UTILIZATION OF DEOILED SOYA MEAL FOR DEVELOPMENT OF VALUE ADDED FOOD PRODUCTS

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B.Sc. Home Science

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PARBHANI- 431 402 (M.S.) INDIA

2018

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DISSERTATION

Submitted to

The Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani

in PartialFullfillment of the Requirement

for the Degree of

MASTER OF SCIENCE
(HOME SCIENCE)

IN

(FOODS AND NUTRITION)

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

2018

CERTIFICATE-I

This is to certify that **Miss. DipaliSakharamsangekar**has satisfactorily prosecuted her course of research for a period of not less than two semesters and that her dissertation entitled, **"Utilization of Deoiled Soya Meal for Development of Value Added Food Products"** submitted by her is the result of original research work and is of sufficiently high standard to warrant it's presentation to the examination.

I also certify that, the dissertation or there part has not been previously submitted by her for the award of degree of any University.

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ACKNOWLEDGEMENT

Thanks to merciful lord for all countless gifts you have offered me, and thanks to my family for their love and support.

I take this opportunity to look back on the path traversed during the course ofendeavour and to remember the guiding forces 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. AshaArya, Professor (CAS) Dept. of Food science and Nutrition, College of Community Science, Vasantrao Naik Marathwada 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.

My sincere thanks to. Dr. Hemanginiserembekar, Associate Dean and Principal, College of Community Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for providing facilities in the College to carry out research work. My sincere thanks to Dr. VijayaNalwade, Professor and Head, Dept. of Food Science and Nutrition, for her valuable guidance during course work and research work. I am sincerely thankful to the advisory committee members Dr. VijayaNalwade. Professor and Head, Dept. of Food science and Nutrition, Dr. Khan T.N., Professor (CAS), Dept. of Food Science and Nutrition, Dr. Farooqui H.F, Assistant Professor, Dept. of Food Science and Nutrition, Dr. SmitaKhodke. Head of the department of Agriculture Process Engineering, College of Agriculture Engineering for their cooperation and valuable suggestions during the period of this project. I am immensely grateful to Dr. V. D. Patil, Dean & DI (F/A),VNMKV,Parbhani.

Prof. A. B. More, Dr. PapitaGourkhede, Assistant Professors Dr. Adkine, AgriAsst, Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani, for their timely help to estimate the mineral content of the food samples.

I express my special thanks to (Ms) JyostnaNerlekar (JRF), ArchanaBhoyar (JRF), Swati Varma, KirtiKasable Lab Assistant for their valuable help, guidance and inspiration during the period of research work.

Words are never sufficient to express my whole hearted sense of reverence to my parents. My way in this world paves through the path carved by my parents Mr. SakharamSangekar and Mrs.Savitasangekar, and my sister Mrs. Umadevi,Vaishali and Swateja whom I wish to idolize throughout my life. I think words with me are insufficient to express the feelings of my heart to acknowledge them who have shaped my life and led me best. I thank my beloved brother Shivprasad for his help and support.

It is my profound privilege to record my whole hearted thanks to all friends Pratibha, Varsha, Vidya, Jyoti, Smita, Ashwini, Snehal and my all seniors Rupali, Jayashree, Aswini and Kalpna, for helping me in the completion of this study, continuous encouragement and co operation. I am thankful to all my well wishers who helped me directly and indirectly during my research work.

I am also thankful to ArjunTak and AkshayTak (Gajraj Computers) who helped to me during thesis preparation and typing work.

Lastly, I express my regards to those whose names I have forgotten to mention here. I express my gratitude for their goodwill and moral support during my academic attainment.

Place: Parbhani(**DipaliSangekar)**

Date: 31.05.2018 Reg.No. 2016/H/03M

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Introduction

CHAPTER-I

INTRODUCTION

Soybean is known as the "Golden bean" or the super legume of the twentieth century. The origin and history of soybean is not accurately known. In China it has been used for 5,000 years as a food and a component of drugs. The five largest soybean producing countries are USA, Brazil, Argentina, China and India. The total world production of soybean in 2015 was about 319.7 million tones. Global soybean production of 2016 was forecasted as 314 million tones. India ranked 5th in soybean production with 11.7 million tons (GFP, 2016). However, India's share in world production of soybean is only 3 per cent.

India is blessed with diverse agro-ecological conditions ideally suited for growing oilseed crops. Soybean is the second largest oilseed crop in India next only to groundnut. Compared to figures in past years, soybean sector in India has exhibited spectacular growth in terms of cultivation area, production and productivity. In India, amongst the total oilseeds the groundnut ranks first contributing (32.4%) of the total output followed by soybean (31.1%).

Soya is nature's richest source of protein. The protein content of most beans averages 20-25 percent, but soybean contains about 40 percent protein. The proteins present in soyabean meet the amino acid needs of body, both for adults and children. Generally legume proteins are deficient in essential sulfurated amino acid methionine. However, soya protein contains enough of this important amino acid to meet adult needs. Health professionals consider soya protein as superior protein compared to a lot of vegetable proteins and at par with egg and milk protein. In contrast to other legumes soya contains 18-22 per cent fat. Therefore, it is also categorised as oilseed. Soybean is a rich source of edible oil containing no cholesterol and almost none of the saturated fats. Fat fraction contains mainly triglycerides and minor components include phospholipids, polyunsaturated fatty acid, linoleic acid and lenolenic acid. Soybean contains about 35 per cent carbohydrate. Soybean has more than two

times the amount of most of the minerals, especially calcium, iron, phosphorus and zinc, than any other legume and very low sodium content. Soybean is a good source of B complex vitamins. Soybeans contain both soluble and insoluble fiber. Soluble fiber may help lower serum cholesterol and control blood sugar. Insoluble fiber increases stool bulk, may prevent colon cancer and can help relieve symptoms of some digestive disorders (Zuber *et al.*,2017 a).

In addition to being a rich source of nutrients it contains valuable phyto chemicals as well. Soybeans contain an abundance of chemical substances that are not nutrients in the strict sense of the word but they are remarkably active within the body. These substances include isoflavones, phytosterols, protease inhibitors and phytic acid. Soybeans contain two primary isoflavones called genistein and diadzein, and a minor one called glycitein. Isoflavones have a very limited distribution in nature. Soybeans and soy foods contain approximately 1-3 mg of isoflavones per gram. Soy protein and isoflavones together contribute to a number of health benefits such as cancer prevention, cholesterol reduction, combating osteoporosis and menopause regulation. For the past 30 years, investigators have shown that consumption of soy protein selectively decreases total and LDL cholesterol and maintains HDL cholesterol in individuals with elevated blood cholesterol levels. United States Food and Drug Administration issued a health claim for soya protein in October of 1999. Soybeans are hypoglycaemic. Soybeans glycemic index (GI) is 18-25 and it does come under the list of low GI foods, therefore good for diabetics. Its GI is lower than most legumes (Zuber *et al*., 2017 b).

Soyabean is used in different forms such as whole seeds, dehulled splits, soya flour, deoiled cake or soya meal. Soybean meal is the portion of soyabean remaining after extracting most of the oil from whole seeds. Soyabean meal is the by product of soya oil industry. It is available world wide. In 2014 soyabean meal production reached 190 million tons and accounted for 62.5per cent of oil meals (FAO, 2016). Soybean is crushed into oil and defatted meal is usually used as an animal feed and smaller percent is further processed into

food ingredient (Jideani, 2011). It can be used for human food supplementation. In recent years, there has been increasing interest in utilization of soya meal as a protein source for human foods as it contains about fifty percent protein. This is in view of the easy and abundant availability of this quality protein at relatively low cost.

