategy aimed at improving both diabetes control and cardiovascular risk factors is the use of low glycemic index (GI) diets Mani *et al.*, (1992).

Jenkins *et al.*, (1981) introduced the concept of GI of foods as a physiological basis for ranking carbohydrate foods based on the glycemic response they produce on ingestion. The glycemic value of a food is the response of blood glucose to a particular food is the response of blood glucose compared with an equivalent amount of the standard glucose. Low glycemic foods have a glycemic index of 55 or below. Low glycemic index foods, by virtue of their slow digestion and absorption, produce gradual raises in blood sugar and insulin level, and have proven benefits for health. They have benefits for weight control because they help to control appetite and delay hunger (Silambuselvi and Hemamalini 2016). Low glycemic index nutritious food

products prepared from millets can be used as an effective supportive therapy in the management of diabetes mellitus (Arora and Srivastava 2002).

Millet is one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. It is mentioned in the Bible, and was used during those times to make bread. Millet has been used in Africa and India as a staple food for thousands of years. It is suggested that people were farming millet in India about 2500 B.C. Among the major and minor millets, the minor millets include 6 main grain crops, which are *Eleusine coracana* (ragi or finger millet), *paspalum scrobiculatum* (varagu or kodo millet), *Panicum sumatrense* (samai or little millet), *Setaria italica* (tenai or foxtail millet), *Panicum miliaceum* (panivaragu or proso millet) and (kudiraivali or barnyard millet) ([http://chetday.com / millet.html](http://chetday.com/millet.html)).

Millets are a small-seeded annual coarse cereal grown throughout the world. Millet is known to be a drought-resistant crop, resistance to pests and diseases, short growing season as compared to other major cereals. Millet grains are receiving specific attention in the developing countries (like India, China & some countries from Africa Continent) in terms of utilization as food. Millets contain major and minor nutrients in remarkable amount. They are rich in vitamins, minerals, sulphur-containing amino acids and photochemicals and hence are termed as nutri-cereals also contain higher proportions of non starchy polysaccharides and dietary fiber. Besides, they are rich source of dietary fibre, phytochemicals, micronutrients (Desikachar, 1977). Millets release sugars slowly and thus have a low glycemic index. They have been designated as 'nutritious millets' (Bala Ravi, 2004). Despite the above facts, the nutraceutical property of millets has not been much exploited for treating degenerative disease like diabetes. Millet recognized as high-energy nutritious food to help in reducing malnutrition, nourishing the common population and to help in preventing and curing the diseases like obesity, diabetes, CVD etc. Millet is gluten-free food. Millet can be a substitute for celiac patients. FAO reported that traditional food processing (such as decortications, milling, germination,

fermentation, malting, roasting etc.) is commonly used for preparation of food products of millets to improve their edible, nutritional and sensory properties. Millets can be source of value-added healthy food-products with different varieties for traditional and nontraditional millet users (Sarita and Eakta 2016).

Foxtail millet considered a crop for poor people is grown mainly in China, Bangladesh and India. It grows well in dry zones as rain-fed crops under marginal conditions of soil fertility and moisture in the semi-arid tropic region. Practically foxtail millet is devoid of grain storage pest and has a long storage life. Nutritionally comparable or even superior to staple cereals such as rice and wheat (Gopalan *et al.*, 2004). Foxtail millet has good nutritional profile and is comparable to staple cereals as rice and wheat in terms of protein, fiber, minerals and vitamins and it has non-glutinous and non-acid-forming foods. But its potential role as low GI food has remained unrealized and unexploited. They release sugars very slowly and thus have a low glycemic index (GI) (Bala Ravi 2004) and hence can be used in therapeutic diet. In addition, millets contain water-soluble gum β -glucans which improve glucose metabolism. Therefore, the millets are suitable in diabetic diet to improve metabolic control of glucose.

Diet has been recognized as the corner stone in the management of diabetes, but without a complete deviation from normal diet. Therefore is immediate need to solve prevalence of globally type 2 diabetes through diet. (Raghuram, 1999).

Nowadays, the role of special ingredients in foods termed as, nutraceuticals/functional foods is increasing. However, pharmaceutical nutritional products tend to be costly and difficult for many to take on regular basis. It is better to consume nutritional and functional foods as normal foods (Juneja, 2003). Millets termed as nutraceuticals can be exploited for use as functional foods (Chandrashekhar, 2003).

Hence the present study is undertaken with objective to develop low GI foxtail millet biscuit and test the clinical efficacy in terms of glycolipemic responses among diabetics.

Objective:

1. To develop and evaluate foxtail millet biscuit
2. To analyze the nutrient content of the developed biscuit
3. To study the glycemic index of developed biscuit
4. To study the effect of supplementation of foxtail millet biscuits on glycolipemic response in diabetics

REVIEW OF LITERATURE



CHAPTER-II

REVIEW OF LITERATURE

Millets are one of the cereals besides the major wheat, rice and maize. It is one of the most important drought-resistant crops and the 6th cereal crop in terms of world agriculture production and has resistance to pests and diseases, short growing season and productivity under drought conditions compared to major cereals (Devi and others 2011). Millets are major food sources for millions of people, especially those who live in hot, dry areas of the world. Millet grains, before consumption and for preparing of food are usually processed by commonly used traditional processing techniques include decortication, malting, fermentation, roasting, flaking and grinding to improve their edible, nutritional and sensory properties.

It has been reported that millet has many nutritious and medical functions (Obilana and Manyasa, 2002; Yang *et al.*, 2012). The recent advances in the field of nutrition, 'nutraceuticals' has gained much importance. It is combination of the word 'nutrition' and 'pharmaceuticals' meaning foodstuff that can be used as preventive drug or food supplement (Srilakshmi, 2000). Millets a lesser known unconventional food source can be used for such purpose. Millet grains are not only nutritionally comparable but are also superior to major cereals (Desikachar, 1977; Gopalan *et al.*, 1999). Unfortunately, the potential of millet has been ignored since long, by the general masses-farmers and consumers and nutrition scientists. Many countries advocate different nutritional policies to augment food availability through introduction of high yielding seeds, pest control and preservation. However, one method that has often been neglected is the exploitation of underutilized food source like millets. A very few research studies has been conducted on food and therapeutic use of millets. Therefore not much literature is available especially on foxtail millet. Hence Present review has been collected regarding millets and their relation to diabetes under following heading.

2.1 Studies on millets

2.2 Botanical description and general information of foxtail millet

2.3 Studies on product development from foxtail millet

2.4 Studies on low glycemic response of foxtail millet product

2.1 Studies on millets

In the recent years, there has been an increasing recognition of the importance of millets as the substitutes for major cereal crops. Considering their nutritional value, ease of cultivation, low investment and proportionately high returns, these crops deserve greater attention and investment in research than what had been accorded to them. At the national and state levels attempts are now being made for popularizing and improving the millet crops. A brief review regarding consumption and utilization of millet-based foods has been presented below.

Baker (1996) showed the classification of millet. Millets include five genera *Panicum*, *Setaria*, *Echinochloa*, *Pennisetum* and *Paspalum* in the tribe panicea. The species cultivated under this tribe are proso millet (*Panicum miliaceum*), foxtail .millet (*Setaria italica*), Japanese barnyard millet (*Echinochloa frumentacea*), pearl millet (*Pennisetum glaucum*) and kodo millet (*Paspalum scrobiculatum*). The second tribe is chloridae which includes one genus *Eleusine* and species finger millet (*Eleusine coracana*). The third tribe is Festucea, which has one genus *Eragrostis* and species is teff millet(*Eragrostis tef*).

Millet is a collective term referring to a number of small seeded annual grasses that are cultivated as grain crops; primarily on marginal lands in dry areas in temperate, subtropical and tropical regions (Baker, 1996). They are the oldest food known to human and possibly the first cereal grains to be used for domestic purposes. For millions of people in the semi arid tropics of Asia and Africa millets have been staple important grains for thousand years and

evidence show that they were grown as early as 2700 B.C. in China. These were main staple grains before rice become the dominant staple (Raiely, 2000).

Ahmed *et al.*, (2013) reviewed on nutritional quality, processing and potential health benefits improvement of millet grains. In the 21st century, climate changes, water scarcity, increasing world population, rising food prices and other socioeconomic impacts are expected to generate a great threat to agriculture and food security worldwide, especially for the poorest people who live in arid and subarid regions. These impacts present a challenge to scientists and nutritionists to investigate the possibilities of producing, processing and utilizing other potential food sources to end hunger and poverty. Cereal grains are the most important source of the world's food and have a significant role in the human diet throughout the world. As one of the most important drought-resistant crops, millet is widely grown in the semiarid tropics of Africa and Asia and constitutes a major source of carbohydrates and proteins for people living in these areas. In addition, because of their important contribution to national food security and potential health benefits, millet grain is now receiving increasing interest from food scientists, technologists and nutritionists.

Amadou *et al.*, (2013) reviewed millet nutritional composition, health benefits and processing. It was stated that millet are good source of energy, protein fatty acid, minerals, vitamins, dietary fiber and polyphenols. Especially millet protein contains high quality of essential amino acids (metionine and cysteine). The millet is source of antioxidant like phenolic acid. Millet foods are characterized to be potential prebiotic and can enhance the viability or functionality of probiotics with significant health benefits. The nutritional significance of millets demands for an examination of the nutritional characteristics and functional properties of different millet cultivars as well as developing value added products from millets.

Sarita and Ekta (2016) emphasized on nutrients composition and health benefits of millets. Millet grains have substantial benefits as a draught

resistant crop, yield good productivity in the areas with water scarcity, possesses remarkable edible & nutritive values and ease of processing & food manufacturing millets are used as “food medicine” and fulfill the nutritional need of global population and combat malnutrition. Millet oil could be a good source of linoleic acid and tocopherols. Millet is an alkaline forming grain that is gluten-free. Millets are also rich sources of phytochemicals and micronutrients, play many roles in the body immune system. Millets have nutraceutical properties in the form of antioxidants which prevent deterioration of human health such as lowering blood pressure, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes, decreasing tumor cases etc. Other health benefits are increasing the time span of gastric emptying, provides roughage to gastro intestine. Millet is an alkaline forming food. Alkaline based diet is often recommended to achieve optimal health.

2.2 Studies on botanical description and general information of foxtail millet

Foxtail millet is a small seeded annual grass included among the minor millets. Foxtail millet is the third largest crop among the millets cultivated for food in semi-arid tropics of Asia and as forage in Europe, North America, Australia and North Africa. Foxtail or Italian millet may well have unrealized potential for grain production. The grains are very similar to paddy rice in grain structure. They contain an outer husk which needs to be removed in order to be used. China grows most of the world's crop but some Italian millet is grown in India, Japan and Russia. Generally foxtail millet grown in semi-arid regions foxtail millet has a low water requirement and successful almost entirely to its short growing season.

Family: Grasses

Genus: *Setaria*

Species: *Setaria italica* (L.) P. Beauv ssp. *Italic*

Botanical name: *Setaria italica*

Origin: China

Plant: 3.9-6.6ft (120-200cm)

Leaves: slim, vertical, leafy stem

Seed: 2 millimeters in diameter

Colour of seed: yellow

Sowing: July-August

Harvesting: 85-95 days from sowing

Yield: 11,000 kg per ha

Seed use: For medicinal use

Common name: Italian, German, Hungarian, Siberian, Kangani, Navane, Thanahal

Major areas of production for grains: China, Myanmar, India, Eastern Europe.

Malleshi and Desikachar (1985) reported that the crude fibre content in foxtail millet is 8-9 times higher than wheat and more than 40 times higher than rice.

Hadimani and Malleshi (1993) reported calcium content (mg%) of 28.20 for dehusked foxtail millet. The phosphorus content (mg%) was found to be 384.50 and total iron content (mg/100g) was found to be 0.5 in native and 0.9 in dehulled foxtail millet.

Pawar and Pawar (1997) reported crude fibre of 9 per cent in native form and 3.6 per cent in dehulled form of foxtail millet.

Sharma *et al.*, (2015) studied the antioxidant activity, total phenolics, flavonoids and antinutritional characteristics of germinated foxtail millet. The best combination of germination bioprocess variables for producing optimized germinated foxtail millet flour with the highest AoxA (90.5%), TPC (45.67 mg gallic acid equivalent (GAE)/100 g sample) and TFC (30.52–43.96 mg RU/g sample) were found with soaking time of 15.84 min having germination temperature of 25°C. The optimized germinated foxtail millet flour was nutritionally rich as it produced higher protein (14.32 g/100 g), dietary fibre (27.42 g/100 g), calcium (25.62 mg/kg), iron (54.23 mg/kg), magnesium (107.16 mg/kg) and sodium (69.45 mg/kg) per kg as compared to un-

germinated foxtail millet flour. The results shown that with increase in (ST) Soaking time, (Gt) germination time and temperature (GT), antioxidant activity (AoxA), TPC (free/bound) and total phenolic contents (TFC) of foxtail millet increased significantly.

Sharma and Niranjana (2017) reviewed properties, processing, health benefits and uses of foxtail millet. Foxtail millet grains processed using techniques like drying, roasting, germination and fermentation can produce products that can be nutritionally preferable to decorticated grains. Various food products can be prepared using processed whole grain flours for example breads, cookies and porridge. Foxtail millet contains significant levels of protein, fiber, mineral and phytochemicals. Anti-nutrients such as phytic acid and tannin present in this millet can be reduced to negligible levels by using suitable processing methods. The millet is also reported to possess hypolipidemic, low-glycemic index and antioxidant characteristics. Physicochemical and health-functional properties of foxtail millet and the processing technologies employed to improve these properties and develop more palatable food products.

Doddamani and Yenagi (2018) studied the nutrition composition of pre-treated foxtail millet rice in comparison with raw foxtail millet grains. Pre-treatments were given to the millet grains in different combination such as roasting; cooking, drying and roasting. Pre-treatment reduced the moisture, protein, fat content of millet grains significantly ($p < 0.05$). More reduction was observed in cooked, dried and roasted grains and minimum reduction was observed in roasted grains. There was no significant difference observed in ash content. Carbohydrate content increased more in cooked, dried and roasted grains (62.14 g) than roasted grains (56.77 g). Roasting increased insoluble dietary fibre (12.95 g) and total dietary fiber (13.60 g) whereas it decreased in cooked, dried and roasted grains (10.70 and 11.05 g). Maximum increase was observed in cooked, dried and roasted grains (3.03 g) and minimum increase was observed in roasted grains (2.14 g). Pre-

treatments did not affect the iron, zinc and manganese content of grains whereas it decreased the calcium content and increased the copper content significantly ($p < 0.05$). More reduction in calcium was observed in cooked, dried and roasted grains (28.50 mg) than roasted grains (31.84 mg). It was concluded that pre-treatment reduced the nutrients like protein, mineral composition and phyto chemicals however there was an effective improvement in the dietary fibre composition and resistant starch which delays the gastric emptying and slows down the digestion.

2.3 Studies on product development from foxtail millet

Millets are versatile foods suited for varied purposes. Many types of millets are easy to blend with several food ingredients. Many studies have been conducted to develop foxtail millet based foods for specific end uses and to introduce millet based new foods, which have potential market value in the modern era of busy work schedules. A brief review regarding nutritional value of foxtail millet-based foods is presented below.

Meghana *et al.*, (2012) studied the enrichment of biscuits with nutritious foxtail millet using butter which is low in transfat. Ingredients viz. cumin seeds, bishop's weed seeds and ginger were selected for savoury biscuits based on their health benefits. To improve flavor and taste, coriander leaves, green chillies and salt were added. Trials were conducted to optimize the incorporation level of foxtail millet. It was found that up to 40 per cent refined wheat flour could be replaced with foxtail millet to obtain acceptable sensory characteristics along with increase in the fiber and nutrients. It was observed that fiber and mineral content of millet savoury biscuits was 3.5 and 1.5 times respectively higher than control biscuits indicating its suitability for diabetics and improving their health. It was observed that textural properties did not vary significantly and were acceptable by the sensory evaluation panel. From the study it was concluded that these millet savoury biscuits are suitable snack for diabetics as they contain high fibre and less calorigenic than sweet cookies.

Ballolli *et al.*, (2014) studied the development and quality evaluation of foxtail millet incorporated bread. Foxtail millet incorporated breads were developed by incorporating foxtail millet flour at 10, 30 and 50 per cent level in the recipe. Value addition to breads with foxtail millet resulted in significant change in colour of both crust and crumb. Crumb colour changed from white to dull yellowish with increased incorporation of millet flour. The highest L value was found for 50 per cent (67.24) incorporated breads followed by control (53.56), 30 per cent (48.47) and 10 per cent (40.86). The breads were evaluated for sensory quality using nine points hedonic scale by semi trained panel of 15 to 20 judges Height of the breads affected significantly at 50 per cent incorporation of foxtail millet flour. Compressive test of bread crumb showed significant difference between control and foxtail millet incorporated breads, the study indicated the potentials of development of foxtail millet incorporated breads at 50 per cent level.

Murthy *et al.*, (2016) developed complementary food using malted foxtail millet and wheat flours, skimmed milk powder, sugar, ghee and whey protein concentrate. Different proportions of malted wheat and foxtail millet flours were taken which accounted for 70 parts to which 30 parts of skimmed milk powder, ghee was added at the rate of 7 per cent. The levels of malted foxtail millet flour, millet flour and wheat flour were taken at the following proportions 30:40, 35:35, 20:50 and 10:60, whey protein concentrate at 1, 2 and 3% levels and sugar at 10, 12 and 14% in order to enhance the taste. The dry blends of complementary food CF1, CF2 and control were reconstituted with 25 per cent total solids, cooked into gruel and 5 subjected to sensory evaluation by panel member by using 9-point hedonic scale. The study concluded that, the complementary food can be formulated with WPC at industrial level and without WPC at household level using foxtail millet and wheat malt blends.

Dhumketi *et al.*, (2017) evaluated the suitability of foxtail millet semolina and soy grits for the formulation of instant upma mix. Instant upma mix was prepared using foxtail millet along with soya grits .The instant upma mix were evaluated for sensory characteristics, proximate composition, colour values and cooking quality . Results of study showed that the mix prepared from 75% foxtail millet, 20% wheat semolina and 5% soy grits was well accepted. The colour value was decreasing with increasing level of foxtail millet semolina.

Kumar *et al.*, (2017) developed RTE functional gluten free foxtail millet halwa. The *halwa* was prepared with foxtail millet semolina, ghee, oil, water, cashew, cardamom and retorted to the total lethality value of 5.26 minutes. The retorted products were stored under refrigerated and ambient conditions and the changes in physico-chemical properties were evaluated. During the storage period, the shelf life study revealed that there were much less significant changes in the physico-chemical properties under both storage conditions. Comparatively equal amount of changes occurring in the refrigerated storage and ambient storage conditions, the appearance and texture of the products stored in ambient storage conditions rather than in refrigerated conditions were found to be good. Hence, ambient storage conditions can be suggested for storage of these products after retorting.