It is estimated that approximately 90 per cent of soybean produced in India is used for oil extraction. There fore the production of DOC is also very huge. De-oiled cake is largely exported; however, domestic demand for it is also increasing. At present one-fourth of de-oiled cake is consumed in the country and three-fourths is exported. India's soybean industry is flourishing very fast on account of DOC export potential and availability of raw material. Soya meal emerged as a significant "net exporter" and highest foreign exchange earner among all oilseeds/meal. Therefore, very rapidly soybean gained its rank next only to groundnut both in the area under cultivation as well as production.

The soyabean meal is called "high protein" with 44-49 per cent protein and 3 per cent crude fiber obtained from dehulled seeds and the "conventional" soyabean meal with 43-44 per cent protein, that contain the hulls (Cromwell, 2002). It has very good amino acid balance and contains high amount of lysine, tryptophan, theronine and isolucine which are often lacking in cereal grains (MC Donald *et al*., 2002). Amino acid digestibility is also very high (more than 90% for lysine) .

In recent year there has been a considerable shift in the consumer's perception of food due to changing lifestyle, modernization, increased women employment, increased per capita income and newer marketing strategies employed by major food manufacturers. Most consumers demand convenience food, ready to eat snacks or food which add bulk and satisfy appetites without taking up preparation time (Peter *et al.,* 2012). Besides recently consumer awareness is increased and people feel that there is need to eat nutritionally superior and healthy foods. There has also been renewed interest in

micronutrients such as those with antioxidant activity, with recommendations for intakes beyond the traditionally officially recommended dietary allowances. Such interests have led the food industry to introduce a number of value added products that are claimed to be beneficial for specific physiological functions, including physical and mental performance, or to have an added nutritional value (NRLO , 2010). These products, which are known as value added foods may contain either nutrients and bioactive constituents in a higher quantity than present in corresponding conventional foods such as for antioxidant vitamins.

In general, adding value is the process of changing or transforming a product from its original state to a more valuable state. The value of a changed product is added value. New and improved products play an important role in maintenance of health as well for economic growth. Hence, there is an ample scope to formulate value added food products of consumer interest.

Deoiled soya meal has a great potential to be used as an ingredient for value addition by virtue of its nutrient richness and health benefits. There are several products which are empty calorie foods and they are deficient in protein, and micronutrients. The nutritional value of such products both quantitatively and qualitatively can be increased by using soyabean meal. If the utilization of this nutrient rich ingredient in the country for human consumption is increased then it may be help to tackle the widely spread problem of Protein Energy Malnutrition.

Apart from this, being rich in protein and low content of carbohydrates the products prepared by incorporation of deoiled soya meal are good for diabetics. Very less oil content makes this food supplement suitable for people with hypercholesterolemia, hypertension and persons with liver diseases where the oil restriction is necessary. Hence deoiled soya meal can be considered for supplementation of food products to provide a more balanced nutritional profile at low cost.

Defatted soya flour can be used in variety of forms such as incorporation in bakery products such as biscuits, pasta, cookies etc. or even in snacks for

improving nutritional properties. It can be used for preparation of baby foods or the food supplements specially designed for school children, pregnant women, lactating mothers or elderly people. Therefore, the present study was under taken for development of the value added products with following objectives.

Objectives

1. To study the nutrient content of deoiled soya meal
2. To standardize value added food products by incorporating defatted soyabean meal
3. To find out the acceptability of developed value added food products
4. To assess the nutritional quality of the most accepted value added food products
5. To determine the keeping quality of highly accepted value added food products.

Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

The studies which are documented in the literature pertaining to deoiled soya meal and its use for human consumption were reviewed and presented in this chapter under following heads.

2.1 Studies on Utilisation and Health Benefits of Soybean

2.2 Studies on Nutrient Content of Deoiled Soya Meal

2.3 Studies on Products Incorporated With Deoiled Soya Meal

2.1 Studies on Utilisation and Health Benefits of Soyabean

Non traditional soya products in Asia were reviewed byAlstair (1999). It is stated that soybeans provide both protein and edible oil as their main components. Culture and geography are the main determinants of end users of soybeans. In addition to traditional soya foods which have been produced in many countries in Asia for several millennia, several non traditional soya products have recently been produced in many countries. These are baked/roasted whole seeds and soya meal; products from full-fat soya flour; roasted soya products; soya products from defatted soybeans; isolated soya protein products; soya flour concentrates and grits products (bakery ingredients, meat products); special diet foods; soya products from crude soya oil; soy flour etc.

Nutritional and health benefits of soya were mentioned by Friedman and Brandon (2001). To improve the nutritional quality of soy foods, inhibitors and lectins are generally inactivated by heat treatment or eliminated by fractionation during food processing. Although lectins are heat-labile, the inhibitors are more heat-stable than the lectins. Most commercially heated meals retain up to 20 per cent of the Bowman-Birk (BBI) inhibitor of chymotrypsin and trypsin and the Kunitz inhibitor of trypsin (KTI).

Varma*et al*.,(2014) reviewed soyabean a synanom for nutrition, health and longevity and mentioned that soyabean a nutrient nugget, is in use for more than 5000 years in china and south East Asia as a food stuff. Despite being a legume crop in many countries soyabean has immense potential as a nutritive protein food. It can supply the much needed protein to human diets as it contains above 40 per cent protein with essential amino acids, particularly rich in tryptophan and lysine. It has high content of polyunsaturated fatty acids, fiber, vitamins and minerals and low in saturated fat. Epidemiological studies show its importance in the prevention of several diseases. Consumption of soy foods may contribute to a lower incidence of coronary artery disease, type 2 diabetes mellitus, certain cancers such as breast and prostate and ensure a better bone health, relief of menopausal symptoms, as well as weight control. Many health benefits of soyabean are derived from its secondary plant metabolites such as flavones, phyto –sterols, lecithins, saponins etc.

Soybean Consumption and Health Benefits were discussed by Kusuma(2018). It is stated that soy foods are rich source of dietary protein. Soy based foods are rich in a class of compounds called isoflavones. Isoflavones have chemical structure that is similar to the hormone estrogen receptors commonly called phytoestrogens. The consumption of soy isoflavones appears to result in health benefits for cancer, heart disease, menopausal symptoms and osteoporosis. Therefore, soy protein has become major component of food.

Acceptance of soyabean seems to increase. Soyabean proves to be the most popular means of relief from Protein Calorie Malnutrition (PCM) as protein from animals is beyond the cost many people can afford. To bridge the widening gap between protein requirement and availability, soyabean is expected to constitute the main source of protein for the future. The relatively recent discovery that soyabean may prevent a number of diseases may result in increased acceptance of soyabean if there is adequate awareness. The quality of soyabean has actually been underestimated until recently. It is now concluded that the quality of soyabean protein is comparable to that of animal protein

sources such as milk and beef. Soyabean produces high quality oil about 20 per cent of its content and protein about 40 per cent of the bean. Its protein content is superior, with substantial levels of most essential amino acids. Consumption of foods containing soyabean and soyabean products has been associated with improved heart disease risk factors, reduced osteoporosis, alleviation of menopausal symptoms, reduced cancer risk and in a limited number of studies reduced diabetes and helps people to stay lean and has no cholesterol. The degree of milling soyabean influences the palatability and digestibility. High protein yield is ensured at the end of processing as well as maintenance of texture. There is the need for increased utilization and awareness about its health benefits (Fabiyi, 2016).

Soya foods have long been recognized as sources of high-quality protein and healthful fat (Markmesina, 2016). Over the past 25 years these foods have been rigorously investigated for their role in chronic disease prevention and treatment. There is evidence, that they reduce risk of coronary heart disease and breast and prostate cancer. In addition, soy alleviates hot flashes and may favourably affect renal function, alleviate depressive symptoms and improve skin health. Much of the focus on soy foods is because they are uniquely-rich sources of isoflavones. Isoflavones are classified as both phytoestrogens and selective estrogen receptor modulators. Despite the many proposed benefits, the presence of isoflavones has led to concerns that soy may exert untoward effects in some individuals. However, these concerns are based primarily on animal studies, whereas the human research supports the safety and benefits of soy foods. In support of safety is the recent conclusion of the European Food Safety Authority that isoflavones do not adversely affect the breast, thyroid or uterus of postmenopausal women.