The development of low glycemic index cookie bars from foxtail millet, arrowroot flour, and kidney beans was studied by Lestari *et al.*, (2017). The physical, chemical, and sensory properties were evaluated by selecting the best formula to test the glycemic index. Three formulae of cookie bars, which had different per centages of foxtail millet, kidney beans and arrowroot flour, were evaluated. The results showed that the three formulae (F1, F2, and F3) had Hue values of 53.77, 58.46, and 58.31 and breaking force of 8.37, 10.12, and 5.87 N, respectively. The F2 cookie bar was selected and evaluated for the glycemic index because it has the best sensory properties, lowest total sugar and available carbohydrate content. F2 cookie bars that contain 15% foxtail

millet, 15% arrowroot flour and 30% of kidney beans have a glycemic index of 37.6 hence it could be classified as a low glycemic index cookie bar.

Kadam *et al.*, (2018) developed foxtail millet based extruded product and its quality evaluated. A total of five treatments with different proportions (T0)100:0,(T1) 95:5, (T2)90:10,(T3)85:15 and (T4) 80:20) of the foxtail millet were given for development of product. Analysis of Physico-chemical parameters such as protein, fat, fiber, moisture, ash content and along with sensory evaluation for all the treatments was performed. Protein and Fat content increased gradually with increase in the Foxtail millet content whereas moisture content % (max. 4.79 and min. 3.62), ash content % (max. 0.55 and min. 1.42) and crude fiber % (max. 2.35 and min. 1.32), increased with an increase in the foxtail millet proportion. On optimization and evaluation of all the parameters and considering the results of sensory evaluation, T3 sample containing (85:15) ratio of millet was found to be the most optimum treatment for the incorporation of foxtail millet based extruded.

2.4 Studies on low glycemic response of millet based product

Various epidemiological studies have shown that, GI was designed for people with diabetes as a guide to food selection Therefore it is now suggested that a diet with low glycemic index improves postprandial blood glucose levels, the blood lipid profile have a therapeutic role in the treatment of diseases related with insulin resistance (Ostman *et al.*, 2001).

Mani *et al.*, (1992) studied the glycemic index of conventional carbohydrate meals. A total number of 30 non insulin dependent diabetes mellitus over 40yrs of age randomly selected for the study the five meal tested R1, semolina alone; R2, semolina and black gram dhal; R3, semolina and green gram dhal; R4, semolina and Bengal gram dhal; R5, semolina alone. The GI value of R1, R2, R3, R4 and R5 was 55, 46, 62, 54 and 76 per cent respectively. It is clear from the result that R2 i.e. semolina and black gram dhal had lowest

GI. The fasting and postprandial glucose response to the test meal did not show significant difference among the meal.

Urooj and Puttaraj (2000) evaluated in vivo glycemic responses to six cereal-based foods traditionally consumed in South India in patient with non-insulin-dependent diabetes mellitus (NIDDM) and healthy volunteers. The result of study included that the postprandial responses to the foods at 30, 60 and 120 min were significantly ($P>0.05$) lower than those to the reference glucose, in both groups. The peak glucose responses for three foods, i.e. chapatti, idli and poori, occurred 60 min postprandially in both groups. The glycemic index (GI) values ranged from 67 to 90 in NIDDM and from 44 to 69 in healthy subjects with no significant differences within the groups. It was concluded that GI concept is useful for identifying foods in the habitual Indian diet with attributes of the desired glycemic effect such as delayed peak rise and low.

Mohan *et al.*, (2009) examined the association of dietary carbohydrates and glycaemic load with the risk of type 2 diabetes among (1843) were randomly selected an urban adult subject aged >20 yr oral glucose tolerance tests were performed using 75 g glucose in all subjects. The result of the study is included that refined grained intake was positively associated with the risk of type 2 diabetes while dietary fiber intake was inversely associated with diabetes.

Anju & Sarita (2010) evaluated suitability of foxtail millet (*Setaria italica*) and barnyard millet (*Echinochloa frumentacea*) for development of low glycemic index biscuits, the biscuits were prepared using 45% of millet flour and 55% of refined wheat flour. All the three types of biscuits prepared were found to be acceptable by a trained panel and diabetic subjects. The result of the shelf life study indicated that the biscuits made from both types of millet flour can be successfully stored for a period of 60 days in a thermally sealed single polyethylene bag at room temperature. The biscuits from foxtail millet flour had the lowest GI of 50.8 compared to 68 for biscuits from barnyard millet flour and refined wheat flour.

Thathola *et al.*, (2010) determined effect of foxtail millet Supplementation on serum glucose, serum lipids and glycosylated hemoglobin in type 2 diabetics. Two sweet from foxtail millet viz. biscuit and burfi were selected for the study. The glycemic index of biscuit was 50.8 and burfi was 37.5. A total number of thirty type -2 diabetes subjects (16 male) and (14 female) age 36-78 yr with body mass index in the range of 17.5 to 32.3 kg/m² were selected , they were divided into three groups. Experimental 1, 2, 3 EG-1 patients were supplemented with 100 g of foxtail millet biscuits and EG-2 patients with 100g foxtail millet burfi for 30 days. The result of the study revealed that there was a significant reduction in serum glucose (23%), serum cholesterol (6%), serum LDL (20%) and GHb (16.5%), and a slight decrease in serum triglycerides and VLDL however serum HDL increased significantly by 23 per cent.

Itagi and Naik (2012) reported on response of a millet based mix in a non-diabetic and diabetics. Foxtail millet and little millet were used to formulate the mix. The blend formulated by mixing wheat semolina and black gram dhal at 10 per cent level along with spice mixture of fenugreek, coriander and cumin seeds, black pepper at 8%. A millet mixes were analyzed for proximate principles. The GI of foxtail millet and little millet mix was 54.39 and 58.75 respectively. The difference in GI of mixes was not significant statistically further the long term feeding study was conducted on six non diabetics and nine type 2 diabetics volunteers for four week. The subject were asked to replace part daily cereal intake by millet mix each subject consume 87 g of mix per day, this was providing at least 50% of recommended dietary fiber. The result included that 18.94 % and 16.46% reduction in plasma glucose of experimental diabetic and non diabetic group after consumption of foxtail millet mix. Similarly 16.54% and 8.49% reduction in plasma glucose of experimental diabetic and non diabetic group after consumption of little millet mix. Also the considerable change was observed in positive direction with plasma glyco-lipemic parameters.

Bisht & Srivastava (2013) developed three types of burfi (a sweet confection) namely, foxtail millet burfi (FMb), barnyard millet burfi (BMb) and control Bengal gram flour Burfi (CBGFb), for the consumption of diabetics. The flour blends for FMb and BMb contained 43% of foxtail millet and barnyard millet flour respectively and 57% of bengal gram flour. The CBGFb was prepared by using 100% Bengal gram flour and served as control. The burfis were analysed for sensory quality, acceptability, storage stability, nutritional quality, glycemic index (GI) and glycemic load (GL). All the three burfis were acceptable to diabetic as well as non-diabetic subjects and could be stored easily for 15 days under ambient conditions. The millet burfis possessed fiber and starch contents which contributed to a low GI value of 37.5 for FMb compared to the control. The GL values were 14.7, 17 and 17.9 for FMb, BMb and CBGFb, respectively. Hence the millet, especially foxtail millet which had a low GI value has the potential of being served to diabetics in the form of sweets.

Shubhashini and Ushadevi (2014) determined the GI, of foxtail millet. Food containing 50 g of carbohydrate was given to 10 healthy volunteers. B-glucose curve were constructed from B-glucose value at a time 0, 30, 60, 90 and 120 min after the meal. The GI was calculated by dividing the incremental area under the curve of (IAUC) for the tested food by that for the standard food (IAUCS). In each volunteer and the GI was obtained and average was calculated. The intake of test food was associated with high average blood glucose at 0 min $P > 0.05$ then later the measurement at 30, 60, 90, 120 min after the ingestion of test food showed a decreases in average blood glucose value which was significantly different ($P < 0.05$) when compare to glucose consumption the GI was found to be low.

Narayanan *et al.*, (2016) concluded study on postprandial glycaemic response of foxtail millet dosa in comparison to a rice dosa in patients with type 2 diabetes. The GI of common Indian recipe rice dosa and foxtail dosa was determined, the GI of foxtail millet-based dosa was 59.25 and that of rice dosa was 77.86. Total 105 type-2 diabetes patient were selected out

of which 69 were male . The mean age of the participants was 49.3 ± 9.9 yr, the mean duration of diabetes was 4.2 ± 1.9 yr. The study participants who consumed millet based dosa showed significant reduction in their postprandial glucose level, when compared to the subject consumed rice based dosa. No significant difference was observed in the fasting blood glucose level in both groups. In conclusion it can be said that foxtail millet has the potential benefits in the diet therapy for patient with diabetes.

MATERIALS AND METHODS



CHAPTER-III

MATERIALS AND METHODS

The present study was designed to determine the effect of supplementation of foxtail millet biscuit on glycolipemic response of selected diabetic subjects. The research was conducted in two phases. In the first phase of experiment developed foxtail millet biscuit was utilizing varying amount of foxtail millet flour. The developed foxtail millet biscuits were evaluated for organoleptic characteristics and highly accepted foxtail millet biscuit was analyzed for nutrient content and determined glycemic index on selected 10 normal subjects. In the second phase of experiment human study was conducted. The twelve type II diabetic subjects were selected by purposive sampling technique in Parbhani city. They were personally interviewed with the help of pre-tested questionnaire to elicit the information regarding socio-economic background, health status and food and nutrient intake. The evaluate impact of highly accepted foxtail millet biscuits supplementation on anthropometric measurements, blood glucose and lipid profile of the selected subjects are determined.

The details of methodology followed in the present study are described under here different heads.

3.1 Collection of materials

Foxtail millet (*Setaria italica*), refined wheat flour, fat, omum, cumin seed, milk, baking powder and salt were procured from local market. Foxtail millet was cleaned, grinded with the help of roller mill and stored in the air tight container till the end of study period.



Plate .1 Foxtail millet



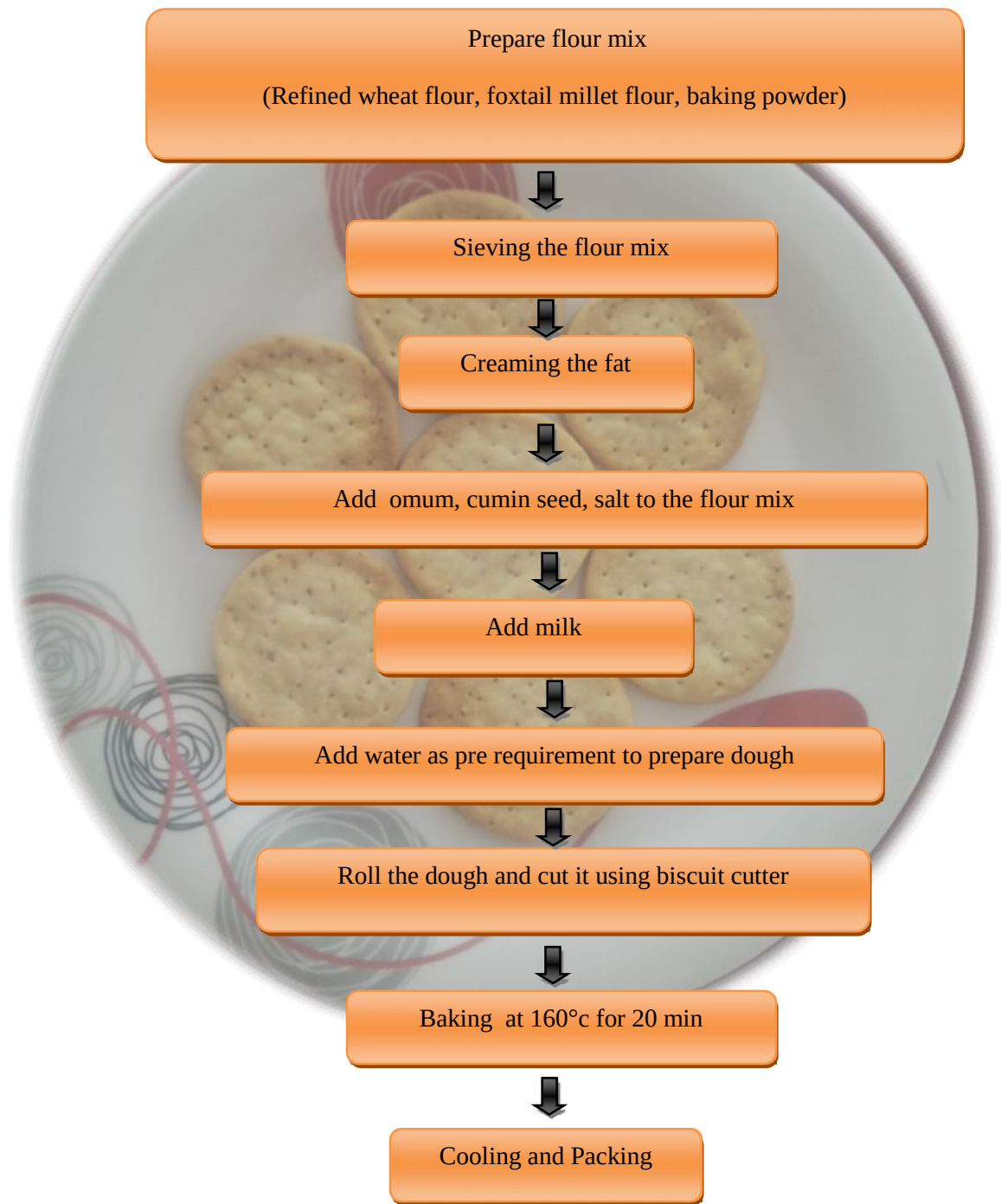
Plate .2 Foxtail millet flour



Plate .3 Preparation foxtail millet biscuits



Plate .4 Baking of foxtail millet biscuits



Flow chart of preparation of foxtail millet biscuit

3.2 Development of foxtail millet biscuits

Recipe of biscuit was prepared basic (control) following the standard procedure.

Five variations of foxtail millet biscuits were developed by utilizing foxtail millet flour with 0, 10, 20, 30, 40 and 50 per cent. The detail description of development of foxtail millet biscuit is as follows.

These studies also reported that foxtail millet flour was structurally more stable and resistant to gelatinization than other millet flours.

All the nutritional properties have made foxtail millet an important ingredient for preparing noodles, nourishing gruel or soup, brewing alcoholic beverages, cereal porridges, and pancakes in China (Krishna *et al* .,2013).

Table 1. General description of development of foxtail millet biscuit

Composition

The composition of FMB and control RWFB is given below:

Ingredient	RWF	FMF	Milk	Fat	Omum	Cumin	Salt	Baking
Variation (%)	(g)	(g)	(ml)	(g)	(g)	seed (g)	(g)	powder
0	35	-	4	10	0.5	0.5	0.5	1 pinch
10	31.5	3.5	4	10	0.5	0.5	0.5	1 pinch
20	28	7	4	10	0.5	0.5	0.5	1 pinch
30	24.5	10.5	4	10	0.5	0.5	0.5	1 pinch
40	21	14	4	10	0.5	0.5	0.5	1 pinch
50	17.5	17.5	4	10	0.5	0.5	0.5	1 pinch

FMF (foxtail millet flour), RWF (refined wheat flour)



0%



10%



20%



30%



40%



50%

Plate 5 . Percent incorporation of foxtail millet in biscuits



Plate .6 Estimation of mineral



Plate .7 Estimation of calcium



Plate.8 Estimation of fat



Plate .9 Estimation of protein

3.3 Organoleptic Quality evaluation

The developed biscuits were subjected to sensory evaluation for their organoleptic properties viz., colour and appearance, flavor, texture, taste and overall acceptability by a panel members using a nine point hedonic scale. The score card used for the evaluation is given in Appendix-I.

3.4 Nutrient analysis

The highly accepted i.e. 40 per cent of foxtail millet biscuit was subjected for the nutrient analysis by following standard procedure. The proximate content was determined following standard procedure of A.O.A.C. (1975), the mineral was estimated by atomic absorption spectrophotometer (Perkin R. Elmer Model-3110). Fatty acid was estimated by (Anon., 1983), and peroxide value estimated by AOCS method Cd 8b-90 (1997).

3.5 Cost analysis of foxtail millet biscuit

The processing techniques such as grinding, baking, packaging etc. was used for during development of foxtail millet biscuits which was feasible to be carried out at household level for small scale production and also at industrial level for large scale production. The economic feasibility of most acceptable variation of (40%) foxtail millet biscuit was assessed by calculating the total cost of production for 1kg of foxtail millet biscuit. 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).

Table 2. Cost assessment of foxtail millet biscuit

Sr. No	Ingredients	Amount	Cost (Rs)
1	Refined wheat flour	420	17
2	Foxtail millet flour	280	23.2
3	Fat	200	18
4	Cumin seed	10	5
5	Omum	10	2
6	Milk	80 ml	4.8
7	Total cost		70
8	Packaging and processing cost at 15 % of the total raw material cost	10.5	
9	Production cost of 1kg foxtail millet biscuits	Rs. 80.5	
10	Cost of biscuit /day supplementation (50 g)	Rs. 4.02	

- Biscuits obtained from 1 kg 150 no.
- Supplementation of foxtail millet biscuits / day 50g (7no)

3.6 Determination of glycemic index

Glycemic index of biscuit was determined on ten normal female subjects. In the age group between 20-25 yrs were selected for the experiment. They were interviewed personally with the help of pretested questioner.

3.6.1 Glucose Tolerance Test (GTT)

The first day of study 25 g of glucose dissolved in 100 ml of water was given to the subject early in the morning before consuming any food. The subjects were instructed to avoid physical exercise during the experimental period. The rise in blood glucose level was measured by drawing the blood sample giving the finger prick through lancet at 0, 30, 60, 90 and 120 min. intervals for estimation of glucose level using Glucometer (One touch) (Plate 10). On the second day of experiment the subject were given 50 g test meal containing 25 g of carbohydrate and rise in blood glucose level was measured following the same procedure. The blood glucose response curves were plotted for both glucose and test carbohydrate meal. With the help of the graph, the postprandial incremental areas were calculated and the glycemic index of value added products was determined following the formula given by Wolever and Jenkins (1986).

$$GI = \frac{\text{Incremental area under blood glucose curve for test food}}{\text{Incremental area under blood glucose curve for reference food}} \times 100$$

3.7 Selection of subject for the study

A total no of twelve subjects suffering from type-2 diabetes (NIDDM) voluntarily ready to cooperate were selected following purposive sampling technique for the present study.