Effect of incorporation of soya flour in wheat flour on nutritional and sensory quality of biscuits was studied by Venkateswari and Parmeshwari (2016). The research was conducted to evaluate the quality characteristics of soya flour enriched biscuits which could be used as a protein incorporated

snack food. In this study wheat flour was replaced with soy flour at different levels that is 10 percent (S1) and 15 per cent (S2). Biscuits were analysed for sensory parameters. Results from nutrition analyses and hedonic evaluation indicated that good quality biscuits can be prepared by substituting wheat flour with 15 per cent soy flour and further addition may affect the baking quality. Protein content of soy incorporation biscuits increased from 13 to 37.5 per cent as compared to control along with significant increased in fat (3 to 20.1) and fibre (1to 3.5%).

Arya*et al.,* (2017) developed millet-based nutritious multipurpose instant mix. It was developed by using ingredients *jowar*, bengal gram dhal, soybean, *ragi, rajgira seed*, niger seed, gingelly seed, coriander seed, cumin seed, omum and salt. Four variations (A,B,C & D) of multipurpose instant mix were formulated. In the beginning one product Chakli was prepared and organoleptically evaluated for the selection of best accepted variation by the semi trained 20 panel members using five point ranking scale. The findings indicated that the variation 'D' was selected as most accepted variation of multipurpose instant mix. In all fifteen products were prepared from most accepted variation. Out of these most accepted ten products viz. *chakli,dhapata, gadgil, kharapara, kheer, poori, shev, shakkarpara,* salty biscuits and sweet biscuits were selected from the prepared ones. The findings of sensory evaluation data indicated that the selected products obtained good scores (>4) for all organoleptic parameters. The most accepted multipurpose mix was analysed for nutritional quality and it was stored in polythene pouch and laminated aluminium pouch to evaluate shelf life. The developed multipurpose instant mix found to contain protein (17.49g), fat (9.32g), total minerals (5.17g), fiber (4.87g), iron (11.67mg), zinc (3.53mg), calcium (269mg) and phosphorus (338mg) per 100g. Protein digestibility and in vitro iron bioavailability of multipurpose instant mix was 72.52percent and 56.94percent respectively. At the end of the six months storage, the chakli prepared from mix was organoleptically acceptable. Effect of storage on biochemical parameters revealed that nonsignificant increase in moisture and

total sugar content was observed in both pouches. Significant increase in peroxide value and reducing sugar was observed during storage of multipurpose instant mix in both the packaging materials. The microbial population of mix packed in both the materials was initially low and it was fit for consumption on 180th day of storage. It is concluded that the developed multipurpose instant mix is nutritious and can be used for preparation of variety of products.

Value added cake was developed by Jondhle*et al.,* (2017). Cake was prepared with and without incorporation of nutritious ingredients viz. *ragi, rajgeera,* garden cress seed and soyabean flour. The prepared cakes were evaluated organoleptically to find out the most suitable and highly accepted level of incorporation. The most accepted variation was assessed for its nutrient content and was stored at room and refrigeration temperature to evaluate the shelf life. Student's 't' test and ANOVA were implied for statistical analysis of data. The organoleptic evaluation indicated that value added cake prepared with incorporation of *ragi, rajgeera,* garden cress seed and soyabean flour at the levels of 5, 10, 5, 5 per cent respectively were significantly higher over the other variations. Due to value addition there was increase in protein (7.265 g/100g), fiber (4.436 g/100g), total minerals (7.429 mg/100g), calcium (11.475 mg/100g), iron (26.849 mg/ 100g) and zinc (2.90 mg/100g) content of cake. The incorporation of nutrient rich ingredients to cake was helpful in increasing its nutrient content significantly. There was no difference between the scores allotted for cake packed in two packaging materials. It is concluded that nutrient content can be increased by incorporating nutritious ingredient *ragi, rajgira,* garden cress seed and soya flour in cakes.

2.2 Studies on Nutrient Content of Deoiled Soya Meal

Effect of incorporation of defatted soy flour on the quality of biscuits was examined by Singh *et al.,* (1996). Crude fibre and nitrogen stability index (NSI) were determined as per AACC (1969) and AOCS (1980) methods respectively. The proximate composition (% dry weight basis) of wheat flour

and DSF used in preparation of biscuits were proteins: 9.81gm and 59.41 gm,crude fat :1.01gm and 0.68, ash:0.47gm and 7.55gm, crude fibre : 0.30 gm and 3.40 gm and carbohydrates: 88.41gm and 28.95gm. The nitrogen solubility index of commercial DSF was 46 per cent.

Nutritional quality of rice, ragi, and defatted soy flour blends as affected by extrusion cooking was evaluated (Dublish et al.,1988). Moisture, protein, fat and ash contents were determined. The results indicated that the samples of rice, ragi and defatted soy flour contained 8.6, 5.8 and 56.9 per cent protein respectively where as the corresponding values of ash content were 0.68, 2.67 and 6.90 per cent. Higher protein content of defatted soy flour made it admirly suitable for blending.

Gandhi *et al*., (2000) studied preparation and characterization of protein isolates from soya meal. Protein isolates were prepared from soya meal following aqueous alkaline extraction method. The extraction was performed under varying conditions with respect to type of extractant, meal ratio, pH and temperature. Sodium hydroxide (o.2m) with 1:20 meal to extractant ratio at 30º C yielded 45percent proteins. The protein isolate had 91 percent proteins and creamy to yellowish in colour. They can be used as supplements to improve the nutritional quality of population.

Ramachandran*et al.,* (2007) mentioned in a review that oil cakes have been in use for feed applications to poultry, fish and swine industry. Being rich in protein, some of these have also been considered ideal for food supplementation. However, with increasing emphasis on cost reduction of industrial-processes and value addition to agro-industrial residues, oil cakes could be ideal source of proteinaceous nutrients and support matrix for various biotechnological processes. Several oil cakes, in particular edible oil cakes offer potential benefits when utilized as substrate for bioprocess. These have been utilized for fermentative production of enzymes, antibiotics, mushrooms etc. Biotechnological applications of oil cakes also include their usages for vitamin and antioxidants production.

In a study on the mineral composition of corn and soybean meal, levels of several nutritionally significant minerals were determined in 16 samples of soybean meal. The findings indicated that 0.67per cent P, 2.05per cent K, 0.31 per cent Ca, 0.28 per cent Mg, 41 mg /kg, Mn, 172 mg / kg Fe, 88 mg /kg Al, 15 mg / kg Cu, 48 mg / kg Zn and 127 mg / kg Na were present in the studied samples of soyabean meal (Batal*et al*., 2010).

Chemical composition of oilseed cakes and deoiled cakes was studied by Sharma (2013) in Nepal. The SDOC (soy deoiled cakes) were assessed. The mean crude fibre content and protein in SDOC was found to be 7.16 per cent 44.80 per cent respectively.

Defatted soya flour was analysed by Naik&Shekhon (2014) to evaluate its influence on quality & stability of pretzel type product. It was noticed that defatted soybean flour used for protein enrichment of pretzels had 7.75, 6.16, 0.25, and 38.1 per cent moisture, ash, fat respectively and proteins where as the control flour had 15.50, 0.58, 0.44 and 8.84 per cent moisture, fat, and proteins respectively.

2.3Studies on Products Incorporated With Deoiled Soya Meal

Effect of incorporation of defatted soy flour on the quality of biscuits was studied Singh *et al.,* (1996). Biscuits were prepared from the blends containing varying proportions (0,10, 20, 30, 40, 50 %) of defatted soy flour (DSF) using the traditional creamery method were evaluated for diameter, thickness, spread ratio, spread factor, hardness and sensory characteristics.The organoleptic characteristics of biscuits were determined using a taste panel, consisting of 10 untrained members. The panellists were asked to evaluate the products for appearance, colour, texture, flavour and overall acceptability. A 9 point hedonic scale was used for the sensory evaluation of biscuits and the results were analyzed. Using multiple comparison test (Larmond 1977). The texture of soy fortified biscuits was significantly affected, as shown by the increased values for hardness from 26.97 N of control to 48.25 N of biscuits from wheat flour replaced with 50 percent DSF. The texture of biscuits

containing 10 percent DSF was comparable with that of control. With the increase in level of soy flour in formulation, the sensory scores for texture and flavour of biscuits decreased sharply from 8.6 to 4.0 and 8.1 to 3.2 respectively. There was no marked reduction in the scores for appearance and colour of biscuits.

Indrani*et al*., (1997) studied the effect of defatted soya flour on the quality of buns. High protein buns were prepared by replacing wheat flour with 5,10 and 15 per cent of defatted soya flour (DSF). Water absorption of dough increased from 60.4 to 67.2 per cent and dough development time from 2.0 to 5.5 min with increasing addition of soya flour. The extensibility and area values decreased gradually from 990 to 780 BU, 138 to 115 mm, 182 to 136 cm^2 respectively, indicating adverse effect on the dough properties. The result indicated that protein content increased by 25.07 per cent, 43.7 per cent and 71.5 per cent for the buns with 5, 10 and 15 per cent DSF respectively. It can be concluded from the result that high protein acceptable quality buns with increased softness can be prepared by replacing wheat flour with 10 per cent defatted soy flour.

Development of some high-protein conventional foods based on wheat and oilseed flours was undertaken by Fatima *et al.,* (2000).Various flour mixtures utilizing wheat, soy and defatted sesame flours in proportions of 70:20:10 (A) 60:20:20 (B), 50:30:20 (C), and 0:50:50 (D) were prepared and subjected to chemical and nutritional evaluation. Defatted sesame and whole soy and wheat contained high protein concentrations of 48.95 and 32.68 per cent respectively. The lipid content of soy was 20.73 per cent protein content increased from 12.11 per cent in wheat flour to 20.12 per cent in flour mixture A, 24.64 per cent in mixture B, 26.30 per cent in mixture C due to substitution of wheat flour (30, 40 and 50% respectively) with soy and sesame fours (50:50). Other constituents such as ash, crude fibre and lipids were minimum (2.21, 1.13, and 4.58% respectively) in mixture A due to the higher proportion of wheat flour. Two products cookies and macroni were prepared from flour

blends. Sensory analysis of the products was performed. A total of 263 untrained members representing both sexes (males 54 % females 46%) belonging to wide variation in their age (14 to 57years) and pertaining to vegetarian (13%) as well as non vegetarian (87%) diet participated in study. The result indicated that products made from all the flour mixtures were accepted by taste panel with overall evaluation. The highest score was obtained by cookies made from flour mixture A followed of B, C and D in that order. It was observed that control scored maximum followed by T2 (20% DSF) and T6 (60%DSF) scored least.

Vaidehi*et al*., (2000) studied high-protein biscuits made with ragi flour and oil seed flour blends. The primary purpose was to compare the acceptability of biscuits made from maida with that of biscuits made from two oil seed flours combined with white and coloredragi flours and their malts. Sixteen types of biscuits were prepared with all purpose flour (maida) for the purpose of comparing the acceptability of the biscuits made from maida with that of those made from combinations of one of two oil seed flours and either the white or the colored verities of ragi flours and their malts. Sensory evaluation on a 5 point hedonic scale showed statistically significant differences regarding the characteristics studied. Coloredragi malt and white ragi flour blended with full-fat peanut flour were found to be the most acceptable alternatives. White ragi malt blended well with defatted soy flour in ratio of 7:3. The protein content of the full-fat peanut flour blend with white ragi flour was 8.0 g per 100 g of biscuits, whereas it was 6.6 g for the control biscuits, which were prepared without peanut flour. The defatted soya flour combination with white ragi malt had a protein content of 11.0 g per 100 g, which was twice the amount found in control biscuits. A cost evaluation showed that for the same cost of regular biscuit preparation a higher amount of protein could be obtained using 70 percent millet and 30 percent defatted soya or peanut flours.

Dhingra and Jood (2001) carried out the supplementations of soy (full fat and defatted) and barley flours to wheat flours at 5, 10, 15 and 20 per cent levels to test the effects on organoleptic and nutritional evaluation of the supplemented bread. Additions of 15per cent barley flour, 10 per cent soy flour (full fat and defatted), 15per cent barley plus full fat soy flour and 15per ccent barley plus defatted soy flour to wheat flour produced acceptable breads. Various nutritional parameters, such as protein, fat, total lysine, protein digestibility (in vitro), sugars, starch digestibility (in vitro), total and available minerals, anti nutrients, dietary fibre and b-glucan were determined in supplemented and control bread. Increasing the level of substitution from 5 to 10 per cent of full fat and defatted soy flour to wheat flour significantly ($P<0.05$) increased protein (from 12.1 to 13.7 and 12.4 to 13.8 per cent), lysine (from 2.74 to 3.02 and 2.76–3.05 mg/100 g protein) and total calcium (from 70.2 to 81.4 and 71.9–81.8 mg/100 g) contents. However, there was also an increase in phytic acid (238–260 and 233–253 mg/100 g), polyphenol (324–331 and 321–329 mg/100 g) and trypsin inhibitor activity (193–204 and 193–198 TIU/g). When barley flour was substituted separately, and in combinations, with full fat and defatted soy flour up to 15percent, this significantly increased the contents of protein, total lysine, dietary fibre and b-glucan. It may be concluded that breads supplemented with barley and defatted soy flour, up to a 15 percent level, were organoleptically and nutritionally acceptable.

Efficacy of defatted soy flour supplement in gulabjamun was studied by Singh *et al*.,(2009). Soya flour was fortified in three levels (3.33, 6.66 and 9.99%) w/w to prepare different compositions of gulabjamuns by replacing wheat –flour in control recipe. It was observed that protein content of soy-fortified mix increase might be due to use of higher protein content of defatted soy flour which was significant in case of 6.66 and 9.99 per cent levels. The fat content of Gulabjamun significantly decreased with the content of raw mix having 3.33, 6.66 and 9.99 per cent levels of defatted soya. The decrease could be due to very low fat content of defatted soy flour.

Effects of defatted soy flour incorporation on physical,sensorial and nutrient properties of biscuits was investigated by Zaker*et al.,*(2011). The defatted soy flour was incorporated in the traditional recipe wheat flour at levels defatted soy flour by 0, 10, 20 and 30 percent in preparation of biscuits. Sugar was replaced by stevia and date paste while traditional shortening was replaced by olive oil. The sensory evaluation of prepared herbal biscuits was carried out by 25 member trained panel. Judgements were made through rating products on a 9 point hedonic scale with corresponding descriptive terms. Result of sensory evaluation of biscuits showed that 20 per cent addition of defatted soy flour had higher overall acceptability, taste, texture and flavour.

Nutritional and sensory evaluation of papad and badi enriched with defatted soy flour and drumstick leaves powder was carried out by Pareek*et al*.,(2011) the low cost nutritious papad and badi were prepared with incorporation of defatted soy flour (10%, 20% and 30%) and drumstick leaves powder (3%,5%,10%) in different proportions. Organoleptic evaluation was done on the basis of 9 point hedonic scale. The results of sensory evaluation revealed that among different forms of papad the papad with (10 % DSF incorporation) was most acceptable. Badiwas most acceptable which was prepared by 10 per cent defatted soy flour and 3 per cent drumstick leaves powder.