Among twelve subjects six subjects were treated as experimental group and remaining six were as control group. The purpose and discipline



Plate .10 Glucose tolerance test

involved in the study was explained to all the subjects. During the study period, the selected subjects were allowed to continue and follow their usual living style, diet, exercise and medicines.

3.8 Collection of general information of selected subject

Twelve selected subjects were personally interviewed by the investigator with the help of questionnaire (Appendix-II) so as to elicit the information regarding of socioeconomic status, age, sex, food habits, anthropometric measurement, family background of disease, duration of disease, life style, diet etc.

3.9 Experimental Techniques

For the study, a total twelve number of selected subjects suffering from type-2 diabetes (NIDDM) were divided into two groups Experimental group and control group viz. each group consisted of six subjects. The EG was supplemented with highly acceptable foxtail millet biscuit every day for a period of 60 days in addition to their daily routine diet as six subject and control group was not receiving the supplementation and were following their daily routine diet.

Foxtail millet biscuit was supplemented to the selected subjects daily in the morning hours i.e. around 9.00 am in an amount of 50 g to each subject for a period of 60 days and observation at 0 and 60 days were recorded.

3.10 Clinical study

The height and weight of each selected subjects were recorded initially and after 60th day following standard procedure.

Glycolipemic response of selected subject was determined by using standard methods. The observation was recorded before administration of foxtail



Plate 11. Personal interview of subject



Plate .12 Measurement of height



Plate .13 Measurement of weight

millet biscuit and after the administration of 60 days. Cholesterol, triglyceride the level of HDL and LDL level in blood was determined.

3.11 Recording anthropometric measurement

The body measurement of selected subjects recorded during the experimental period was height and weight standard procedure by Jelliffie (1996). Detail of procedure followed and material used for measuring different indices are described here under.

3.11.1 Determination of body weight of subjects

A portable weighing balance of 100 kg capacity with a sensitivity of 0.1 kg was used to record the weight of each one of the selected subjects. The body weight was noted on 0.1 kg when the subject was standing on the balance with bare feet and light clothing. This procedure was repeated for two times and the mean value of the weight was taken as a measurement of a body weight of a subjects.

3.11.2Determination of body height of the subjects

The height of selected subject was measured by using non stretchable measuring tape the subject was asked to stand upright with his feet closer together, legs straight, arms at the side and shoulders relaxed against the wall. Cardboard was placed perpendicular to the crown of the head of the subject. Then, a mark was made on the wall with the help of a pencil. The actual height of the subject was measured with the help of a measuring tape to the nearest 0.1 cm by measuring the length from mark to the floor.



Plate .14 Subject consuming foxtail millet biscuit

3.11.3 Determination of body mass index of the subjects

Body mass index (BMI) was calculated from the recorded measurement of the body weight (kg) and height (cm) of subjects by using the following formula.

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

3.12 Analytical techniques

About two ml of blood was taken from antecubical vein of each subject with the help of trained personnel around 8.00 am. The initial blood sample was collected before starting the study and after the administration of herbal composite supplementation with periodical interval of 30 and 60 days.

The collected blood sample were analysed to find the fasting serum lipid profile following the standard method. 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 sample for the estimation of lipid profile.

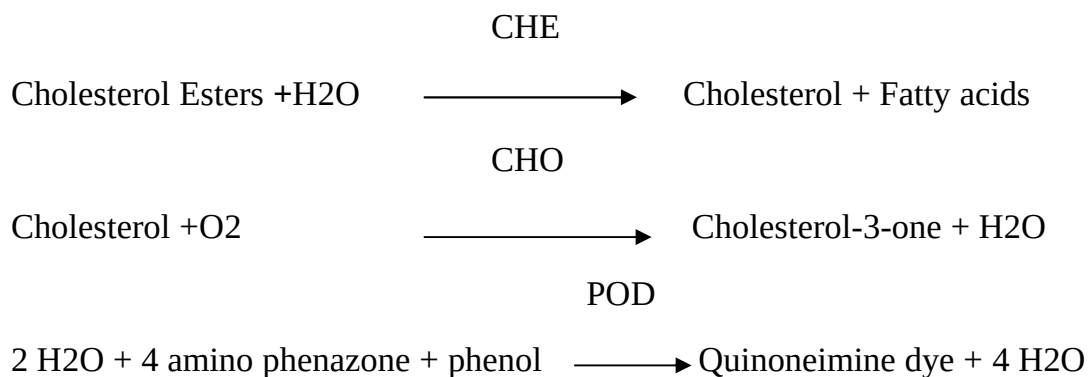
3.12.1 Estimation of cholesterol in serum by CHOD-PAP method (schettle *et al.*, 1975)

3.12.1.1 Principle

The total cholesterol in serum is determined after enzymatic hydrolysis and oxidation. The indicator quinoneimine is formed from hydrogen peroxide and 4-aminophenazone in the presence of phenol and peroxidase.



Plate .15 Collection of blood sample



3.12.1.2 Reagent

A kit purchased from Stand Diagnostics Ltd, Mumbai had the following reagents for ready to use purpose to determine the cholesterol in the serum.

3.12.1.2.1 Enzyme reagent

The reagent contained phosphate buffer (pH 6.5) (100 mmol/lit), 4-amino phenazone (0.2mmol/l) lit, phenol(5mmo/lit)peroxide (> 5Ku/I), Cholesterol Esters (>150 U/I) and cholesterol oxidase (>100).

3.12.1.2.2 Cholesterol standard

The standard solution had 200 mg of cholesterol in 100 ml solution.

3.12.1.2.3 Procedure

As per details given in the table, the solution wear mixed well and incubated for 5.0 minutes at 37°C.

Pipette in to cuvettes	Reagent blank	Sample of standard
Sample/standard	---	10 µl
Reagent	1000 µl	1000 µl

The absorbance of sample /standard was read in spectrophotometer (TRANCESIA) at 500 nm, with in 30 min again the reagent blank (AA).

3.12.1.3 Calculation

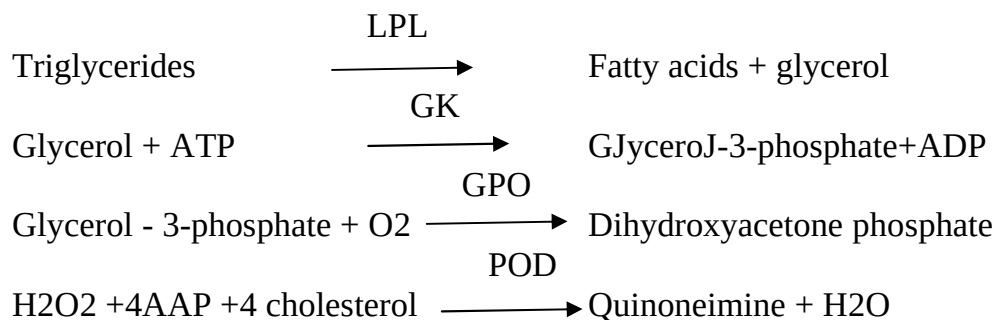
Cholesterol concentration mg/dl= 553× Δ

3.12.2 Estimation of triglycerides in serum

The level of triglycerides in serum was estimated by following by enzymatic colorimeter method GPO-PAP as described by Bucolo *et al.*, (1973).

3.12.2.1 Principle

The principle of determination of triglycerides in based on following reactions.



3.12.2.2 Reagents

All the reagents were obtained as components in kit purchased from Stand Diagnostics Ltd, Mumbai, for ready to use purpose.

3.12.2.2.1 Single reagent

The reagent was stored at 2-8°C it was brought again to room temperature prior to the usage.

3.12.2.2 standard solution

This solution had concentration of 200 mg of triglycerides per 100 ml.

3.12.2.3 Procedure

As per the details given in the following table the solution were mixed and incubated at 37°C for five min.

Pipette in to cuvettes	Reagent blank	Sample of standard
Sample/standard	---	20 µl
Reagent	2 ml	2 ml

Absorbance of standard (As) and sample (Ax) were recorded at 510 nm against reagent blank in spectrophotometer (TRANCESIA).

3.12.2.4 Calculation

$$\text{Triglycerides in mg/dl} = \frac{A_x}{A_s} \times 200$$

3.12.3 Estimation of HDL-cholesterol and LDL cholesterol

HDL –cholesterol and LDL –cholesterol in the serum sample were estimated by higher performance CHOD-PAP method as described by Lopes *et al.*, (1977).

3.12.3.1 Principle

LDL (low density lipoprotein) cholesterol precipitant by adding phosphotungstic and magnesium ions to the sample. Centrifugation levels only the HDL (high density lipoprotein) cholesterol in the supernatant and the cholesterol content is determined enzymatically.

3.12.3.2 Reagents

Reagents were obtained from Stand Diagnostics Ltd, Mumbai, in the form of a kit for ready to use purpose.

3.12.3.2 Precipitant reagent

It contain phosphotungstic acid 0.55 mmol/l and magnesium chloride 25 mmol/l this reagent stored at 15°C to 25°C for the use.

3.12.3.2.1 Procedure

Pipette in to centrifuge tube	Macro
Sample	500 µl
Precipitation	100 µl

The serum sample and precipitation reagent were mixed and allowed to stand for 10 min at room temperature. The contents were centrifuged for 10 min at 4000 rpm. The clear supernatant was separated within two hours and for the cholesterol was determined by CHOD –PAP method as described in this chapter under the estimation for total cholesterol.

3.12.3.4 Calculation of HDL cholesterol

HDL- cholesterol in mg/100ml = $187.9 \times \text{Absorbance of sample}$.

3.12.3.5 Calculation of LDL cholesterol

$$\text{LDL- cholesterol (mg/100ml)} = \text{Total cholesterol (mg/100ml)} - \frac{\text{Triglycerides (mg/100ml)}}{5} - \text{HDL- cholesterol (mg/100ml)}$$

3.12.4 Analysis of very low density lipoprotein (VLDL)

The serum VLDL was calculated on the basis of analysed value of serum triglycerides using the following formula given by Frirwald *et al.* (1972).

$$\text{Serum VLDL} = \frac{\text{Serum Triglycerides}}{5}$$

3.12.5 Analysis of glycated hemoglobin (HbA1c)

The glycated hemoglobin was measured using HPLC Assay Kit (Sacks D.B. *et.al* .,2002).

3.12.5.1 Principle

For the determination of HbA1c analysis of the blood cells is performed first. The samples are incubated at 37 °C to eliminate the unstable aldimine form. After centrifugation the supernatant is injected into the HPLC system. The gradient separation via HPLC at 30°C lasts 5 minutes. The chromatograms are recorded by an UV-detector. The quantification is performed with the delivered blood calibrator; the concentration is calculated via integration of the peak heights respectively areas

3.12.5.1.1 Procedure

3.12.5.1.2 Reagent

1. Reconstitute the calibrator (CAL) in 1 ml deionized water, divide the calibrator in several portions and store them at -20 °C. Avoid repeated freeze-thaw circles. The content of HbA1c might have minor changes from lot to lot.
2. All other test reagents of the HbA1c HPLC Assay Kit are stable at 2-8 °C.

3.12.5.1.3 Sample preparation

1. Pipette into 1.5 ml reaction tubes:

5 µl sample

+

1250 µl HEM

2. Mix well. Leave the tubes for 30 minutes at 37°C and centrifuge afterwards at 10.000 g for 2 minutes.

3. CAL and CTRL are ready to use after reconstitution.

4. Inject 20 µl of the supernatant for chromatography into the HPLC-system. The supernatant is stable in the dark for at least 24 hours at 2-8°C.

After the analysis the column should be flushed with 20 ml deionized water (1 ml/min) and stored in 20% acetonitrile in deionized water. Before use, the system should be equilibrated with approx. 30 ml ELU A.

3.12.5.1.4 Calculation

The area of the HbA1c peak and the total hemoglobin are determined and expressed as % HbA1c of total hemoglobin. The samples are then multiplied with the calibration factor.

$$\text{Calibration factor} = \frac{\text{mean value calibrator (\% HBA1c)}}{\text{determined value calibrator (\% HBA1c)}}$$

$$\text{Patient sample (\% HBA1c)} = \text{determined value (\% HBA1c)} \times \text{calibration factor}$$

3.13 Diet survey of selected subject

The information according to the food consumption pattern of selected subject was obtained by personal interview method. The 24 hour dietary recall methods were used for the food and nutrient intake of selected subject. The intake of the food cooked form was converted into raw food ingredients and the nutritive value of the raw food was determined to find out the nutrient intake of the subjects, following the nutritive value of Indian foods. The intakes of nutrient of food were determined with the help of Recommended Dietary Allowance of ICMR (2010).

3.14 Statistical analysis

The data of acceptability of four developed variation of foxtail millet biscuit were statistically analysed by one way analysis of variances and ‘F’ value was calculated to find out the difference among the developed variations of foxtail millet biscuit with varying amount of foxtail millet flour.

To determine the impact of supplementation of foxtail millet biscuit at 0, 30 and 60 days of experiment on anthropometric measurements of selected subjects the means range standard error of different parameters were calculated.

The difference with regard to value between 0 to 60 days of blood glucose and lipid profile of experimental and control group and

selected subjects and also the difference between initial final values of experimental vs. control group was compared by applying 't' test (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION



CHAPTER-IV

RESULT AND DISCUSSION

The present study was designed in two phases. In the first phase of experiment five variation of foxtail millet biscuit were prepared by utilizing varying amount of foxtail millet and was evaluated by panel members for acceptability in terms of organoleptic characteristics.

In second phase human studies were conducted in order to evaluate the impact of supplementation in the selected diabetic subjects.

The data was tabulated, statistically analyzed and discussed here under various heads.

4.1 Organoleptic evaluation of foxtail millet biscuit prepared by utilizing foxtail millet.

The mean score for organoleptic characteristics of biscuit prepared without and with varying level of incorporation of foxtail millet are presented in Table.3 and elaborated in Figure.1

The mean score for colour of foxtail millet biscuit with 0, 10, 20, 30, 40, and 50 per cent level incorporation of foxtail millet were found to 7.6, 7.8, 7.6, 7.5, 7.9 and 7.9 respectively. The maximum score of 7.9 was obtained for colour of biscuit prepared with 40 and 50 per cent level of incorporation where as minimum score of 7.5 was recorded for colour of biscuit prepared with 30 per cent level of foxtail millet incorporation. The score for the colour of biscuit made with 30 per cent level incorporation of foxtail millet were found to be less than that of the biscuit prepared with 10 and 20 per cent of incorporation.

Statistical analysis revealed that the score obtained for colour of biscuit prepared without and with varying level of foxtail millet did not differ significantly each other.

It can be concluded from the result that among the prepared biscuit the colour of biscuit with 40 and 50 per cent level of incorporation of foxtail millet was found to be most acceptable.

The score obtained for texture of a biscuit prepared with 0, 10, 20, 30, 40, and 50 per cent level of incorporation of foxtail millet were 8.1, 7.8, 7.7, 7.7, 7.9 and 7.9 respectively. The highest score 8.1 was recorded for texture of biscuit 0 per cent level incorporation of foxtail millet, while the lowest score of 7.7 was recorded the biscuit prepared with 20 and 30 per cent level of incorporation of foxtail millet.

Statistical analysis showed that, the score obtained for texture of biscuit with 0, 10, 20, 30, 40 and 50 per cent with incorporation foxtail millet did not differ significantly. The score of 7.9 for texture of foxtail millet biscuit, recorded for 40 and 50 per cent level of incorporation of foxtail millet was noticed significantly closer to record 8.1 with control.

From the finding it can be inferred that 40 and 50 per cent level of incorporation were found to be most acceptable in the context of texture.

In case of flavour of biscuit prepared with 0 to 50 per cent level of incorporation of foxtail millet. The score ranged from 7.6 to 6.0. The highest value was recorded for flavour by the 40 per cent level of incorporation of foxtail millet. The lowest value obtained by the biscuit with 50 per cent level of incorporation of foxtail millet.

Statistical analysis indicated that the score obtained for flavour of biscuit with different level of incorporation of foxtail millet did not differed from one another with exceptions of 50 per cent level of incorporation of foxtail millet biscuit.

In light above results all scores obtained for flavour of biscuit were acceptable.

Table 3. Mean value of organoleptic score for the acceptability of biscuit prepared without and with different levels of incorporation of foxtail millet

Level of incorporation of foxtail millet (%)	Colour	Texture	Flavour	Taste	Over all acceptability
Control(0)	7.6	8.1	7.3	7.6	7.7
10	7.8	7.8	7.5	7.4	7.3
20	7.6	7.7	7.4	7.3	7.8
30	7.5	7.7	7.4	7.3	7.5
40	7.9	7.9	7.6	7.8	7.8
50	7.9	7.9	6.0	6.1	6.9
‘F’ value	0.95 NS	0.67 NS	6.49**	9.60**	6.0**
S.E.	0.17	0.18	0.23	0.21	0.14
C.D.	0.49	0.52	0.66	0.60	0.40

NS Non significant

** Significant at 1% level

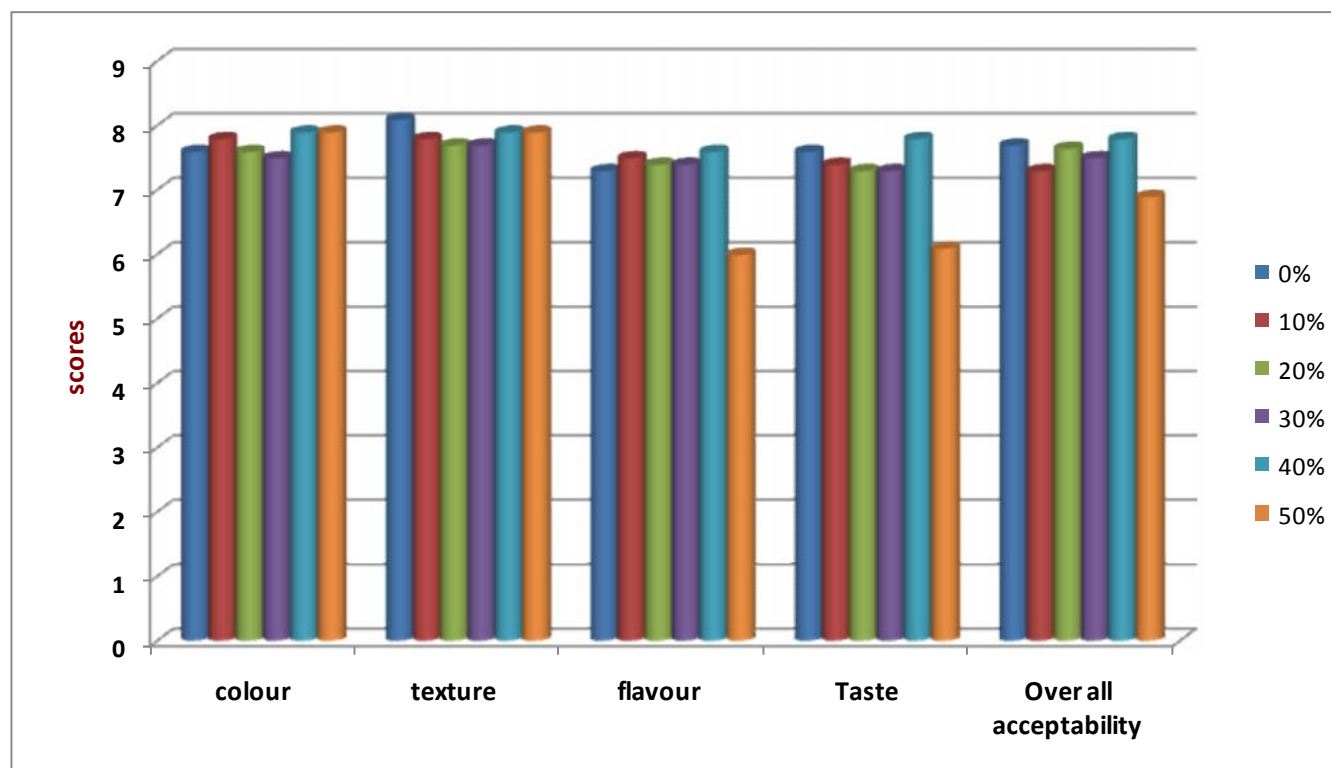


Fig 1. Mean acceptability score of organoleptic characteristics of developed foxtail millet biscuit

The scores registered for the taste were 7.6, 7.4, 7.3, 7.3, 7.8 and 6.1 for 0, 10, 20, 30, 40 and 50 per cent level of incorporation of foxtail millet respectively. The maximum score 7.8 was recorded for taste with 40 per cent level of incorporation followed by control whereas minimum score were obtained by 20 and 30 per cent level of incorporation.