Development of functional chapatti from texturiseddeoiled cake of sunflower, soybean and flax seed was carried out. Texturised defatted meal of sunflower, soyabean and flax seed was blended at 10, 20, 30 and 40 per cent levels with wheat flour (atta) for making chapatti. Sensory evaluation of chapatti was done by a semi trained panel, for top grain, texture, flavour and overall acceptability using a 9 point hedonic scale. The result of statistical analysis showed that there was significant difference in color, appearance, texture, flavour and overall acceptability of chapatti as compared to control. Overall acceptability scores for chapattis incorporated with texturised defatted sunflower, soybean and flaxseed were decreased with increased level ranging

from 7.85 to 5.90, 8.50 to 6.80 and 7.95 to 6.15 respectively. Chapattis made from 10 per cent texturised defatted sunflower, soybean and flaxseed were given maximum overall acceptability scores compared to higher levels. The biochemical analysis indicated that the defatted soyabean meal had 2.70 per cent moisture, 2.26 per cent fat, 52.86 per cent protein, 3.29 per cent fibre and 56.33 per cent protein digestibility. The addition of texturised defatted sunflower, soyabean and flax seed flour in chapattis showed significant improved in crude protein, crude fiber, ash and protein digestibility. It can be concluded that the deoiled cake, a by product obtained from sunflower, soyabean and flax seed oil industry offers great potential for supplementation of proteins in food products (Bhise&Kaur, 2013).

Effect of partial substitution of wheat flour with either defatted soybean or chickpea flours at different ratios on rheological and physical properties of dough, and quality characteristics of biscuits observed by Saleh*et al.,* (2012). The study was conducted to evaluate the effect of partial replacement of wheat flour with either defatted soybean (DSF) or chickpea (CPF) flours at different rates; 5, 10, and 15 percent of both on the rheological and physical properties of dough and quality criteria of produced biscuit, as compared with the biscuit produced by using wheat flour (72% extract) only which was taken as control sample. The DSF at 5 to 15 per cent substitution levels increased the water absorption and the stability, and decreased the degree of softening of dough, while the CPF at same ratios increased the water absorption and degree of softening of dough and decreased the stability of the dough. The DSF caused an increase in the resistance to extension, proportional number, energy and diminished extensibility of dough. However, the CPF increased extensibility, energy of dough, while it decrement the resistance to extension and proportional number of dough. Chemical composition results showed that the DSF had highest crude protein and ash contents, meanwhile the CPF had the highest ether extract and crude fiber contents. In the case of the DSF substitution at different levels in biscuit blends, the crude protein and ash contents increased, while carbohydrates content decreased. Moreover, the

increasing in the CPF levels led to increase in crude protein, ether extract, and crude fiber contents and decreased the carbohydrates content. The addition of the DSF or the CPF adversely affected the thickness and diameter and thus, spread ratio of the substituted biscuits. Evaluation of the organoleptic properties of biscuit revealed that no significant differences were noticed at levels of 5 per cent DSF and 10 per cent CPF, when compared with the control. However, significant differences at level of 10 per cent &15 per cent DSF and of 5 per cent & 15 per cent CPF replacement were observed.

Naik and Sekhon (2014) studied influence of defatted soy flour addition on the quality and stability of pretzel type product. Effect of soya flour addition to 70 per cent extraction bread wheat flour (PBW34) at (0, 5, 10, 20 and 30%) was investigated. Organoleptic evaluation revealed that 5 per cent level of soya flour blended pretzals were found to be best with respect to texture, color and flavour on the basis of mean acceptability scores. Based on rheological and organoleptic studies, defatted soy flour addition up to 10 per cent level is suitable for pretzel production however, to have better storage stability 5 per cent level of addition is the best.

Development of value added fruit jams was carried out byArya*et al.,* (2016). Amala and apple jams were prepared with incorporation of nutritious ingredients (beet root powder, deoiled soya meal powder (DOSM), milk powder and watermelon powder) and were evaluated to find out the most suitable and highly accepted level of incorporation. The organoleptic evaluation indicated that value added amala and apple jam prepared with incorporation of beet root powder, milk powder, watermelon powder and de-oiled soya meal power at the levels of 1, 8, 6 and 5 per cent and 1, 12, 12 and 9 per cent, respectively were well accepted by judges. Due to value addition there was increase in protein (5.85 g/100g), total minerals (0.71 g/100g), calcium (111.5 mg/100g), iron (7.93 mg/100g) and zinc (1.37 mg/100g) content of amala jam. The incorporation of nutrient rich ingredients to apple jam was helpful in increasing its nutrient content significantly. There was increase in

protein (10.36 g/100g), total minerals (1.35 g/100g), fibre (0.49g/100g) calcium (175.73 mg/100g), iron (16.68 mg/100g) and zinc (3.57 mg/100g) content of apple jam. It is concluded that nutrient content can be increased by incorporating nutritious ingredients in both the jams.

Arya*et al., (*2016) developed ready to cook nutritious extruded product *Nutrisnacks.*It was prepared by using nutritious ingredients such as calcium rich amaranth seeds (Amaranthuspaniculatus), iron rich rice flakes and protein rich deoiled soya meal (DSM). Apart from these refined wheat flour, semolina and rice were used. By changing proportion of DSM four variations were finalized for selecting the superior one. The acceptability of selected cooked *Nutrisnack*was assessed by using 9 point Hedonic Scale. The nutrient composition was analyzed and shelf life was studied by packaging in plastic container and aluminum pouch. Student's 't' test and ANOVA were implied for analysis of data. The organoleptic scores of test variations depicted that the maximum incorporation of 20 per cent of DSM in *Nutriasnacks*was best accepted by the panel members. The nutrient composition of basic and accepted *Nutrisnacks*showed moisture 1.73 and 1.92 per cent; protein 9.33 and 23.33 per cent; fat 1.08 and 1.82 per cent; total minerals 1.2 and 1.7 per cent; carbohydrates 85.22 and 68.57 per cent; fibre 1.43 and 2.65 per cent; energy 384 kcal and 386 kcal; iron 11.31mg and 12.65mg; calcium 89mg and 139 mg and calculated beta carotene 4 and 34 µg /100g, respectively. Developed extruded snacks were accepted after a period of 10 months. The findings concluded that deoiled soya meal can be incorporated up to 20 per cent in *Nutrisnacks* to increase its nutritive value significantly.

Doke*et al*., (2016) Development of value added papaya and pineapple jams. Both jams were prepared with incorporation of beet root powder, deoiled soya meal powder (DOSM), milk powder and watermelon powder. The organoleptic evaluation indicated that value added papaya and pineapple jam prepared with incorporation of beet root powder, milk powder, watermelon powder and de-oiled soya meal power at the levels of 2, 3, 10 and 10 per cent

and 1, 5, 6 and 8 per cent, respectively were accepted. Due to value addition there was increase in protein (5.41 g/100g), total minerals (0.73 g/100g), calcium (94.93 mg/100g), iron (7.93 mg/100g) and zinc (2.20 mg/100g) content of papaya jam. There was significant increase in protein (5.4 g/100g), total minerals (1.41 g/100g), calcium (94.2 mg/100g), iron (16.08 mg/100g) and zinc (2.74 mg/100g) content of pineapple jam.

Development of biscuits incorporated with defatted soya flour and carrot pomace powder was studied (Sindhu*et al*., 2016). The research revealed that the healthy biscuits incorporated with carrot pomace powder and defatted soya flour as functional ingredients can be formulated. The fibre content and beta-carotene level significantly improved in the biscuits with the increase in the proportion of DSF and CPP. On the basis of nutritional and sensory quality, biscuit when incorporated with blends of 17 percent defatted soya flour and 12 percent carrot pomace powder resulted in better quality. This functional biscuit is nutritionally more superior to that of whole wheat flour biscuits.