Statistical analysis revealed that score obtained for the taste of all the biscuit prepared without and with foxtail millet differed significantly from 50 per cent level of incorporation of foxtail millet.

In conclusion it can be said that the 40 per cent level of incorporation was found to be highly acceptable and recorded 7.8 score in terms of taste.

With regard to overall acceptability the score of all preparations of biscuit having different level of incorporation of foxtail millet were ranging from 7.8 to 6.9. The maximum score of 7.8 for overall acceptability was registered by 20 and 40 per cent level of incorporation. While the minimum score of 6.9 was registered by the biscuit with 50 per cent level of incorporation of foxtail millet.

The score of overall acceptability of biscuit prepared without and with 10, 20, 30, 40 and 50 per cent level of incorporation differed significantly statistically from 50 per cent level of incorporation.

From the above result it can be said that all the levels of incorporation of foxtail millet in the preparation of biscuit were found to be acceptable the maximum scores for all the organoleptic characteristics were recorded for 40 per cent level of incorporation of foxtail millet in biscuit preparation.

The results of the study conducted by Yang *et al.*, (2012) revealed that the specific composition of foxtail millet gives rise to its nutritional and sensory qualities such as aroma, flavor and appearance

Sharma and Niranjan (2017) reported that foxtail millet is a good and relatively cheap source of protein for value addition into food products.

4.2 Cost analysis of foxtail millet biscuit

The economic feasibility of prepared foxtail millet biscuit estimated on basis of laboratory trials is depicted in Table 2. It was evident that cost of one kg foxtail millet biscuit was about Rs. 80.5/- and per supplementation (approximately 50 g) was about the Rs. 4.02/-. This is comparatively very less than any packaged biscuit sold in market. In addition, this will provide nutritional and therapeutic benefits to the consumer. The foxtail millet biscuit can be prepared / manufactured on home and industrial scale to meet the consumer demands, nutritional security and to save as therapeutic food for diabetic and glycolipemic subjects for their healthy life.

4.3 Nutritional composition of foxtail millet biscuit

Among the five developed foxtail millet biscuit with various level of incorporation of the 40 per cent incorporation was highly accepted in terms of organoleptic characteristics. The nutrient content of biscuit was analyzed for control and 40 per cent level of incorporation of foxtail millet and is given in Table 4 and depicted in Figure 2.

Nutrient content of control and foxtail millet biscuit. The recorded values of nutrients of biscuit prepared without and with incorporation of foxtail millet are given in Table 4 and illustrated in Figure 2.

The content of moisture was high 3.6 per cent in biscuit prepared without of foxtail millet, while it was low 2.7 in biscuit prepared with 40 per cent level of foxtail millet. The observations noticed were statistically highly significant.

Protein, fat and carbohydrate content of biscuit prepared without and with incorporation of foxtail millet registered 8.3; 18.0; 63.0 and 8.7; 17.7; 53.7 per cent respectively. The content of protein was more in the biscuit with incorporation of foxtail millet than that of control.

The observation noticed were statistically non significant. The contents of fat and carbohydrate were less in the biscuit prepared with 40 per cent level of incorporation as compare to control biscuit which were statistically non significant.

Foxtail millet biscuit containing more protein and less amounts of fat and carbohydrate, hence it is a good attribute for therapeutic purpose.

The amount of total mineral and calcium content of without and with incorporation of foxtail millet was 1.45 per cent, 57.7 per cent and 2.1 per cent, 62.3 per cent. The total mineral content and calcium content with incorporation of foxtail millet was found to be more than that of without incorporation of foxtail millet.

Statistically significant difference was noticed in content of total mineral and calcium of biscuit prepared by incorporation of foxtail millet. The estimated value for iron (2.14 mg/100g), zinc (0.48mg/100g), copper (0.242 mg/100g), manganese (0.50mg/100g) and phosphorus (63.43mg/100g) content of biscuit prepared without incorporation of foxtail millet was found to be statistically significant except phosphorus than that of foxtail millet iron

Table 4. Nutrient content of control biscuit and foxtail millet biscuit

Nutrient	Control biscuit	Foxtail millet biscuit	‘t’ value
	Mean $\pm$ SD	Mean $\pm$ SD	
Moisture (g/100g)	3.66 $\pm$ 0.02	2.77 $\pm$ 0.01	179.0**
Protein (g/100g)	8.30 $\pm$ 0.42	8.75 $\pm$ 0.26	0.91 NS
Fat (g/100g)	18.03 $\pm$ 0.75	17.71 $\pm$ 1.64	0.50 NS
Carbohydrate (g/100g)	63.16 $\pm$ 0.26	53.77 $\pm$ 1.76	6.66 NS
Total mineral (g/100g)	1.45 $\pm$ 0.00	2.10 $\pm$ 0.01	129.0**
Calcium (mg/100g)	57.75 $\pm$ 1.62	62.30 $\pm$ 1.55	91.00**
Iron (mg/100g)	2.14 $\pm$ 0.58	2.27 $\pm$ 0.22	0.540 NS
Zinc (mg/100g)	0.48 $\pm$ 0.22	1.00 $\pm$ 0.01	18.81 NS
Copper (mg/100g)	0.24 $\pm$ 0.04	0.40 $\pm$ 0.01	3.75 NS
Manganese (mg/100g)	0.50 $\pm$ 0.07	0.50 $\pm$ 0.15	1.44 NS
Phosphorus (mg/100g)	63.43 $\pm$ 0.96	532 $\pm$ 1.41	1470.78**
Total fiber (g/100g)	6.80 $\pm$ 0.24	16.80 $\pm$ 0.13	37.75*
Soluble fiber (g/100g)	1.68 $\pm$ 0.01	1.87 $\pm$ 0.03	5.57 NS
Insoluble fiber (g/100g)	4.98 $\pm$ 0.03	14.93 $\pm$ 0.09	104.68**

NS Non significant *Significant at 5% level ** Significant at 1% level

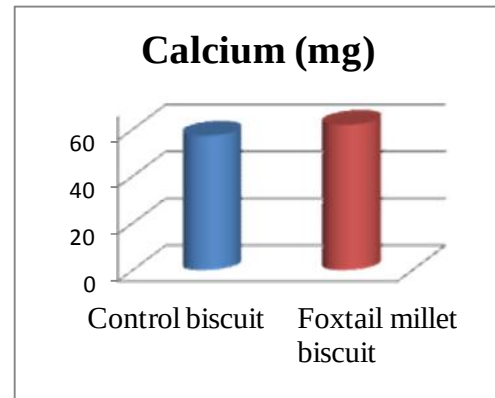
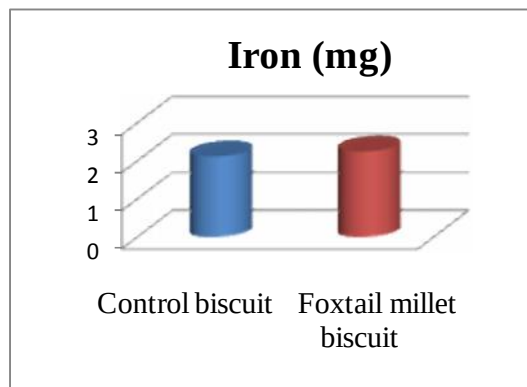
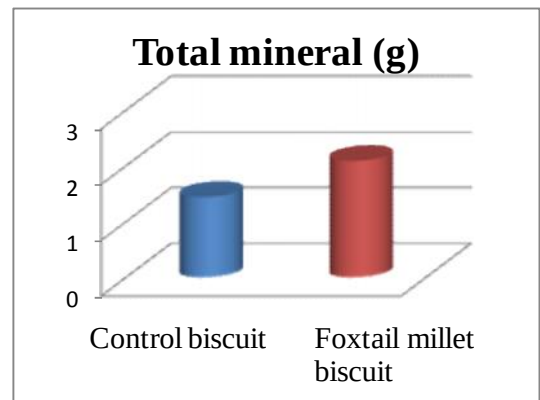
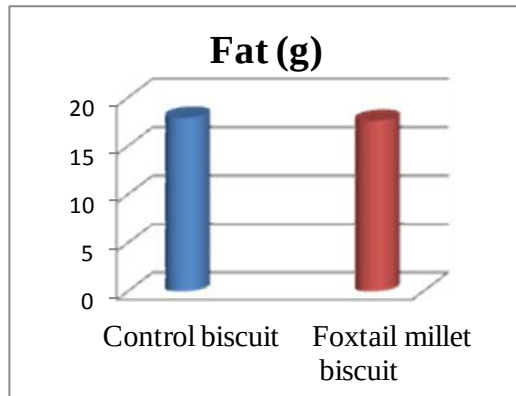
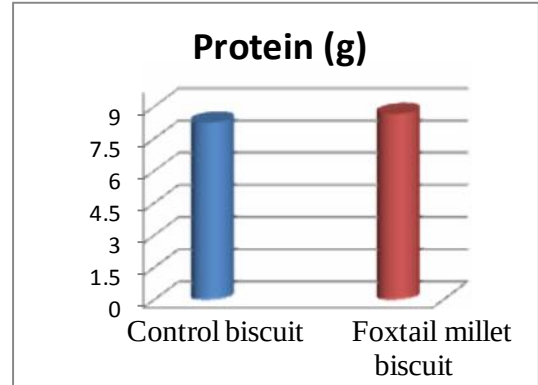
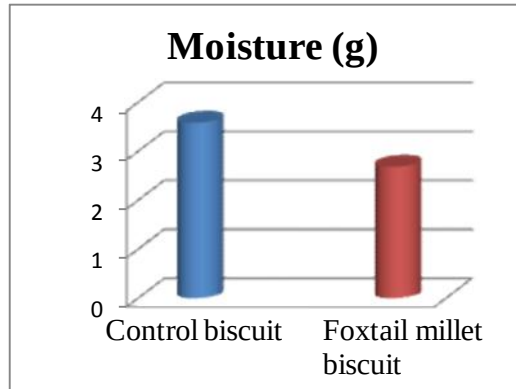


Fig 2. Nutrient content in control biscuit and foxtail millet biscuit

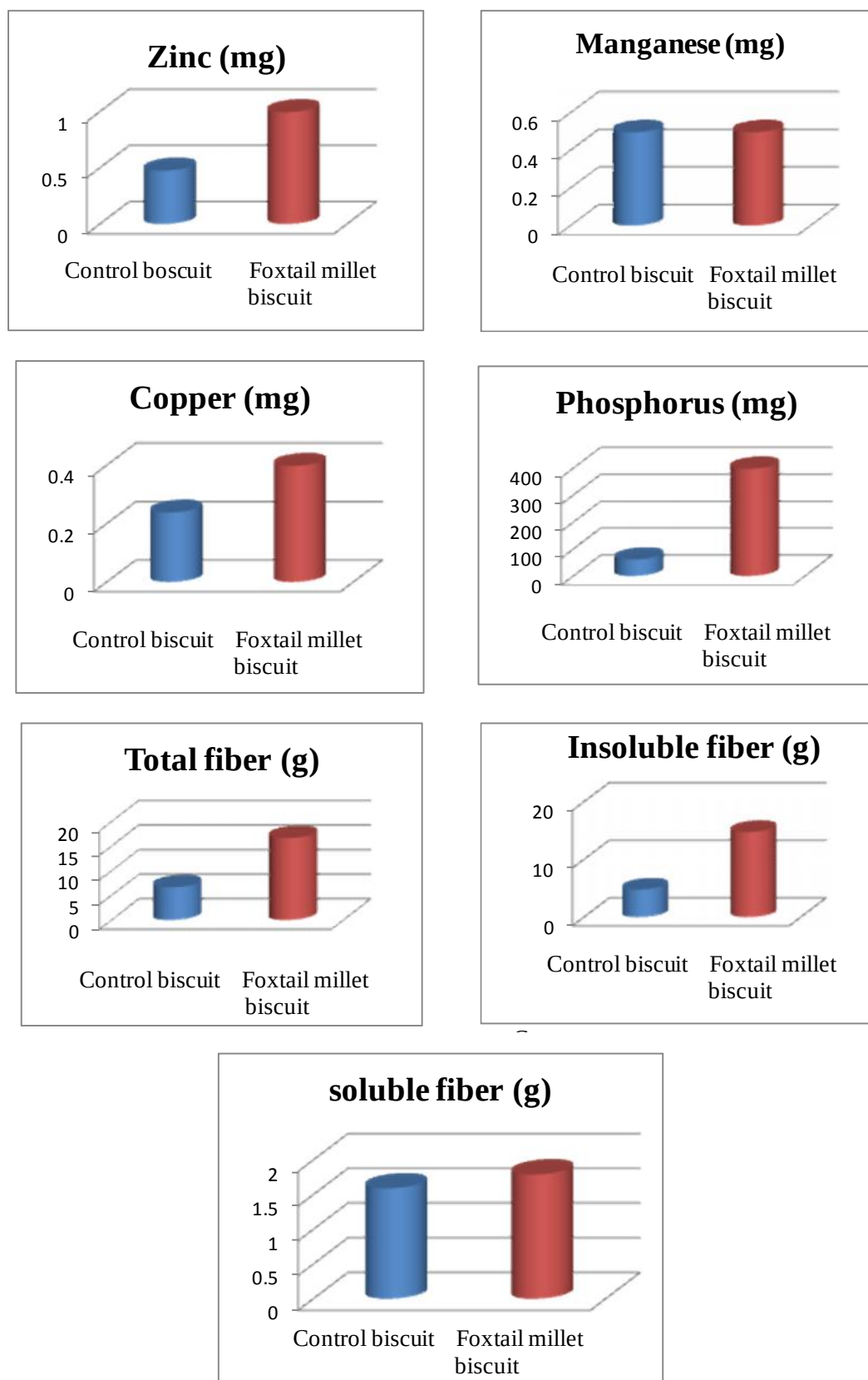


Fig 2. Nutrient content in control biscuit and foxtail millet biscuit

(2.27mg/100g),zinc(1.0mg/100g),copper(0.40mg/100g),manganese(0.5mg/10) and phosphorus (532mg/100g). It is clear from the results that the amount of phosphorus content is exorbitantly increased in the foxtail millet.

The contents of total fiber (6.8, 16.8), soluble fiber (1.68, 1.87) and insoluble fiber (4.98, 14.93) in the biscuit prepared without and with incorporation of foxtail millet was noticed respectively. The total fiber and insoluble fiber content were found to be significantly increased in the biscuit prepared with incorporation of foxtail millet. Whereas the soluble fiber content found to be statistically non significant.

In conclusion it can be said that the content of protein, total mineral, calcium, iron, zinc, copper, manganese, phosphorus, total fiber, soluble fiber and insoluble fiber were found to be more than in biscuit prepared with incorporation of foxtail millet than that of biscuit prepared without incorporation of foxtail millet.

The average protein content in foxtail millet was reported to be about 11.07 per cent (Veena *et al.*, 2005).

Foxtail millet protein is reported to have a positive effect on type 2 diabetes and cardiovascular diseases. (Choi *et al.*, 2005).

Gopalan *et al.*, (1999) reported that the value of foxtail millet for total dietary fiber was 24.71 per cent.

Zinc in protein bound form protects protein from oxidation, is involved in insulin synthesis by pancreatic β -cells and insulin binding to liver and adipose tissue (www.archangelhealth.com). Zinc combines with insulin to form zinc insulin which serves as storage form of insulin (Bhatia.2000b).

Copper is found to protect tissue from the damage caused by free radicals in diabetes. It supports the body's immune function contributing to host defense mechanism in diabetics (www.archangelhealth.com).

Manganese acts as a cofactor for certain key enzymes involved in the intermediary metabolism of carbohydrates (Bhatia, 2000a).

The phosphorus is required for storage of glycogen during the treatment of diabetic acidosis (Bhatia, 2000b).

Foxtail millet contains a pertinent amount of nutritional components, especially starch, protein, vitamins, and minerals. Due to coarse nature of foxtail millet grains, the digestible portion constitutes about 79 per cent and the remaining undigestible part of the grain contains relatively high levels of fiber as well as some anti-nutritional components. Foxtail millet is also a good source of crude fiber, helps in the digestive process and helps to induce bowel movement, thus producing a laxative effect that is beneficial for a healthy digestive system. (Bernard, 1996).

4.4 socio-economic background and health status of the selected subjects

The data of socio-economic background of twelve selected subjects are presented in Table 5.

The general information indicated that among the selected subjects 33 per cent were belonging to the age group of 40-50 yrs and the remaining 67 per cent were having >50-55 yrs of age. Among the selected subjects 67 per cent male and 33 per cent females.