Yadav and Bhatnagar (2016) studied formulation, quality evaluation and shelf – life of value added cereal bar by incorporation of defatted soy flour. Nutrient composition of control cereal bar and value added cereal bar prepared by incorporating defatted soya flour was estimated. It was noticed that the Control was found to contain moisture 0.27 ± 0.09 percent, protein 9.32 ± 0.30 percent, fat 9.68 ± 0.06 percent, ash 1.24 ± 0.00 percent and energy 439 ± 0.68 kcal/100g. The control product was noted to be significantly lower than the DSF added cereal bar ($p \leq 0.05$) *i.e.,* moisture 0.31 ± 0.03 per cent, protein 19.61 ±0.00 per cent , fat 9.91 ± 0.05 per cent, ash 1.63 ± 0.00 per cent and energy 440.37 ± 0.19 kcal/100g. But the carbohydrate content of the DSCB (68.17 ± 0.09 %) was observed to be significantly lower than the control (78.56 ± 0.25 %). Defatted soy cereal bar packed in HDPE by vacuum packing was found stable and acceptable up to three months of storage.

Material and Methods

CHAPTER-III

MATERIALS AND METHODS

The present study was designed to evaluate the acceptability of different food products prepared by incorporating deoiled soya meal. The investigation was carried out in two phases. During phase I a survey was conducted to elicit information on consumption of deoiled soya meal. During phase II different food products were prepared by incorporating deoiled soya meal and their acceptability was evaluated. The highly accepted variations among selected products were analyzed for nutrient composition.

3.1 Survey

A house to house visit was given and a survey was carried out for obtaining information on consumption and storage practices of deoiled soya meal and to assess the nutritional awareness regarding deoiled soya meal.

3.1.1 Survey Schedule

A questionnaire was framed containing different questions to obtain information on socioeconomic status, literacy level & consumption pattern of deoiled soya meal. Questions included were regarding the frequency of consumption, form of consumption, method of procurement, storage, awareness regarding the nutritional importance and health benefit of deoiled soya meal (Appendix I).

3.1.2Selection of Sample

Hundred households were selected at random from different parts of Parbhani city for conducting the survey. The selected households were personally interviewed to elicit the information regarding consumption pattern of deoiled soya meal (plate 1).

3.2Procurement of Deoiled Soya meal

Good quality deoiled soya meal was procured from a soya oil mill located in MIDC area of Parbhani. Meal was cleaned to remove impurities. The

Plate 1. Investigator conducting survey

selected deoiled meal in raw form was sterilised to make powder. After sterilization it was ground to fine powder & sieved through 40 mesh sieve. Deoiled soya meal powder was stored in air tight container in the refrigerator for development of food products (plate 2 and 3).

3.3Selection of Recipes

Seven recipes that are commonly prepared at household level inMaharashtraian families such as bhakari, chapatti, chakali, fenugreek leaves paratha, kharapara, rawaladdu, shev, and two bakery products viz. salt biscuits and sweet biscuits were selected for incorporation of DSM. Among the selected products bhakri and chapati are commonly prepared as a part of regular meals. *Chakli,kharapara*, rawaladduand *shev* are used as snack items where as *sweet biscuits* and salt biscuits are used as bites. The selected products are very popular and are consumed by all the age groups.

3.4 Acceptability Studies

The acceptability studies comprised of selection of level of soya meal incorporation and sensory evaluationof products**.**

3.4.1Selection of Level of Incorporation

After experiments on trial and error basis of acceptability, levels for incorporation of deoiled soya meal into different recipes were decided. The selected levels were 10, 20, 30 and 40 per cent. Thus, five variations of each product were prepared for further sensory analysis. Variation one was basic recipe which was prepared without incorporation of deoiled soya meal and it served as control. Variations II to V were experimental samples with varying levels of soya meal incorporated in it.

3.4.2Sensory Evaluation

The threshold test was carried out on 30 panel members. Out of this 15 panel members who were having highest score for threshold test were selected as judges for organoleptic evaluation of the recipes. The samples of all variations of each selected recipe were served in fresh state to 15 selected

Plate 2. deoiled soya meal

Plate 3. Powder of deoiled soya meal

Plate 4. Sterilization of deoiled soya meal

judges for the evaluation of sensory characteristics. The sensory evaluation was carried out by following five point ranking test (Shrilakshmi, 2004). The sensory parameters evaluated were colour, flavour, texture, taste and overall acceptability. Each parameter was evaluated for maximum score of 5 points with the help of proforma (Appendix-III).

3.4.3Final Selection of Recipes

Among the four variations of the products prepared with incorporation of deoiled soya meal evaluated by sensory evaluation, one variation was selected for further nutritional analysis. The basis for final selection of the recipe was maximum mean score of acceptability of that variation. For each recipe one such particular variation with highest acceptability score was selected.

3.5Nutrient Analysis

Basic and the best accepted variations of the products under study were bio-chemically analyzed for assessing their nutrient content. The proximate composition (moisture, protein, fat, fiber, total minerals, and carbohydrates) calcium and trace elements viz. iron, magnesium, manganese, copper and zinc were estimated (plate 4).

The proximate composition was carried out as per procedures prescribed by A.O.A.C.,(1975) method. The trace elements were estimated by Atomic Absorption Spectrophotometer (Perkin R. Elmer Model-3110). The calcium was estimated by EDTA method. The values for all nutrients except moisture were averages of triplicate value on dry weight basis. Moisture was expressed on fresh weight basis (Appendix IV).

3.6 Acceptability of Value Added Products During Storage

Highly accepted variations of bhakari, chapati, fenugreek leaves paratha, kharapara, rawaladdu, shev, salt biscuits and sweet biscuits were stored at room temperature. Acceptability of salt biscuits and sweet biscuits was assessed by fortnightly up to 60 days, kharapara, chakali, semolina laddu and shev were

assessed by 28 days using five point ranking scale.*Fenugreek leaves paratha* was assed everyday. All products were evaluated till they were very well accepted by judges.The sensory evaluation was carried out by following five point ranking test (Shrilakshmi, 2004). The sensory parameters evaluated were colour, flavour, texture, taste and overall acceptability. Each parameter was evaluated for maximum score of 5 points with the help of proforma (Appendix-III).

3.7 Statistical Analysis

The collected data was consolidated, tabulated and analyzed statistically. Suitable statistical tests were used to find out the difference between different variables. The analysis of variance was followed for interpreting the differences between different variations for individual sensory characters. The statistical difference with regard to nutrient content of developed products prepared with and without incorporation of deoiled soya meal was tested by‘t’ test (Panse and Sukhatme, 1985).

Plate 4. Analysing the mineral content of developed food products

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

Deoiled soya meal is by product obtained after extraction of oil from soyabean. As it is rich in protein, it can be used for value addition. Hence, the present investigation "Utilization of defatted soya meal for development of value added food products" was undertaken. Nine food products such *as bhakari, chapati, chakali, fenugreek leaves paratha, kharapara , semolina laddu, salt biscuits, sweet biscuits and shev* were prepared with incorporation of deoiled soya meal at various levels and evaluated organoleptically for acceptability. These products were analysed in the laboratory for their nutritional composition. Shelf life of developed products was assessed. The data were tabulated and analysed statistically. The results obtained are presented in this chapter under various heads.

4.1a. General Information of Homemakers from Selected Households; Consumption Practices and Nutritional Awareness of Deoiled Soya Meal

4.2 Nutritional Profile of Deoiled Soya Meal

4.3 Development of Value Added *Bhakari*

4.4 Development of Value Added *Chapati*

4.5 Development of Value Added *Chakali*

4.6 Development of Value Added Fenugreek Leaves Paratha

4.7 Development of Value Added *Kharapara*

4.8 Development of Value Added *Semolina Laddo*

4.9 Development of Value Added *Salt Biscuits*

4.10 Development of Value Added *Sweet Biscuits*

4.11 Development of Value Added *Shev*

4.1. General Information of Homemakers from Selected Households; Consumption Practices and Nutritional Awareness of Deoiled Soya Meal

A survey of randomly selected 100 households was conducted in Parbhani city. The information regarding general information regarding general aspects of households and consumption pattern of deoiled soya meal was collected with the help of pre tested questionnaire by personally interviewing the homemakers (Table1).