It is clear from the result that 33 per cent had income 15,000-30,000 25 per cent subjects had income between >30,000-40,000 and 42 per cent were found to have monthly income of Rs. more than 40,000.

Maximum number (11) of the selected subjects were from nuclear family while only one family belongs to joint family. The selected subjects were having qualification of primary, secondary, higher secondary and college levels were 33 per cent, 17 per cent, 33 per cent and 17 per cent respectively.

Majority of the subjects (42%) were government servant followed by home maker (33%) and (25%) of subjects were having the business.

Majority of (75%) of the selected subjects were vegetarian while (25%) of the selected subjects were non-vegetarian.

Among the selected subjects maximum number of subjects (9) where having the history of disease from 2-5 yrs and minimum number of subjects (3) were having disease from more than 5 yrs. All the subjects reported that they were taking allopathic medicines regularly no one taking any other type of medicines among the selected subjects.

Table 5. Socio-economic status and health status of the selected diabetic subjects (n=12)

Attributes	Diabetic subjects (n=12)	
	Number	Percentage
Age in years		
40-50	4	33
>50-55	8	67
Sex		
Male	8	67
Female	4	33
Monthly family Income		
Rs.15,000 - 30,000	4	33
Rs.>30,000 - 40,000	3	25
Rs. >40,000	5	42
Type of the family		
Joint	1	8
Nuclear	11	92
Educational Status		
Primary	4	33
Secondary	2	17
Higher Secondary	4	33
College	2	17
Occupation		
Government Service	5	42
Business	3	25
Home maker	4	33
Food habits		
Vegetarian	9	75
Non-vegetarian	3	25
Duration of disease		
2- 5 years	9	75
>5 years	3	25
Kind of medicine		
Ayurvedic	0	
Allopathic	12	100
Daily exercise		
Yoga	5	42
Cycling		
Walking	12	100

Daily walking was the exercise performed by 100 per cent of the subjects 42 per cent of the subjects were performing yoga also along with walking.

On the whole, it can be said that they were belonging to high income, nuclear family had the history of disease less than 5 yrs performing daily exercise and were taking allopathic medicines.

4.5 Assessment of dietary and nutritional intake

4.5.1 Adequacy in the intake of different food per day by the experimental group.

Per cent adequacy in the intake of different foods per day by the experimental group is presented in Table 6.

The per cent adequacy for cereals, pulses, fruits, green leafy vegetables, milk and milk product and sugar and jaggery by the male respondent of experimental group varied from 50 to 80 per cent. The 100 per cent adequacy value in the intake of fats and oil was observed. On the other hand 20 and 25 per cent adequacy was found for other vegetables and roots and tubers.

In case of female respondent of experimental group the intake of cereal, pulses, green leafy vegetables, milk and milk product, sugar and jaggery and fat and oil was 66 to 90 per cent where as fruits, other vegetables and roots and tubers per cent adequacy were 32, 20 and 20 respectively.

On the whole, per cent adequacy in male respondents in regard to cereals, pulses, fruits, green leafy vegetables, milk and milk product, sugar and jaggery and fats and oil was more than 50 per cent.

While the per cent adequacy in female respondent for fruit, other vegetables and roots and tubers were less than 50 per cent.

4.5.2 Adequacy in the intake of different food per day by the control group.

Per cent adequacy in the intake of different foods per day by the experimental group is presented in Table 7.

The per cent adequacy for cereals, pulses, fruits and green leafy vegetables, milk and milk product and fats and oil by the male respondent of control group varied from 40 to 82 per cent. The 100 per cent adequacy value in the intake of sugar and jaggery and fats and oils were observed. Minimum adequacy 25 and 31 per cent were found for the other vegetables and roots and tubers.

In case of female respondent of control group the intake of cereal, pulses, green leafy vegetables, milk and milk product and fats and oils per cent adequacy were 86.66, 63.33, 70, 73.33 and 80 respectively. On the other hand sugar and jaggery, other vegetables and roots and tubers per cent adequacy were found to be less than 50 per cent.

On the whole, 100 per cent adequacy value in the intake of sugar and jaggery and fats and oils were observed in male respondents while, the per cent adequacy in female respondents in regard to other vegetables was less than 25 per cent.

Table 6. Adequacy in the intake of different food per day by the experimental group (n=6)

Food stuffs (g)	Mean intake (Male) (n=3)	Required intake	% Adequacy	Mean intake (Female) (n=3)	Required intake	% Adequacy
Cereal	275	375	73.33	243	270	90
Pulses	52	75	69.33	40	60	66.66
Fruits	50	100	50	32	100	32
GLV	80	100	80	80	100	80
Other vegetables	40	200	20	40	200	20
Roots and tubers	50	200	25	40	200	20
Milk and milk product	200	300	66.66	200	300	66.66
Sugar and jaggery	15	20	75	15	20	75
Fats and oils	25	25	100	20	25	80

(ICMR 2010)

Table 7. Adequacy in the intake of different food per day by the control group (n=6)

Food stuffs (g)	Mean intake (male) (n=5)	Required intake	% Adequacy	Mean intake (female) (n=1)	Required intake	% Adequacy
Cereal	268	375	71.46	234	270	86.66
Pulses	45	75	60	38	60	63.33
Fruits	40	100	40	35	100	35
GLV	82	100	82	70	100	70
Other vegetables	50	200	25	45	200	22.5
Roots and tubers	62	200	31	50	200	25
Milk and milk product	240	300	80	220	300	73.33
Sugar and jaggery	20	20	100	10	20	50
Fats and oils	25	25	100	20	25	80

(ICMR 2010)

4.5.3 Adequacy in the intake of different nutrients per day by the experimental group (n=6)

Per cent of adequacy in the intake of different nutrients per day by the experimental group is presented in Table 8.

The per cent adequacy of fats (g), calcium (mg) and iron (mg) supplied from the diet consumed by the male respondent was 132, 155.5 and 158.8. The responding values for the corresponding nutrients were 168, 137.7 and 118.4 by female respondent. Per cent adequacy recorded was more than RDA in both the respondent. On the other hand the per cent adequacy in supply of energy, protein was ranging from 65-80 per cent in male and female. In case of carbohydrate per cent adequacy was noticed to be 47.89 and 48.52 for male and female respondent respectively. Whereas the diet was deficient in supply of fiber as the per cent adequacy found to be less than 30 per cent by both the respondent.

In conclusion consumption of fat, calcium and iron were found to be more than RDA. Energy, protein and carbohydrate were found to be less besides the diet was grossly deficient in fiber content.

Table 8. Adequacy in the intake of different nutrients per day by the experimental group (n=6)

Nutrients	Mean Intake (male)	RDA	% Adequacy	Mean Intake (male)	RDA	% Adequacy
Energy (Kcal)	1535.13	2320	66.16	1378	1900	72.52
Protein (g)	43.03	60	71.18	44.04	55	80.4
Fat (g)	33.11	25	132	33.76	25	135
CHO (g)	182	380	47.89	184.4	380	48.52
Fiber (g)	6.5	25	24.8	7.08	25	28.8
Calcium (mg)	647	600	115.5	827	600	137.7
Iron (mg)	27	17	158.82	24.92	21	118.4

(ICMR 2010)

Table 9. Adequacy in the intake of different nutrients per day by the control group (n=6)

Nutrients	Mean Intake (male)	RDA	% Adequacy	Mean Intake (male)	RDA	% Adequacy
Energy (Kcal)	1410.12	2320	60.78	1258.93	1900	69.88
Protein (g)	41.66	60	68.3	42.01	55	70
Fat (g)	31.6	25	126.4	26.9	25	10
CHO (g)	175	380	46	152	380	40
Fiber (g)	5.7	25	22.8	3.8	25	15.2
Calcium (mg)	664	600	110.6	552	600	92
Iron (mg)	19.8	17	116.4	14.3	21	84.11

(ICMR 2010)

4.5.4 Adequacy in the intake of different nutrients per day by the control group (n=6)

Per cent of adequacy in the intake of different nutrients per day by the control group is presented in Table 9.

It is evident from the result that maximum adequacy value was noticed in (male) for consumption of fat 126.4 per cent, calcium 110.6 per cent and iron 116.4 per cent where as fiber recorded minimum adequacy 22.8 per cent. The maximum adequacy value was noticed in (female) consumption of fat 104 per cent where as fiber 15.2 per cent.

Even in the intake of energy and protein in male and female the per cent of adequacy were found to be in range 60-70 per cent. The adequacy value of intake carbohydrate in male 46 per cent. In female the adequacy value of calcium and carbohydrate was 92 and 40 per cent respectively.

From the result it can be said that the intake of energy, protein, carbohydrate and fibers was less than RDA in control group.

4.6 Glycemic Index of Foxtail Millet Biscuit

Glycemic index (GI) is important parameter that measure how a food rises blood glucose. Food are ranked depending on their ability to rise the blood glucose in comparison with reference food mostly glucose. A food with high GI raise blood glucose more than a food with medium or low GI. Foods with low GI are recommended to diabetes and to keep normal spectrum of lipoprotein (Subhashini and Ushadevi 2011). GI of foxtail millet biscuit were estimated to check its suitability to feed the diabetic subjects. The glycemic response of the subjects after ingestion of glucose and foxtail millet biscuit was measured and the data is presented in Table 10 and Figure 3.

Table 10. Glycemic response and glycemic index of foxtail millet biscuit

Sr. no.	Time (min)	Blood glucose level (mg/dl) (mean $\pm$ SD)		't' value	GI of foxtail millet biscuit
		After ingestion of glucose	After ingestion of test food		
1	0	93.70 $\pm$ 3.020	92.40 $\pm$ 4.11	0.779	44.66 $\pm$ 3.27
2	30	127.40 $\pm$ 18.35	107.50 $\pm$ 4.11	3.824**	
3	60	112.60 $\pm$ 17.45	100.40 $\pm$ 8.73	3.15*	
4	90	103.70 $\pm$ 10.10	94.60 $\pm$ 4.85	3.842**	
5	120	91.60 $\pm$ 9.53	87.30 $\pm$ 6.97	2.199	

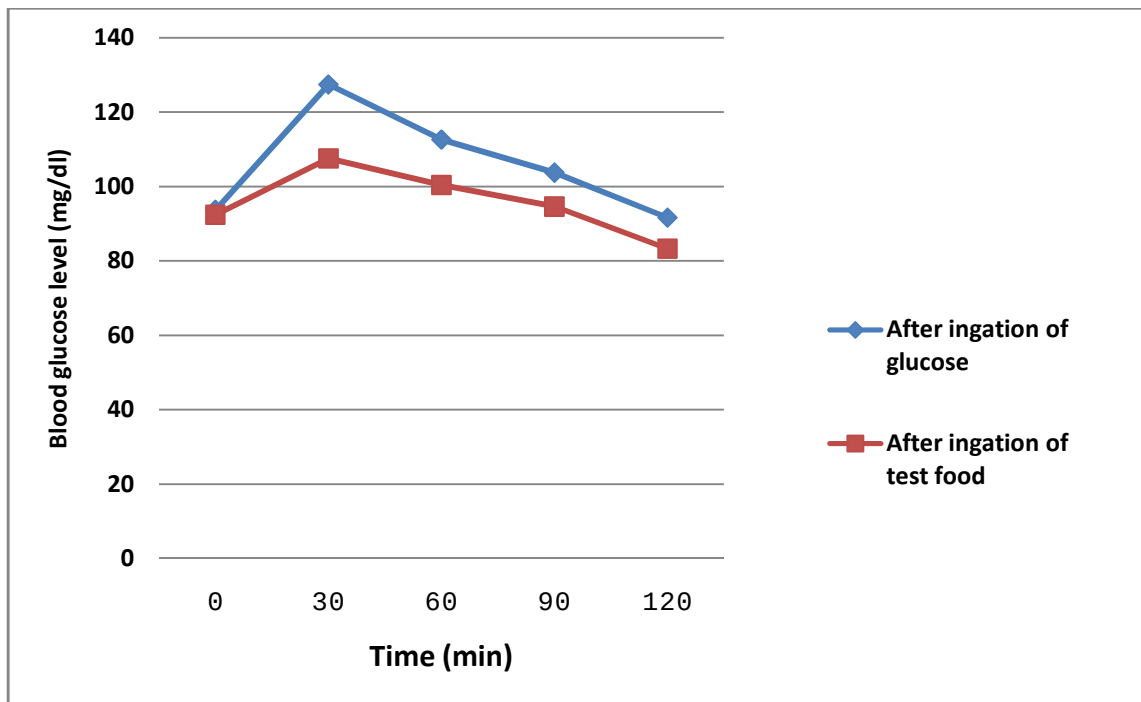


Fig. 3 Blood glucose levels at fasting and after feeding glucose and foxtail millet biscuit

The mean fasting blood glucose of the subjects was 93.70 mg/dl it was raised gradually after ingestion of 25 g glucose up to 127.40 mg/dl in 30 min and reached to peak after 60 min to 112.60 mg/dl. Therefore the blood glucose was reduced to 103.70 mg/dl with in 90 min and slided down almost to base level with in two hour (91.60 mg/dl). The similar trend to blood glucose was noticed in the subjects after consumption of foxtail millet biscuit. The initial value of blood glucose was 92.40 mg/dl. It increased and reached to peak (107.50 mg/dl) with in half and hours. After that it stated declining and reduced 100.40, 94.60 mg/dl and 87.30 mg/dl at the assessment intervals of 60, 90 and 120 min respectively. The statistical comparison of data indicated that at the blood glucose assessment interval of 30, 60 and 90 min the difference in the blood glucose level was significant between the glucose and test foods. The increase in the glucose content of blood was significantly less after consumption of developed foxtail millet biscuit the ingestion of glucose.

The glycemic index value calculated by determining the ratio of area under the glucose response curve for the foxtail millet biscuit and the area for the glucose was 44.66 which is categorized as low according to classification of glycemic index. Hence it can be concluded that the foxtail millet biscuit in the present study without any hypoglycemic agents exhibited a significantly low GI of 44.66. This is very important for development of designer food for diabetic.

The data with regard to glycemic response of the selected subjects towards the glucose and developed foxtail millet biscuit evident that the mean blood glucose level significantly increased within 30 min when 25 g of glucose was given to them. It is well known fact that glucose is monosaccharide and readily absorbed in blood stream from GI tract. This is the reason why glucose is used reference food for conducting glycemic index studies (Wolver *et al.*,1991).

The data emerged from blood glucose level of the subjects after consumption of foxtail millet biscuit showed that there was a significant

increase in the blood glucose value at 30 min over the initial one. Which was also noticed as a peak value.

The insoluble dietary fibers from foxtail millet could also inhibit α -amylase activity and delay the digestibility of carbohydrates and deter the release of glucose. This is known to improve the insulin sensitivity and lower the risk of diabetes mellitus (Ju-Sung *et al.*, 2011). Hence it can be concluded that though equicarbohydrate portion of foxtail millet biscuit was fed to the subjects, the rise in the blood glucose was significantly less which proves that the developed snacks being low in GI is suitable for diabetic subject.

4.7 Anthropometric assessments

The measurements of anthropometric indices are useful to assess the health status of the subjects. This is also useful to compare them with their other counter parts and with previous health status.

4.7.1 Anthropometric measurements of experimental group before and after supplementation

The mean value of anthropometric assessments of experimental group (0 days) and after (30 and 60 days) supplementation are presented in Table 11.

The mean value of body weight of experimental group before supplementation was 63.71 ± 3.68 kg and it was ranged from 60 to 68kg. Whereas after supplementation at 30 and 60 days it was 63.23 ± 3.71 and 62.46 ± 4.01 respectively.

It was found that after 60 days of supplementation the weight of experimental group reduced by 1.22 kg. However the reduction of weight was found to be statistically significant ($P > 0.01$).

The height of the experimental group was ranged from 150-170 cm with an average value of 161.3 ± 63.71 cm.

The body mass index (BMI) of experimental group was 24.6 ± 2.84 , 24.40 ± 2.84 and 24.14 ± 2.87 at 0, 30 and 60 days of supplementation respectively. Results indicated that BMI of experimental group decreased with the increases in period of supplementation and it was statistically significant.

In conclusion it can be said that statistically significant ($P > 0.01$) decrease in the body weight and BMI of experimental group.

Digestion and subsequent absorption of any functional component by the human body plays an important role in the health-benefitting properties of that component. Even though heat processing improves the starch digestibility, a fraction is believed to be rendered resistant to mammalian digestive enzymes. This starch fraction, known as resistant starch, exerts a significant positive effect on human health, particularly in glucose metabolism, management of chronic diet related diseases, mental performance and weight control.(Bangoura *et al.* , 2012).

Table 11. Anthropometric measurements of experimental group before and after supplementation (n=6)

Parameters	Initial		30 days		60 days	
	Range	Mean $\pm$ SE	Range	Mean $\pm$ SE	Range	Mean $\pm$ SE
Weight (Kg)	60-68	63.71 $\pm$ 3.68	59.8-67.8	63.23 $\pm$ 3.71	58-67.4	62.46 $\pm$ 4.01
Height (cm)	150-170	161.3 $\pm$ 63.71	150-170	161.3 $\pm$ 6.80	150-170	161.3 $\pm$ 6.80
BMI	20.7-28.3	24.6 $\pm$ 2.84	20.6-28.1	24.40 $\pm$ 2.84	20-27.7	24.14 $\pm$ 2.87

‘t’ value of anthropometric measurements (student ‘t’ test)

Days	Weight	Height	BMI
0 Vs 30	2.35 NS	0.00	3.53*
30 Vs 60	3.50*	0.00	3.40*
0 Vs 60	5.83 **	0.00	5.94**

*Significant at 5% level

** significant at 1% level

NS non significant

4.7.2 Anthropometric measurements of experimental and control group before and after supplementation

The changes in the mean values of anthropometric measurements of experimental and control group before and after supplementation of foxtail millet biscuit are presented in Table 12.

The mean decreased in body weight due to supplementation in case of experimental group was 1.25 ± 0.39 and 0.3 ± 0.02 kg in control group. However the comparison of the mean decreased in body weight of experimental showed significant and control group showed non significant difference whereas, the difference between the initial and final value were found to be statistically non significant in both the group.

The average height of experimental and control group was 161.3 ± 6.80 cm and 158.4 ± 6.40 cm respectively. The difference in height was not seen throughout the study period.

The mean decreased in the body mass index of experimental group was found to be 0.45 ± 0.00 which was statistically significant, while in case of control group there was reduction to the tune of 0.22 ± 0.36 which was statistically non significant.

On the whole the result indicated that supplementation of foxtail millet biscuit for 60 days showed significant impact body weight and body mass index.

Table 12. Anthropometrics measurements of experimental and control group before and after supplementation (n=12).

Parameters	Mean $\pm$ SE		Difference	't' value	
	Initial (0 days)	Final (60 days)		I Vs F (0 Vs 60 days)	E Vs C 60 days)
Weight (kg)					
Experimental	63.71 $\pm$ 3.62	62.46 $\pm$ 4.01	1.25 $\pm$ 0.39	5.83*	0.57NS
Control	54.6 $\pm$ 4.50	54.9 $\pm$ 4.52	0.3 $\pm$ 0.02	0.47 NS	
Height(cm)					
Experimental	161.3 $\pm$ 6.80	161.3 $\pm$ 6.80	0.00	0.00	3.51 NS
Control	158.4 $\pm$ 6.40	158 $\pm$ 6.41	0.00	0.00	
BMI					
Experimental	24.61 $\pm$ 2.84	24.14 $\pm$ 2.82	0.45 $\pm$ 0.00	5.94*	1.29 NS
Control	21.76 $\pm$ 2.01	21.96 $\pm$ 2.37	0.22 $\pm$ 0.36	0.92 NS	

I-Initial

F-Final

E-Experimental

C-Control

*Significant at 5% level

**Significant at 1% level

NS Non Significant

4.8 Blood glucose of selected subjects

Hyperglycemia is the scientific term used for high blood glucose which is caused when the body has too little insulin or when the body cannot use insulin properly.

In recent year there is a tremendous interest in the possible role of nutrient in prevention of diseases. Therefore an effort to manage hyperglycemia without side effect was tried by supplementing the foxtail millet biscuit.

4.8.1 Blood glucose of experimental group before and after supplementation

The mean value of blood glucose and HbA1c of experimental group before (0days) and after (60 days) supplementation is presented in Table 13 and illustrated in Figure 4.

The subjects were found to have the initial value of blood glucose and HbA1c in the range of 153 to 240 mg/dl and 7.2 to 9.4 per cent respectively.

Initially the mean recorded value for blood glucose was 191 ± 28.39 mg/dl and HbA1c was 8.31 ± 0.73 per cent. After 60 days of supplementation of foxtail millet biscuit the value blood glucose was found to be decreased 174 ± 36.75 mg/dl and HbA1c was found to be decreased 7.6 ± 0.88 per cent. The difference between initial and final values of blood glucose was statistically significant at one per cent level ($P < 0.01$) while in HbA1c initial and final values was slightly decreased but it was statistically non significant.

It is evident from the result that increases in the period of study decrease progressively the blood glucose and HbA1c. The result of statistical analysis showed significant decreases in blood glucose at 60 days of supplementation.

The result of present study demonstrated the utility of foxtail millet biscuit in controlling the hyperglycemia.

Table 13. Blood glucose of experimental group before and after supplementation (n=6)

Blood glucose	Initial (0 days)		Final (60 days)	
	Range	Mean $\pm$ SE	Range	Mean $\pm$ SE
Blood glucose (mg/dl)	153-240	191 $\pm$ 28.39	235-130	174 $\pm$ 36.75
HbA1c (%)	7.2-9.4	8.31 $\pm$ 0.73	7-8.7	7.6 $\pm$ 0.88

‘t’ value of blood glucose (student ‘t’ test)

Days	blood glucose	HbA1c
0 Vs 60	3.559*	2.397 NS

*Significant at 5% level

**Significant at 1% level

NS Non Significant

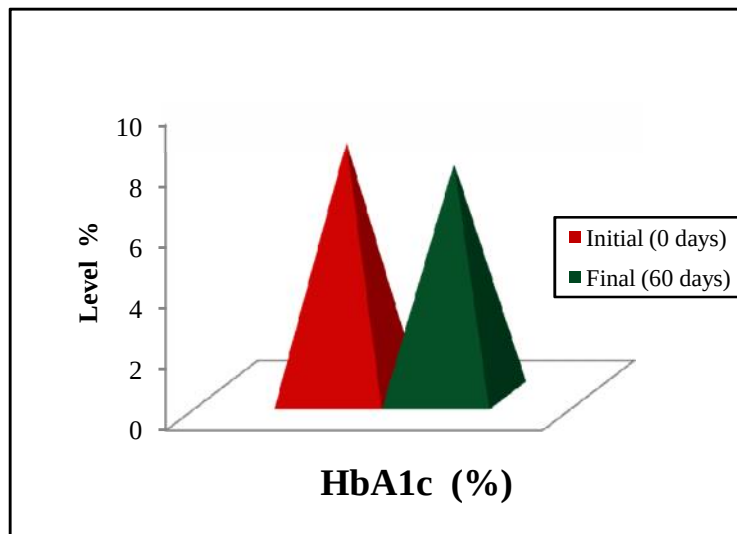
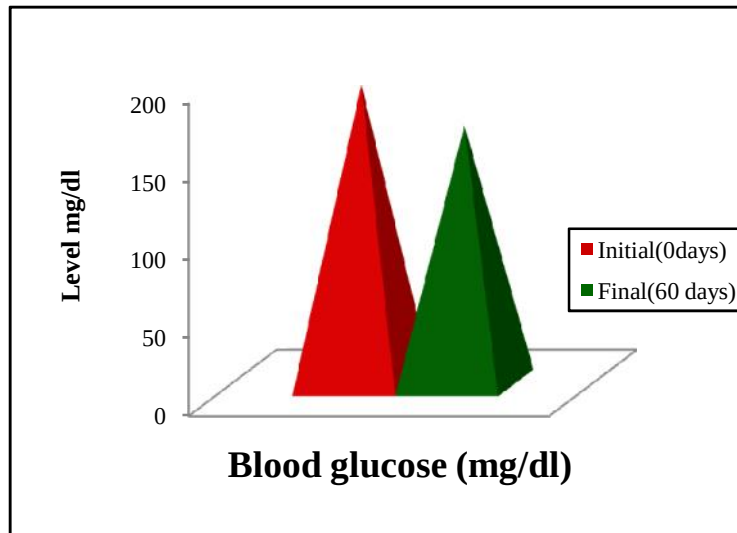


Fig 4. Blood glucose of experimental group before and after supplementation

4.8.1 Blood glucose of experimental and control group before and after supplementation

The change in mean value of blood glucose and HbA1c of experimental and control group before and after supplementation of foxtail millet biscuit are presented in Table 14 and illustrated in Figure 5.

The results for supplementation of foxtail millet biscuit showed that there was decrease in blood glucose by 17.7 ± 1.69 mg/dl in experimental group whereas the increase of $(4.7 \pm 20.18\%)$ was noticed in control group at 60 days. The mean value decreased in blood glucose was found to be statistically significant at 5 per cent level in experimental group while in control group the difference was non significant.

It was found that supplementation of foxtail millet biscuit for 60 days exhibited slightly decrease in HbA1c 0.63 ± 0.15 per cent in experimental group but it was statistically non significant. In control group difference was not found between the initial and final values of HbA1c.

It is evident from the results that supplementation of foxtail millet biscuit beneficial to reduce blood glucose. It has been observed that low glycemic index of foxtail millet biscuit responsible for reducing blood glucose.

Hence supplementation of foxtail millet biscuit can occupy a firm and definite role in therapeutic aspects of hyperglycemic subjects.

The study conducted by veena *et.al* (2005) indicated that the high dietary fiber and low carbohydrate content (53-66%) of low digestibility (20-28%, over 2 h assay), may support the reduction in glucose levels.

The results are on confirmly with studies of Jali *et al.*, 2012. Daily consumption of 80 g of foxtail millet diabetic diet by diabetic volunteers lowered the HbA1c (19.14%), fasting glucose (13.5 %), and homocysteine (0.85%)

concentrations and increased the insulin (1-9%) in their blood. Reduction was also noticed in the plasma lipid parameters viz, total cholesterol concentrations by 13.25 per cent, triglyceride concentrations by 13.51 per cent, and very-low density lipoprotein cholesterol concentrations by 4.5 per cent in the patients with type 2 diabetes. Whereas increase was noticed in the concentration of high density lipoprotein cholesterol by 17.39 per cent.

Table 14. Blood glucose of experimental and control group before and after supplementation (n=6)

Parameters	Mean $\pm$ SE		Difference	't' value	
	Initial (0 days)	Final (60 days)		I Vs F (0 Vs 60 days)	E Vs C 60 days)
Blood glucose					
Experimental	191.8 $\pm$ 28.36	174.1 $\pm$ 36.7	17.7 $\pm$ 1.69	3.55*	0.142 NS
Control	165.8 $\pm$ 22.87	170.5 $\pm$ 43.05	4.7 $\pm$ 20.18	0.46 NS	
HbA1c					
Experimental	8.31 $\pm$ 0.73	7.68 $\pm$ 0.88	0.63 $\pm$ 0.15	2.39 NS	0.475 NS
Control	7.36 $\pm$ 0.78	7.36 $\pm$ 1.06	0.00 $\pm$ 0.28	0.07 NS	

I-Initial

F-Final

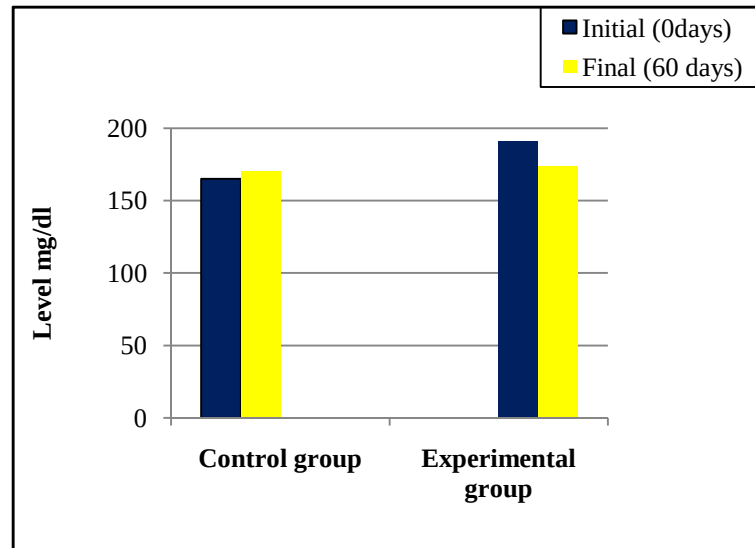
E-Experimental

C-Control

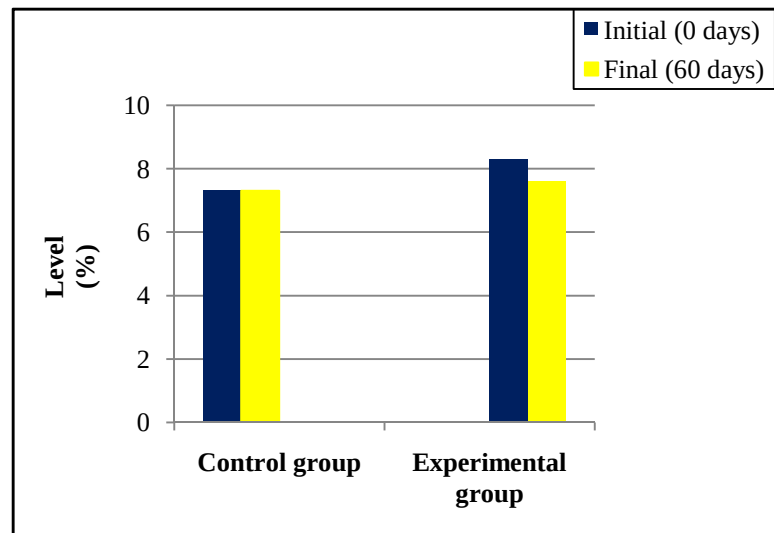
*Significant at 5% level

**Significant at 1% level

NS Non Significant



Blood Glucose



HbA1c

Fig 5. Blood glucose of control and experimental group before and after supplementation

4.9 Lipid profile of selected subjects

Diabetes is characterized by chronic hyperglycemia and disturbances of carbohydrate, lipid and protein metabolism. Foxtail millet is mainly attributed to the antioxidants, vitamins, minerals, phytochemicals, and other bioactive compounds. Therefore an efforts was made to prepare foxtail millet biscuit utilizing foxtail millet flour which has low glycemic index and beneficial for diabetes.

4.9.1 Lipid profile of experimental group before and after supplementation

The mean value of lipid profile in the serum of experimental group 0 days and after 60 days supplementation are presented in Table15 and illustrated in Figure 6.

The initial mean value of triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol and VLDL cholesterol prior to the supplementation of foxtail millet biscuit were 320 ± 105.49 , 234.5 ± 33.23 , 129.9 ± 9.6 , 47.0 ± 6.38 and 58.6 ± 23.65 mg/ dl of serum respectively.

The value obtained after the supplementation of foxtail millet biscuit at the end of 60 days of the study period for the triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol and VLDL cholesterol parameters were 253.5 ± 60.88 , 210.8 ± 29.90 , 119.91 ± 11.62 , 48.66 ± 8.84 and 51.75 ± 23.20 mg/dl of serum respectively.

In case of triglycerides in serum at 60 days of supplementation of foxtail millet biscuit, the value was found to be decreased from initial value. When 't' test was applied the difference between two values was noticed to be significant at 5 per cent level ($P > 0.05$).

Result indicated that there was a reduction in the contents of total cholesterol and LDL cholesterol in the serum after supplementation of foxtail

millet biscuit for a period of 60 days. The difference between initial and final values noticed to be statistically non significant.

On the other hand there was an increase in the levels of HDL cholesterol after supplementation of foxtail millet biscuit. Initially the value was found to be 47.0 ± 6.38 mg/dl of serum and at the end of 60 days it was 48.66 ± 8.84 mg/dl. The difference between initial and final values found to be statistically non significant. The enhancement of HDL cholesterol was observed which is considering being good cholesterol and it is beneficial for health.

The mean value of VLDL cholesterol at initial was 58.6 ± 23.65 mg/dl and at the end of 60 days it was 51.75 ± 23.20 mg/dl. It is evident from the results that there was a marked reduction in the VLDL cholesterol, while the result showed that the difference between initial and final values were statistically non significant.

In nutshell the result of serum lipid profile of experimental group revealed that supplementation of foxtail millet biscuit for 60 days showed the decrease in the value triglycerides which was statistically significant. On the other hand there was reduction in the value of total cholesterol, LDL cholesterol and VLDL cholesterol which was not statistically significant. The HDL value was increased slightly but it was non significant.

Hence the intake of foxtail millet biscuit recommended for consumption among hyperlipidemic subjects as there was reduction in the triglycerides and increase in the HDL cholesterol was noticed.

Sireesha *et al.*, (2011) epidemiological studies have shown that an expanded consumption of foxtail millet in normal daily diets lowers the risk of developing chronic diseases, like cholesterol metabolism and type 2 diabetes mellitus.

The results of Thathola *et al.*,(2010) are in line they have concluded that the supplementation of low GI foxtail millet based biscuit and *burfi* lead to a significant decrease in serum glucose (23.18 mg/dl), total cholesterol (15.55 mg/dl), LDL cholesterol (6.3mg/dl), TG (16.35mg/dl) and VLDL (3.27mg.dl) and GHb (0.97%) in type 2 diabetics. Thus, it can be concluded that millets do have a potential for a protective role in the management of diabetes.

Table 15. Lipid profile of experimental group before and after supplementation (n=6)

Lipid profile	Initial (0 days)		Final (60 days)	
	Range	Mean $\pm$ SE	Range	Mean $\pm$ SE
Triglycerides (mg/dl)	256- 452	320 $\pm$ 105.49	152-318	253.5 $\pm$ 60.88
Total cholesterol (mg/dl)	187-260	234.5 $\pm$ 33.23	187-250	210.8 $\pm$ 29.90
LDL cholesterol (mg/dl)	117- 138.8	129.9 $\pm$ 9.6	105-135.7	119.91 $\pm$ 11.62
HDL cholesterol (mg/dl)	36-54	47.0 $\pm$ 6.38	39-60	48.66 $\pm$ 8.84
VLDL cholesterol (mg/dl)	33.6-88.3	58.6 $\pm$ 23.65	33.8-87.3	51.75 $\pm$ 23.20

‘t’ value of lipid profile measurements (student ‘t’ test)

Days	Triglycerides	Total cholesterol	LDL cholesterol	HDL cholesterol	VLDL cholesterol
0 Vs 60	2.645*	1.658 NS	2.152 NS	0.396 NS	1.736 NS

*Significant at 5% level

**Significant at 1% level

NS Non Significant

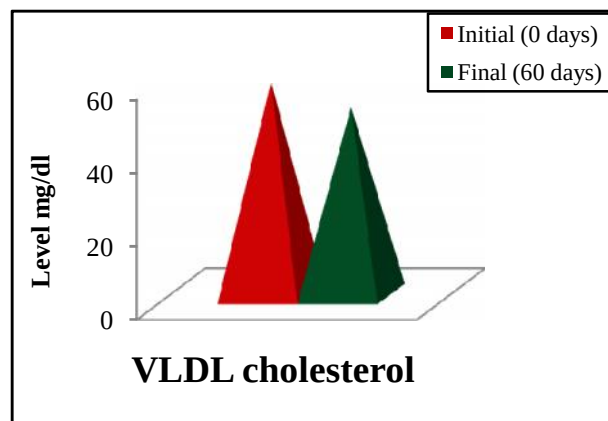
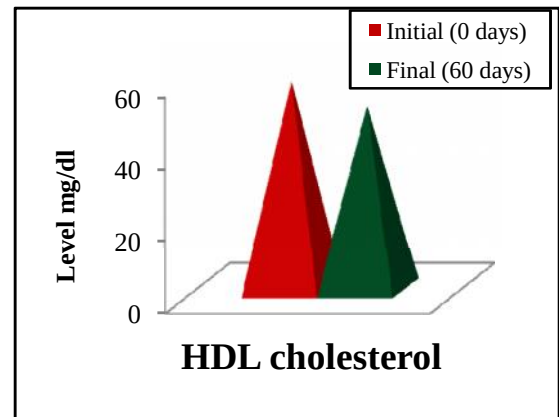
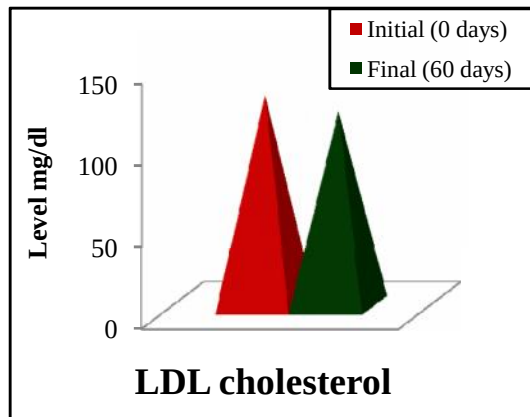
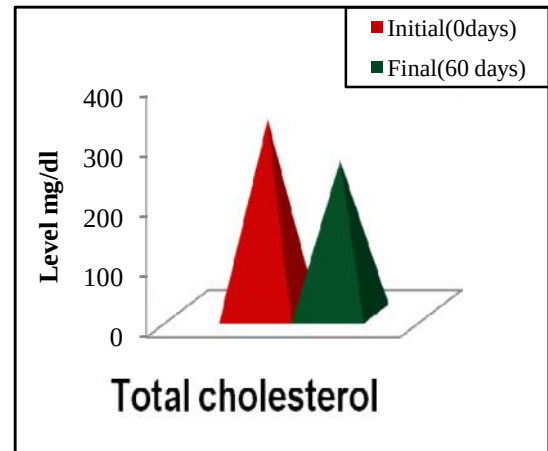
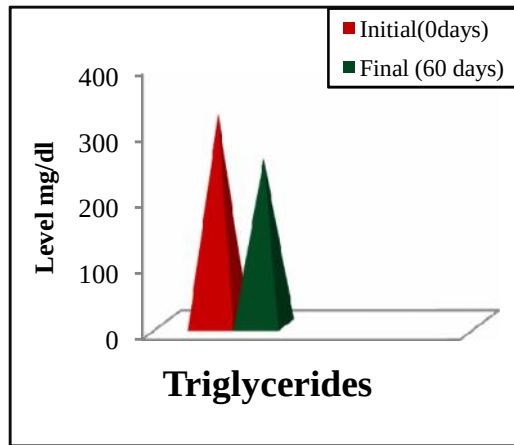


Fig 6. Lipid profile of experimental group before and after supplementation

4.9.2 Lipid profile of experimental and control group before and after supplementation

The changes in the mean values of lipid profile of experimental and control group before and after supplementation of foxtail millet biscuit are presented in Table 16 and illustrated in Figure 7.