The data regarding general information of homemakers from selected households indicated that age group of selected subjects was ranging from 25 to 45 years. Most of the respondents (64%) were belonging to 30-45 years of age while 36 per cent were of the age 25 to 30 years. The subjects from nuclear families were 74 per cent and 26 per cent were from joint families. The data with regard to occupation revealed that maximum subjects (50%) were housewives, 22 per cent subjects were engaged in different services, 16 per cent were laborers and 12 per cent were farmers. Monthly income of households reveled that 4 per cent respondents had less than Rs. ten thousand, 24 per cent were earning 10 to 20 thousand rupees, 31 per cent were having between 20 to 30 thousand rupees, 27 per cent earned 30 to 40 thousand rupees and 14 per cent were having it above 40 thousand rupees. On the whole, it is concluded that majority of selected respondents were housewives, belonging to middle age, nuclear families and were having monthly income between 10 to 40 thousand rupees.

Information regarding consumption and nutritional awareness of deoiled soya meal as reported by homemakers indicated that 66 per cent respondents were vegetarian while remaining 34 per cent non vegetarians. None of the surveyed household consumed deoiled soya meal. Among the selected housewives 87 per cent were not at all aware regarding deoiled soya meal while, only 13 percent of them reported that they knew about deoiled soya meal. Awareness about nutrient content, the nutritional importance and health benefits and nutrient richness was noticed among only 7 per cent subjects however, 93 per cent were unaware about nutritional aspects of deoiled soya meal. Awareness regarding value addition was not found among 92 per cent housewife while, only 8 per cent of them were aware about it. None of the selected respondent knew about the price of deoiled soya meal.

Table 1. General information ,Consumption practices and nutritional awareness regarding deoiled soya meal by selected households

A	S.no	Age group	Percent	Type of family	Percent	Occupation of homemakers	Percent	Monthly income	Percent
	1.	25 to 30	36	Nuclear	74	Teacher	13	I - < Rs.10000	4
	2.	30 to 45	64	Joint	26	Lecturer	02	II (Rs.10000-20000)	24
						Other jobs	10	III - (Rs.20000-30000)	31
						Labour	14	IV - (Rs.30000-40000)	27
						Farmer	11	V - (>Rs.40000)	34
						Housewife	50		

B	Food habits		Consumption of DOSM		Awareness about DOSM		Awareness About nutrient content of DOSM		Awareness about nutritional importance and health benefits of DOSM		Awareness regarding nutrient richness		Awareness about value addition		Practice of value addition		Price of DOSM	
	Food Habits	percent	Responce	percent	Responce	percent	Responce	percent	Responce	percent	Responce	percent	Responce	percent	Responce	percent	Responce	percent
	veg	66	yes	0	yes	13	yes	7	yes	7	yes	7	yes	8	yes	0	Yes	0
	Non veg	34	No	100	No	87	No	93	No	93	No	93	No	92	No	100	No	100

4.2 Nutritional Profile of Deoiled Soya Meal

Table 2. reveals the data about nutrient content of deoiled soya meal.

Table 2. Nutrient content of deoiled soya meal (per 100g)

Nutrients	Mean ± SD
Moisture (g)	5.87± 0.01
Protein (g)	58.68 ± 1.28
Fat (g)	3.21± 0.02
Total minerals (g)	4.82± 0.46
Crude Fiber (g)	4.48± 0.34
Carbohydrates (g)	23.03 ±0.16
Calcium (mg)	175.0±34.77
Iron (mg)	9.73±0.20
Copper (mg)	4.18±0.18
Zinc (mg)	6.57±0.38
Manganese (mg)	10.89±0.05

The moisture content of the deoiled soya meal was 5.87± 0.01 per cent while protein content was 58.68 ± 1.28 per cent. The fat content and total mineral content was found to be 3.21± 0.02 and 4.82± 0.46 per cent respectively. It was noticed that the fiber content of the deoiled soya meal was 4.48 ± 0.34 g/100g. The calculated value of carbohydrate was 23.03±0.16 per cent. Trace elements were analysed using Atomic Absorption Spectrophotometer (AAS). The data indicated that the deoiled soya meal contained 175±34.77mg calcium, 9.73±0.20mg iron 4.18±0.1mg copper 6.57±0.38 mg and 10.89±0.05 manganese per 100gm.

From these findings it is revealed that, deoiled soya meal is a very rich source of protein, total minerals, crude fiber, calcium and iron. The carbohydrate content seems to be low which may be because of presence of other major nutrients in higher amount. Incorporation of deoiled soya meal in food products would be helpful in increasing the level of these nutrients in the products.

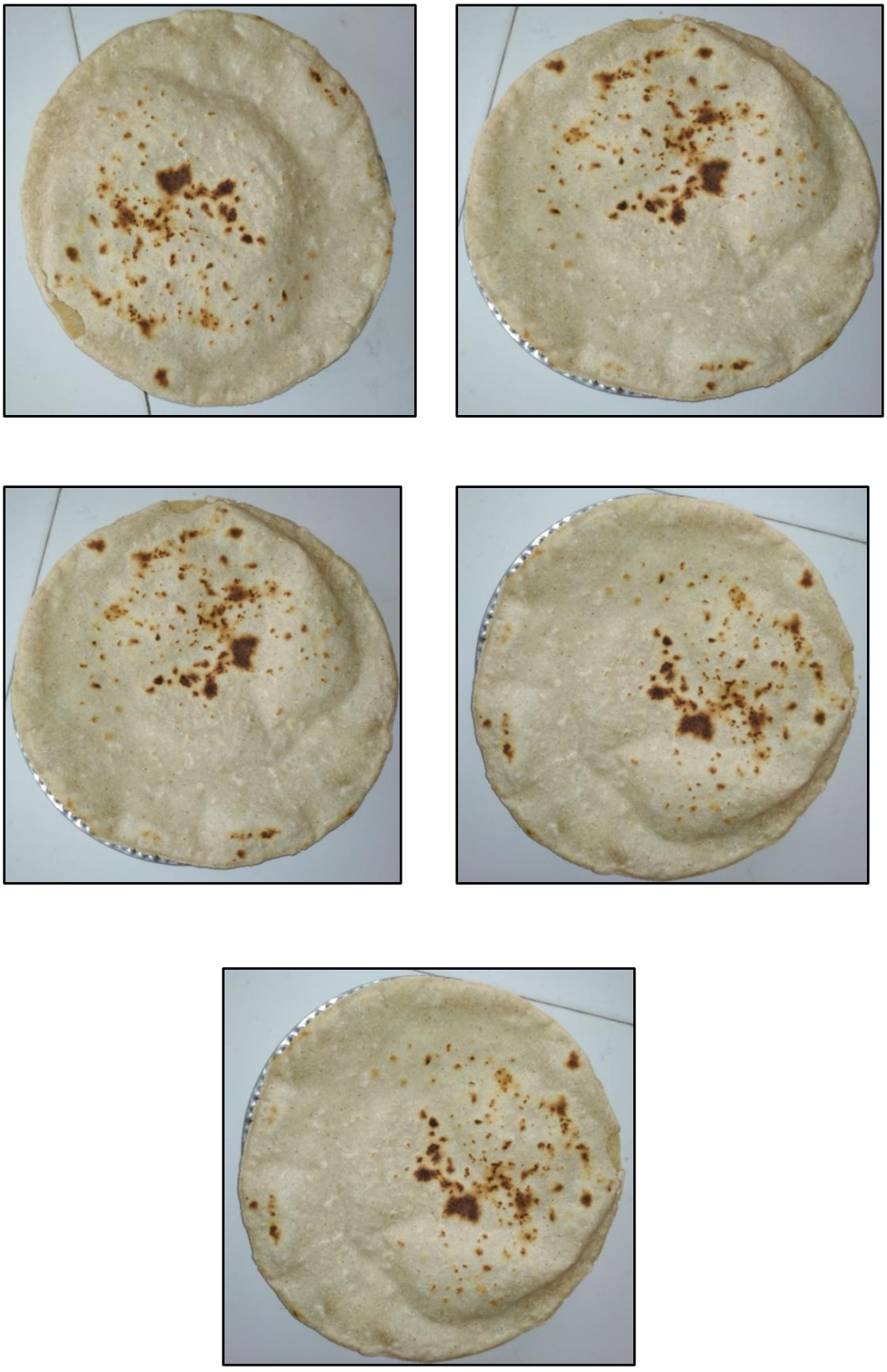


Plate 5. *Bhakari* prepared with incorporation of deoiled soya meal at different levels