It was found that the supplementation of foxtail millet biscuit for 60 days exhibited the decrease in triglyceride value over the initial value which was statistically significant at ($P > 0.05$). In case of control group slightly decrease in triglycerides was recorded. Decrease in the triglyceride value in control group may be attributed to number of factors like health condition, intake of regular medicine and dietary intake etc.

The mean decrease in total cholesterol of experimental and control group was 23.7 ± 3.33 and 7.23 ± 30.07 mg/dl respectively. The decrease in total cholesterol was statistically non significant in both the groups.

In case of LDL cholesterol it was observed that supplementation of foxtail millet biscuit to the experimental and control group for 60 days decline the difference to the tune of 10 ± 2 and 6.1 ± 0.08 mg/dl over initial value and the difference was statistically non significant.

On the other hand there was increase in the level of HDL cholesterol due to supplementation of foxtail millet biscuit in the experimental group, the level of HDL cholesterol was increased by 1.6 ± 2.42 . The mean value of HDL was decreased in control group by 2.6 ± 4.47 mg/dl. The difference in the initial and final value was found non significant in both the groups.

Frost *et al.* (1999) reported that low GI of food is inversely related to HDL concentration and positively related to plasma TG. The low GI diet increases HDL concentration by improving insulin sensitivity which is accompanied by a fall in TG level.

The mean value of VLDL in experimental group decreased (6.9 ± 0.4 mg/dl) whereas in control group the value was increased (4.36 ± 1.79 mg/dl) which were statistically non significant.

The biochemical parameters of experimental and control group were compared and the result was found statistically non significant.

From the present study it can be concluded that the incorporation of 40 per cent foxtail millet flour was acceptable in the preparation of biscuit. Thus, besides its traditional use in making *chapatti* and porridge, millet can be exploited for the development of low GI therapeutic food products like biscuit.

The foxtail millet biscuit in the present study without any hypoglycemic agents exhibited a significantly low GI of 44.66. This is very important for development of designer food for diabetic. The difference between initial and final values of blood glucose was statistically significant at one per cent level ($P > 0.01$) while in HbA1c initial and final values was slightly decreased but it was statistically non significant. It is evident from the results that supplementation of foxtail millet biscuit beneficial to reduce blood glucose. It has been observed that low glycemic index of foxtail millet biscuit responsible for reducing blood glucose. It is suggested that a diet with low glycemic index improves postprandial blood glucose levels, the blood lipid profile have a therapeutic role in the treatment of diseases related with insulin resistance. It was concluded that GI concept is useful for identifying foods in the habitual Indian diet with attributes of the desired glycemic effect such as delayed peak rise and low.

The foxtail millet has the potential benefits in the diet therapy for patient with diabetes. The total cholesterol, LDL cholesterol and VLDL cholesterol. On statistical analysis the result were noticed non significant. On the other hand the experimental group consuming foxtail millet biscuit for 60 days showed significant decrease in triglycerides which was statistically significant.

Besides there was increase in the HDL cholesterol which was non significant. The changes in biochemical constituents after supplementation of low GI foxtail millet biscuit may be due to high fiber content. A high intake of millet based dietary fiber, improves glycemic control, decreases hyperinsulinemia, and lowers plasma lipid concentrations in patients with type 2 diabetes.

Bangoura *et al.*, (2013) also showed that foxtail millet derived insoluble dietary fibers could delay the diffusion of glucose and promote its absorption in the gastrointestinal tract. Dietary fibers are responsible for many favorable physiological effects like laxation, blood cholesterol attenuation, and blood glucose reduction. Dietary fibers in foxtail millet have been found to have similar physicochemical properties to soy insoluble fibers, which help in aiding gastrointestinal functions and decreasing the postprandial hike in serum glucose concentrations with modest effect on the serum cholesterol concentrations.

The health benefits of foxtail millet are mainly attributed to the antioxidants, range of vitamins, minerals, phytochemicals, and other bioactive compounds, which also makes it a promising functional food (Zhang and Liu 2015).The results of the nutritional intake also relevant that the diet was grossly deficient in supply of fiber. Whereas consumption of fat and calcium was found to be more than RDA. This may be reason why the selected subjects were having high blood glucose and lipid profile values. At present GI can be considered as an effective clinical tool for formulating the diabetic diet. The foxtail millet as a low GI food products leads to modest improvement in long term glycemic and lipidemic control in type 2 diabetics.

In conclusion, study indicated the potential benefits of foxtail millet in the diet therapy for patients with diabetes. However, there is a scope to explore the potential benefits of millets in the management of metabolic disorders through

long-term feeding interventions. If used on a long-term basis, it could be beneficial in controlling lipid profile as well as the HbA1c levels in such patients.

Table 17. Lipid profile of experimental and control group before and after supplementation (n=12)

Parameters	Mean $\pm$ SE		Difference	't' value	
	Initial (0 days)	Final (60 days)		I Vs F (0 Vs 60 days)	E Vs C (60 days)
Triglycerides (mg/dl)					
Experimental	320 $\pm$ 105.49	253.1 $\pm$ 60.8	67 $\pm$ 44.69	2.64*	0.614 NS
Control	233.8 $\pm$ 76.8	223.6 $\pm$ 70.0	10.2 $\pm$ 6.8	0.66 NS	
Total cholesterol (mg/dl)					
Experimental	234.5 $\pm$ 33.23	210.83 $\pm$ 29.9	23.7 $\pm$ 3.33	0.25 NS	0.839 NS
Control	207.83 $\pm$ 35.19	200.6 $\pm$ 5.12	7.23 $\pm$ 30.07	0.84 NS	
LDL cholesterol (mg/dl)					
Experimental	129.9 $\pm$ 9.60	119.9 $\pm$ 11.6	10 $\pm$ 2	2.15 NS	2.084 NS
Control	132 $\pm$ 14.98	138.1 $\pm$ 14.9	6.1 $\pm$ 0.08	1.79 NS	
HDL cholesterol (mg/dl)					
Experimental	47.0 $\pm$ 6.38	48.6 $\pm$ 8.8	1.6 $\pm$ 2.42	0.39 NS	0.333 NS
Control	49.6 $\pm$ 10.0	47 $\pm$ 5.21	2.6 $\pm$ 4.47	1.16 NS	
VLDL cholesterol (mg/dl)					
Experimental	58.6 $\pm$ 23.6	51.7 $\pm$ 23.2	6.9 $\pm$ 0.4	1.73 NS	0.443 NS
Control	42.8 $\pm$ 14.94	47.15 $\pm$ 13.15	4.36 $\pm$ 1.79	0.86 NS	

I-Initial

F-Final

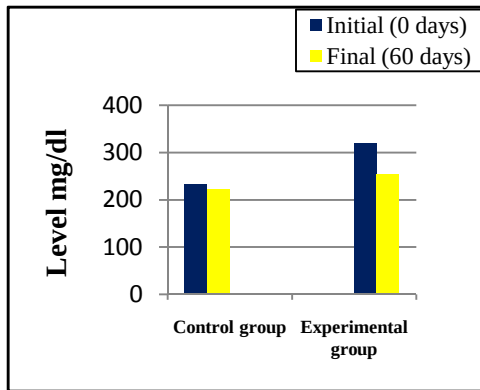
E-Experimental

C-Control

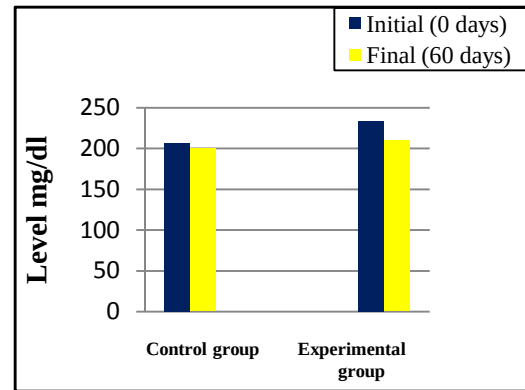
*Significant at 5% level

**Significant at 1% level

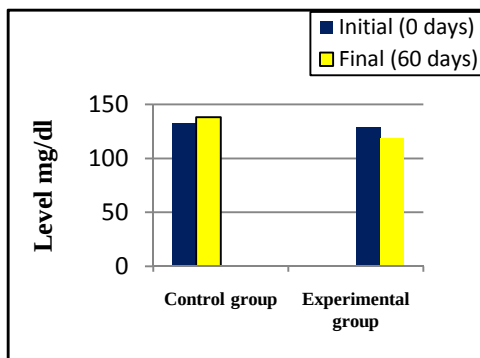
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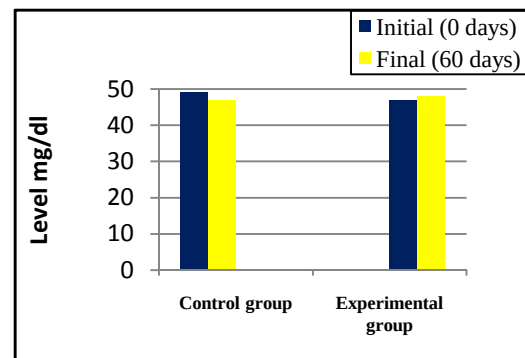
Triglyceride



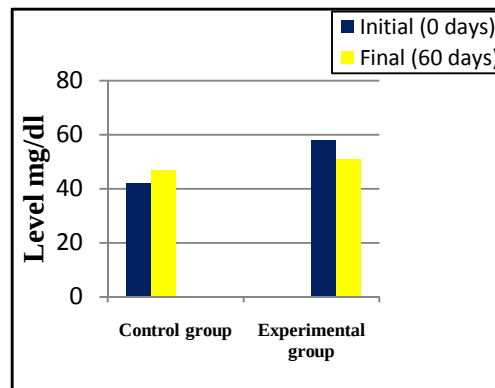
Total Cholesterol



LDL cholesterol



HDL cholesterol



VLDL cholesterol

Fig 7. Lipid profile of control and experimental group before and after supplementation

SUMMARY AND CONCLUSION



CHAPTER-V

SUMMARY AND CONCLUSION

Millet is a minor cereal of grass family, Poaceae. They are small seeded, annual cereal grasses, many of which are adapted to tropical and arid climates and are characterized by their ability to survive in less fertile soil. Millet includes sorghum, Pearl millet, finger millet, foxtail millet, proso millet, little millet, kodo millet, barnyard millet and brown top millet (Gopalan *et al.*, 1989 and Hulse *et al.*, 1980).

Foxtail millet is one of the world's oldest cultivated crops. Foxtail millet has been identified as major millet in terms of worldwide production, as it is the sixth highest yielding grain. Foxtail millet comprises a wide range of health-benefiting components that not only make it a valuable source but also unique among the cereal category for the particular balance of nutrients it contains. The main components of foxtail millet are starch, protein, dietary fibers, fat, vitamins and minerals. The specific composition of foxtail millet gives rise to its nutritional and sensory qualities such as aroma, flavor and appearance.

Foxtail millet has been found to possess some phytochemical with considerable antinutrient effects. Apart from proteins, antioxidants constitute the other major functional component present in foxtail millet. Phenolics are one of the major antioxidants found in foxtail millet, which chemically act by donating hydrogen atoms via hydroxyl groups on benzene rings to electron deficient free radicals and form a resonance stabilized and less-reactive phenoxyl radical. Foxtail millet can be potentially used to prepare various low-glycemic index foods that can lead to a prudent improvement in the longer-term control of diabetes and cholesterol.

There have been some reviews of foxtail millet but there is a global lack of awareness among the people about that nature of work carried out on diverse aspect viz. clinical trials safe study and formulation research.

Besides its traditional use in making *chapatti* and porridge, millet can be exploited for the development of low GI therapeutic food products like biscuits. The aim of the present study was to explore the effect of foxtail millet biscuits on blood glucose level and lipid parameter in type 2 diabetes person subjects.

The study was carried in two phase. In first phase of experiment five variations of foxtail millet biscuits were developed utilizing refined wheat flour, foxtail millet flour, fat, milk, cumin seed, omum, salt and baking powder. The developed foxtail millet biscuits were evaluated for organoleptic characteristics and highly accepted foxtail millet biscuit was analyzed for nutrient content and determined glycemic index on selected 10 normal subjects using glucose tolerance test.

In second phase of study clinical trials were conducted a total number of twelve diabetic subjects were selected following the purposive sampling techniques. The selected subjects were personally interviewed with the help of pretested questioner to elicit information regarding socio economic background, health status and food consumption pattern. The selected subjects divided into two groups experimental and control consisting six subjects in each group. The highly accepted foxtail millet biscuits (50g) containing 25 g of carbohydrate was supplemented to experimental group for 60 days. The anthropometric measurements i.e. height and weight was recorded at 0, 30 and 60 days of experimental and control group. The biochemical parameters such as blood glucose and lipid profile were studied at initial (0 days) and at the end of

experimental period (60 days). The recorded values were consolidated, tabulated and analyzed statistically.

The result of organoleptic characteristics of foxtail millet biscuits revealed 40 per cent incorporation of foxtail millet flour registered significantly higher score for colour (7.9), texture (7.9), flavour (7.6), taste (7.8) and overall acceptability (7.8) from the result it was inferred that the 40 per cent incorporation of foxtail millet flour was found to be most acceptable in term of all organoleptic characteristics. The cost of 1 kg of foxtail millet biscuits was Rs. 80.5/- and supplementation of 50 g was Rs.4.02 /-.

The highly accepted foxtail millet biscuit was analyzed for nutrient content. The content of moisture (g), protein (g), fat (g), carbohydrate (g), total mineral (g) in foxtail millet biscuit were 2.7, 8.75, 17.71, 53.77 and 2.10 per cent respectively. Beside the value for calcium, iron, zinc, copper, manganese, phosphorus (mg/100g) and total fiber, soluble fiber, insoluble fiber (g) were 62.3, 2.27, 1.0, 0.40, 0.50, 532 (mg/100g) and 16.80, 1.87, 14.93 per cent respectively.

It is evident from the result that the developed foxtail millet biscuit content more amounts of protein, calcium, iron zinc, manganese was found in good amount but phosphorus and insoluble fiber are extremely high in amount.

The data on socio economic background and health status indicated that most of the subjects were belonging to high income, nuclear family, highly education, taking allopathic medicines and had the history of disease <5 years.

The result of dietary and nutritional intake indicated that the per cent adequacy in the intake of different foods per day by the experimental group and control group was indicate in supply of all major food stuffs like cereals, pulses , fruits, green leafy vegetables, other vegetables, roots and tubers, milk and milk

products, sugar and jaggery. On the other hand the per cent adequacy of fats and oils was found to be 100 per cent in control and experimental group men.

Per cent adequacy of different nutrients per day by the experimental and control group showed that the consumption of fat, calcium and iron was found to be more than RDA. Whereas energy, protein, carbohydrate was found to be less further, the diet was grossly deficient in supply of fiber in both the groups.

GI of the foxtail millet biscuit was estimated to check its suitability to feed to the diabetic subjects. Glycemic index of developed foxtail millet biscuit was 44.66 which are categorized as low glycemic index < 55 (Wolver and Jenkins, 1986).

The anthropometric measurement of experimental and control group at 0, 30 and 60 days were recorded. The result of the study showed that the corresponding values of weight ranged between 63.71, 63.23 and 62.46 kg and 54.6, 55.1 and 54.9 kg, for body mass index 24.61, 24.40 and 24.14 and 21.76, 22.0 and 21.96 respectively.

On the whole the supplementation of foxtail millet biscuits for 60 days showed significant impact on body weight and body mass index. Among experimental group in controlling the weight of the subjects.

The mean value of blood glucose and HbA1c of experimental group at 0 to 60 days recorded were 191.8 ± 28.36 , 174.1 ± 36.7 mg/dl and 8.31 ± 0.73 , 7.68 ± 0.88 per cent respectively. The corresponding values recorded for control group were 165.8 ± 22.87 , 170.5 ± 43.05 mg/dl and 7.36 ± 0.78 , 7.36 ± 1.06 per cent.

The results for supplementation of foxtail millet biscuits showed that there was decrease in blood glucose by $(17.7 \pm 1.69$ mg/dl) in experimental group

whereas the increases (4.7 ± 20.18) was noticed in control group at 60 days. The mean value decrease in blood glucose was found to be statistically significant at 5 per cent level in experimental group while in control group the difference was non significant.

It was found that supplementation of foxtail millet biscuits for 60 days exhibited slightly decrease in HbA1c ($0.63 \pm 0.15\%$) in experimental group but it was statistically non significant. In control group difference was not found between the initial and final values of HbA1c.

It is evident from the results that supplementation of foxtail millet biscuits beneficial to reduce blood glucose. It has been observed that low glycemic index of foxtail millet biscuits responsible for reducing blood glucose.

The initial mean value for triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol and VLDL cholesterol of experimental group were 320 ± 105.49 , 234.5 ± 33.23 , 129.9 ± 9.60 , 47.0 ± 6.38 and 58.6 ± 23.6 mg/dl of serum respectively. The value obtained after supplementation of foxtail millet biscuit at the end of 60 days of study period for the corresponding parameter were 253.5 ± 60.88 , 210.8 ± 29.90 , 119.91 ± 11.62 , 48.66 ± 8.84 and 51.75 ± 23.20 mg /dl of serum respectively.

On the whole it can be concluded that the supplementation of foxtail millet biscuit to experimental group for 60 days reduced significantly triglycerides over initial value. Enhancement of HDL cholesterol was observed which is considered to be good cholesterol whereas the level of total cholesterol, LDL cholesterol and VLDL cholesterol decreased slightly.

The initial mean value for triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol and VLDL cholesterol of control group were 233.8 ± 76.8 , 207.83 ± 35.19 , 132 ± 14.98 , 49.6 ± 10.0 and 42.8 ± 14.94 mg/dl of serum

respectively. The values at the end of 60 days of study period for the corresponding parameter were 223.6 ± 70.0 , 200.6 ± 5.12 , 138.1 ± 14.9 , 47 ± 5.21 and 47.15 ± 13.15 mg/dl of serum respectively.

In a nutshell organoleptic characteristics of 40 per cent incorporation of foxtail millet flour was found to be most acceptable and contained high amount calcium, total mineral, insoluble fiber and phosphorus.

The result of dietary intake of selected subjects showed that the diet was inadequate in supply of major food stuff like cereals, pulses, fruits, green leafy vegetables, other vegetable, roots and tubers, milk and milk product and sugar and jaggery where as the intake of fats and oils was found to be 100 per cent. In case of nutrient intake it was found that the intake of energy, protein, carbohydrate and fiber was inadequate but it was vice versa for fat, calcium and iron.

The findings of the study revealed that the supplementation of foxtail millet biscuits reduced slightly in the body weight of experimental group.

The result shown that increases in the period of study decrease progressively the blood glucose and HbA1c. The result of statistical analysis showed significant decreases in blood glucose at 60 days of supplementation in experimental group.

The result of lipid profile showed that the supplementation of foxtail millet biscuit for a period of 60 days decreased value of significantly the value of triglycerides. Whereas slightly decreased in total cholesterol, LDL cholesterol and VLDL cholesterol. Further the enhancement in the HDL cholesterol was observed.

Thus it can be concluded from the above result that the supplementation of foxtail millet biscuit had exerted a positive impact on the studies parameters associated with selected subjects.

A high intake of millet based dietary fiber, improved the glycemic control, decreased the hyper insulinemia, and lowered the plasma lipid concentrations in patients with type 2 diabetes. The observations are in line with other studies (Ramachandran *et al* ., 2010 and Jarvi *et al* .,1999) regarding lowering the serum triglycerides, serum cholesterol and serum glucose in patients taking low glycemic index diet. Considerable level of positive change in glycolipemic parameters may be attributed to presence of fiber content in foxtail millet which is slowly digested and absorbed in the intestine. Further specific combination of five spices used in the diet mix exhibit hypoglycemic and hypocholestrolemic effects when consumed with the diet.

Foxtail millet comprises a wide range of health-benefiting components that not only make it a valuable source but also unique among the cereal category for the particular balance of nutrients it contains. The main components of foxtail millet are starch, protein, dietary fibers, fat, vitamins, and minerals. Thus, it can be concluded that foxtail millet do have a potential for a protective role in the management of diabetes.

Hence this foxtail millet based biscuits can be used by diabetic patients for the management of diabetes as well hyperlipidemia to certain extent. Also foxtail millet biscuit is worth popularization for improving people health standard and can be used for management of health problem.

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websites

- Encarta.msn.com/index/concise/index12S/htm.I-9p.
- <http://chetday.com/millet.html>
- www.archangelhealth.com

APPENDIX



Appendix I

Sensory analysis

Name of panel member-

Date-

Name of product-

Variation	Colour	Taste	Texture	Flavor	Over all acceptability
Control					
T 1					
T 2					
T 3					
T 4					
T 5					

1-Dislike extremely

5-Neither like nor dislike

9-Like extremely

2-Dislike very much

6-Like slightly

3-Dislike moderately

7-Like moderately

4-Dislike slightly

8-Like very much

Signature

Appendix II

QUESTIONNAIRE TO ELICIT INFORMATION REGARDING HEALTH OF DIABETIC SUBJECTS

I. GENERAL INFORMATION

1. Name:
2. Age:
3. Gender:
4. Religion: Hindu / Muslim / Christian
5. Address:
6. Designation:
7. Income (Rs):
8. Education: Primary School/Secondary School/ Higher
secondary/College
9. Family type: Joint ☐ Nuclear ☐
10. No family member:
11. Food habits: Vegetarian ☐ Non-vegetarian ☐

II. DISEASE HISTORY

1) Duration of diabetes:

2) In case of diabetes, are you on?

- Diet restriction

Yes ☐ No ☐

- Diet + oral hypoglycemic drugs

Yes ☐ No ☐

If yes mention the name of the drug.....

III. HEALTH HABITS

1. Whether you follow any of the following activities

Activities	Duration (hr/min)
Yoga	
Cycling	
Jogging	
Walking	
Fitness exercise	
None	

IV. ANTHROPOMETRIC MEASUREMENTS

1. Height

2. Weight

3. BMI

V. BLOOD GLUCOSE AND LIPID PROFILE

Parameters	Response to the list with levels	
	0 day	60 day
Glucose level (mg/dl)		
HbA1c %		
Total Cholesterol (mg/dl)		
HDL-cholesterol (mg/dl)		
LDL-cholesterol (mg/dl)		
Triglyceride (mg/dl)		
VLDL- cholesterol (mg/dl)		

VI. MEAL PATTERN

1. Number of times you consume food in a day

2 meals /day, 3 meals /day, 4 meals /day

VII. 24 hour Diet Recall

Meal pattern	Food item	Amount consumed
Early morning		
Breakfast		
Lunch		
Snacks		
Dinner		
Bed time		

APPENDIX III

Written consent of subjects in local language for participating in clinical study

संमती पत्र

मधुमेह

संशोधनाचा विषय: राळयाच्या तांदुळापासून बिस्कीट विकसीत करणे आणि मधुमेही व्यक्तींमधील रक्तातील साखरेच्या व स्निग्धांच्या प्रमाणावर होणा-या परिणामाचा अभ्यास करणे.

संमतिसंदर्भातील आजार : मधुमेह

संशोधना बददल

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.

राळयाच्या तांदळाचा क्रियात्मक पदार्थ :

राळयाचे बिस्कीट तयार करण्यासाठी मैदा, राळयाच्या तांदळाचे पीठ, तुप, ओवा, जिरे, मीठ, दुध व बेकींग पावडर हे अन्न पदार्थ वापरण्यात आले. विकसीत बिस्कीट हे तंतुमय पदार्थांनी युक्त आहे व त्या ग्लायसेमिक इंडेक्स कमी आहे, म्हणून विकसीत बिस्कीट पदार्थ दररोज ५० ग्रॅम प्रमाणे मधुमेही व्यक्तींना सलग दोन महिने देवून रक्तातील साखरेच्या व रक्तातील स्निग्धांच्या प्रमाणावर होणारा परिणाम तपासणे हा या अभ्यासाचा विषय आहे.

संशोधनातील समाविष्ट मानके आणि तुमचा सहभाग :

तुमच्या रक्तातील साखरेची पातळी तपासण्यासाठी तुमच्या बोट्यातून थोडासा रक्ताचा नमुना (०.०२ ते २ मि.ली.) घेवून त्यातील साखरेचे प्रमाण तपासले जाईल त्याच सोबत वेळोवेळी केलेल्या तपासण्यांच्या निष्कर्षाची नोंद ठेवली जाईल. लाभार्थाची उंची, वजन व उच्च रक्त दाब या विषयी देखील नोंद ठेवली जाईल.

रक्तातील होणा-या साखरेच्या व स्निग्धांच्या प्रमाणात होणारा परिणाम पडताळून बघण्यात येईल, म्हणून यासाठी तुमचा सहभाग आवश्यक आहे.

धोका :

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

संशोधनाचे फायदे :

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

आम्ही उभा केलेली माहिती आणि तुमची ओळख ही गुप्त ठेवली जाईल. जर तुम्हाला प्रकल्प सोडायचा असेल तर तुम्ही स्वेच्छेने कोणत्याही वेळी प्रकल्प सोडू शकतात.

तुमच्या शंका : जर तुम्हाला या अभ्यासाबद्दल कुठलीही शंका असेल तर मोकळेपणाने संशोधक विद्यार्थीनी कु. अंकिता चौधरी, सामुदायीक विज्ञान महाविद्यालय, वनामकृवि, परभणी यांना संपर्क करू शकता आणि शंकेचे निरसन करू शकता.

संशोधनाबद्दल संमति : मला या संशोधनाबद्दल माहिती मिळालेली आहे. मला या संशोधनाबद्दल कसलीही शंका नाही. मी या संशोधनाचा लाभार्थी म्हणून माझ्या कडून काय अपेक्षा आहे. याची मला माहिती देण्यात आलेली आहे.

माझी या संशोधनात सहभागी होण्यासाठी संमती आहे.

लाभार्थीची नाव :-

लाभार्थीची स्वाक्षरी :-

दिनांक : / /२०१९

संशोधकाची स्वाक्षरी :-

दिनांक : / /२०१९

APPENDIX - IV

1 Determination of moisture content

Moisture content of the powder was determined by oven drying method (A.O.A.C., 1975).

Procedure

Three samples of cinnamon powder were accurately weighed in an amount of 5.0 g each in weighing bottle (previously heated to 90OC to 100OC and cooled in a desicator). The bottles were loosely covered with lids which contain sample transferred to oven for 3 hours at 105OC. After 3 hours bottles were removed from oven, allowed to 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 sample was calculated by the formula

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

Where,

W1 = Initial weight of bottle with sample before drying.

W2 = Final weight of bottle with sample after drying

W = Weight of sample

2 Determination of total protein content of selected samples

Total protein content of the samples was estimated by determining total nitrogen content using standard macro-kjeldhal method (N.I.N., 1983). Total protein content was calculated by multiplying the estimated total nitrogen content with a factor 6.25

2.1 Preparation of reagents

2.1.1 Catalyst mixture

It was prepared by grinding together 98 parts of potassium sulphate (K₂SO₄) and 2 parts of copper sulphate (CuSO₄).

2.1.2 40 per cent sodium hydroxide solution

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

2.1.3 Methyl red indicator

2.1.4 2 per cent boric acid solution

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

2.1.5 0.1 N sulphuric acid

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

Procedure

One gram of defatted powdered sample of cinnamon powder were weighed on a butter paper, in triplicate and placed in 500 ml kjeldhal flask. An amount of 5.0 gm of catalyst mixture, 20 ml of concentrate sulphuric acid and 2.3 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 100 ml. volumetric flask and the volume was made up to mark with distilled water.

10 ml of boric acid solution was delivered into a 100 ml 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; 5 ml of digested sample was delivered into the distillation apparatus. Then 10 ml of 40 per cent NaOH was added and the funnel was washed with 2 to 3 ml of distilled water. Steam distillation was carried out and it was continued for 15 min, until about 40 ml of distillate collected in boric

acid solution. The tip of 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 N sulphuric acid required to neutralize the collected sample was noted.

Total protein content of sample was calculated by formula.

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

Where,

$$\text{Nitrogen (\%)} = \frac{(\text{Titrate value of sample}) - (\text{Titrate value of blank}) \times \text{normality of sulphuric acid} \times 14 \times 100 \times \text{dilution factor}}{\text{Wt. of sample (mg)}}$$

3 Determination of total fat content

The fat content of selected sample was estimated by the Soxhlet method of A.O.A.C. (1975).

Procedure

Three Soxhlet flask of 250 ml capacity were cleaned and dried in an oven to a constant weight. Then three samples in an amount of 5.0 g were accurately weighed on a filter paper of cinnamon powder.

Each weighed sample was placed in thimbles and plugged with fat free cotton. Then the thimbles with the weighed sample were placed in the syphon portion of soxhlet apparatus. The volume of 160 ml 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 soxhelt syphon and condenser. The condenser was plugged with moistened cotton. It was refluxed for 5-7 times at 60OC. Then ether was distilled off and flaks were placed on hot plate for 3 hours at 105OC for drying, cooled in a desicator and weighed. Fat content of sample was calculated by using the formula

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

Where,

W2 = Weight of round bottom flask with fat

W1 = Weight of empty round bottom flask

X = Weight of sample

4 Estimation of total minerals content

The total minerals of selected samples were estimated by the ashing method of A.O.A.C. (1975).

Procedure

Three samples of cinnamon powder weighing 2.0 gm were taken in silica crucibles which were heated previously at 100°C and cooled. The crucibles were placed on a clay pipe triangle and were heated on a low flame till the samples were completely charred. The charred samples were ignited by placing crucibles in muffle furnace for 5 hours at 600°C. Thereafter crucibles were allowed to cool in desiccator and weighed. This procedure was repeated till the consecutive weights obtained were concurrent and the ash was in grayish white colour. Total mineral content of the samples was calculated by using the formula

$$\text{Total mineral content of the sample (\%)} = \frac{W3 - W1}{W2} \times 100$$

Where,

W3 = Weight of crucible with ash

W1 = Weight of crucible

W2 = Weight of sample

5. Determination of crude fiber content

Crude fiber content of selected samples was determined by the method of A.O.A.C. (1975).

5.1 Preparation of reagent

5.1.1 0.255 N sulphuric acid solution

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

5.1.2 0.313 N sodium hydroxide solution

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

Procedure

Exactly 2.0 g of moisture and fat free sample was weighed in triplicate in a 500 ml of beaker. Then 200 ml of 0.255 N sulphuric acid solution was added into each beaker and the mixture was allowed to boil for 30 min keeping the volume constant by the addition of water at frequent intervals, glass rod was used to stirr 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; 200 ml of boiling 0.313 N sodium hydroxide was added and boiled for 30 min keeping the volume constant by using distilled water. The mixture was again filtered through a muslin cloth and residue was washed with hot water till it was made free from alkali. The residue was washed with hot water to make it free from alkali and some alcohol. Then residue was transferred to crucible which was dried in an oven overnight at 80 OC and weighed accurately (W1). The crucible was heated in a muffle furnace at 600 OC 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 content of crude fiber in sample was calculated by using following formula.

$$\text{Crude fiber content g/100 g} = \frac{100 - (\text{Moisture} + \text{fat}) \times \text{weight of Fiber}}{\text{Weight of sample taken}} \times 100$$

6 Determination of CHO content (NIN, 1983)

The content of carbohydrate in the samples was obtained by subtracting from 100, the sum of values of moisture, protein, fat, ash and crude fibre content per 100 gm of the sample.

$$\text{Carbohydrate} = 100 - (\text{Moisture} + \text{protein} + \text{fat} + \text{ash} + \text{crude fibre})$$

7 Determination of calcium content

Calcium content of selected samples was estimated by EDTA method.

7.1 Preparation of Reagents

7.1.1 N sodium hydroxide

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

7.1.2 Ammonium purpurate indicator

0.5 gm of ammonium purpurate was thorough mixed with 100 gm of powdered potassium sulphate.

7.1.3 Ethylene diamine tetra acetic acid (Versenate) solution (0.01N)

2.00 gm of disodium dihydrogen ethylene diamine tetra acetate and 0.05 g of magnesium chloride hexahydrate were dissolved in water and volume was made up to 1000 ml.

Procedure for Calcium

0.5 ml of aliquot of ash solution was taken into beaker and 5 ml of water was added. Then 0.25 ml (5 drops) of 4 N sodium hydroxide and approximately 50 mg of ammonium purpurate indicator were added. It was titrated against 0.01 N EDTA. The end point of titration was noted when 0.01 EDTA produced a colour change from orange red to lavender to purple. The volume of 0.01 EDTA solution required to neutralize the sample was noted.

The calcium content of sample was calculated by formula

$$\text{Ca (me/lit)} = \frac{R \times \text{Normality of EDTA} \times 1000}{(a) \text{ Aliquot (ml) taken}} \times \frac{5}{\text{wt. of sample}}$$

$$\text{Ca (me/100 g)} = \frac{100 \times a}{(b) 1000}$$

$$\text{Ca (mg/100 g)} = b \times 20$$

Where,

R = volume (ml) of EDTA used in titration

1. Determination of copper, zinc, iron and phosphorus

The trace element (copper, zinc, iron and phosphorus) from the ash solution of the samples of cinnamon powder were estimated by atomic absorption spectrophotometer (Perkin R. Elmer Model-3110). The aliquots of each solution

were fed to atomic absorption spectrophotometer through a capillary and readings were obtained directly in ppm.

$$\text{Fe in ppm} = \frac{R \times 100}{\text{Wt. of sample}}$$

Where,

R – The reading on atomic absorption Spectrophotometer

$$\text{ppm} = \text{mg}/1000\text{gm}$$

$$\text{Fe in mg}/100 \text{ g} = \frac{\text{ppm value of Fe}}{10}$$

$$\text{Zn in ppm} = \frac{R \times 100}{\text{Wt. of sample}}$$

Where,

R – The reading on atomic absorption Spectrophotometer

$$\text{ppm} = \text{mg}/1000\text{gm}$$

$$\text{Zn in mg}/100 \text{ g} = \frac{\text{ppm value of Zn}}{10}$$

$$\text{P in ppm} = \frac{R \times 100}{\text{Wt. of sample}}$$

Where,

R – The reading on atomic absorption Spectrophotometer

$$\text{ppm} = \text{mg}/1000\text{gm}$$

$$\text{P in mg}/100 \text{ g} = \frac{\text{ppm value of P}}{10}$$

APPENDIX – V

Procedure for preparation of foxtail millet biscuit

Ingredients	Amount (gm)
Refined wheat flour	21
Foxtail millet flour	14
Fat	10
Milk	4
Omum	0.5
Cumin seed	0.5
Salt	to taste
Baking powder	a pinch
Water	as require

Procedure:

- Millet flour, refined wheat flour, salt and baking powder were mixed thoroughly
- Hydrogenated fat was creamed till it fluffy
- Add flour mix in to the creamed fat and mix well
- Crushed omum and cumin seed and add in to the mixture
- Mix well all the ingredients add milk in to it, water was added as required and prepare soft dough
- Make biscuit with using biscuit cutter
- The biscuit were placed on a greased tray baked at 160 c for 20 min in preheated oven or in local bakery.