4.3. Development of Value Added *Bhakari*

Bhakari is a commonly consumed staple recipe included in the full course meal was prepared with and without deoiled soya meal. It was prepared using jowar flour without addition of deoiled soya meal and with varying levels of deoiled soya meal. It was evaluated for following parameters.

4.3.1 Sensory Evaluation of *Bhakari*

A brief picture of mean scores of various organoleptic parameters of *bhakari without* and with incorporation of deoiled soya meal is presented in Table 3 and illustrated in Plate 5 and Fig.1

Table 3. Sensory evaluation scores of *bhakari*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.7	4.7	4.7	4.7
II	10	4.5	4.5	4.5	4.5	4.5
III	20	4.6	4.6	4.6	4.6	4.6
IV	**30**	**4.8**	**4.7**	**4.8**	**4.7**	**4.8**
V	40	4.2	4.2	4.1	4.2	4.2
CD		0.48	0.47	0.41	0.37	0.35
SE ±		0.16	0.15	0.14	0.163	0.15
F-value		1.9 NS	1.4 NS	3.1 NS	1.4 NS	2.3 NS

NS – Non significant

The incorporation of deoiled soya meal was at the levels of 10, 20, 30 and 40 per cent. Addition of deoiled soya meal at 40 per cent level increased the sensory scores of all organoleptic parameters except taste and flavour. The score of taste, and flavour of *bhakari* of basic sample and sample with 40 per cent incorporation of deoiled soya meal were observed to be same. Other parameters such as colour, texture and overall acceptability were given scores of 4.7 for basic and 4.8 for variation IV (30 per cent incorporation of deoiled soya meal) by the judges. Above data indicates that the *bhakari* can be very well prepared with incorporation of 30 per cent deoiled soya meal.

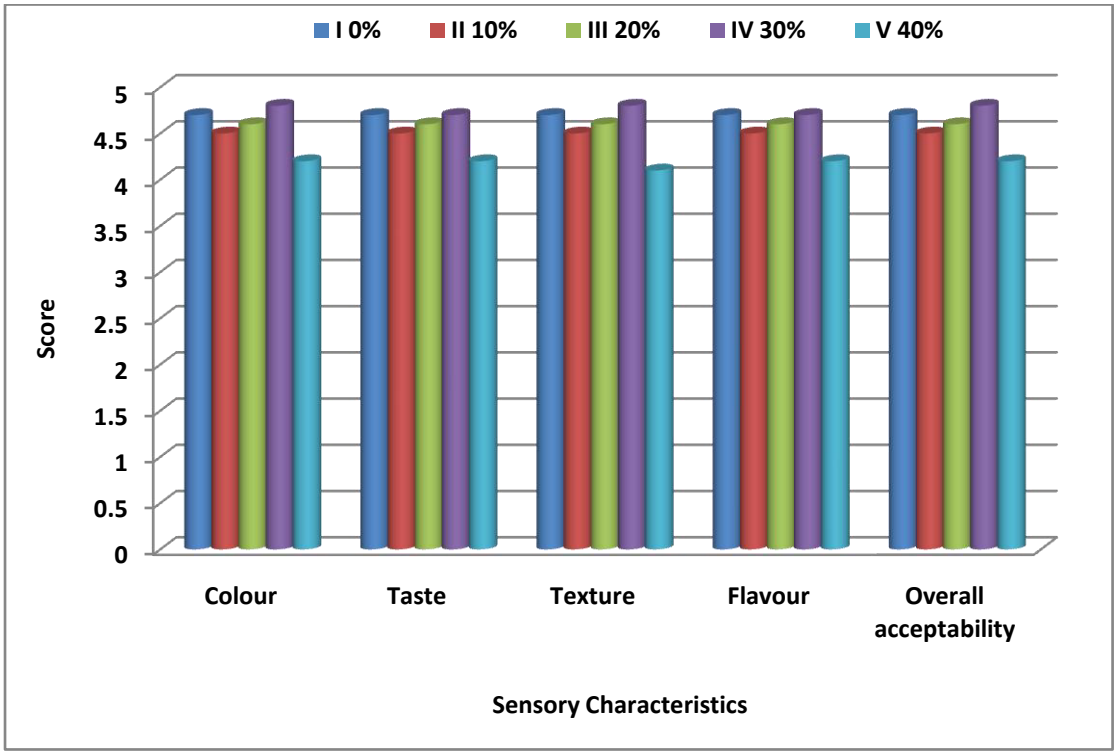


Fig. 1. Sensory evaluation scores of *bhakari*

The statistical analysis of data indicated that there was no significant difference in the scores of various attributes. The scores of all parameters for different variations were at par. From these findings, we can suggest that 30 per cent incorporation of deoiled soya meal is suitable for preparation of *bhakari*

4.3.2 Nutrient Content of *Bhakari*

Table 4. denotes the proximate nutrient content of *bhakari*. The moisture content of basic *bhakari* was 7.53 per cent whereas for value added *bhakari* it was 8.10 per cent. The protein content of basic and value added *bhakari* was 8.19 and 18.9 per cent respectively. The protein content of deoiled soya meal incorporated *bhakari* was increased by 10.71 g. The fat content of value added *bhakari* was increased from 1.75 per cent to 2.1 per cent. The fiber and total mineral content of experimental variation sample was increased by 0.9 g (from 1.05 to 1.95 g/100g) and 0.36 g (from 0.017 to 0.37 g/100g) respectively. The increase in the fiber and total minerals content was statistically not significant. The carbohydrate content of basic sample was significantly higher (80.72 %) than value added sample (66.61 %).

Table 4. Nutrient content of *bhakari* (per 100g)

Nutrients	Basic *Bhakari*	Value added *Bhakari*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	7.53±1.5	8.10 ± 0.92	0.56^{NS}	+0.93
Protein (g)	8.19 ± 0.07	18.9± 0.7	21.53**	+10.71
Fat (g)	1.75 ± 0.35	2.1± 0.57	1.39^{NS}	+0.35
Total minerals (g)	1.05± 0.05	1.95± 0.45	2.88^{NS}	+0.9
Fiber (g)	0.017±0.01	0.37± 0.2	2.5^{NS}	+0.36
Carbohydrates (g)	80.72 ± 0.32	66.61± 0.5	33.61**	-14.11
Calcium (mg)	25±5	40.5 ± 5	4.36*	+15
Iron (mg)	1.81±0.1	4.17.±0.5	6.55**	+2.36
Copper (mg)	0.22±0.05	0.56±0.51	0.96^{NS}	+0.34
Zinc (mg)	0.95±0.12	0.98±0.44	0.93^{NS}	+0.3
Manganese (mg)	0.77 ± 0.04	0.78 ± 0.004	3.03^{NS}	+0.1

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

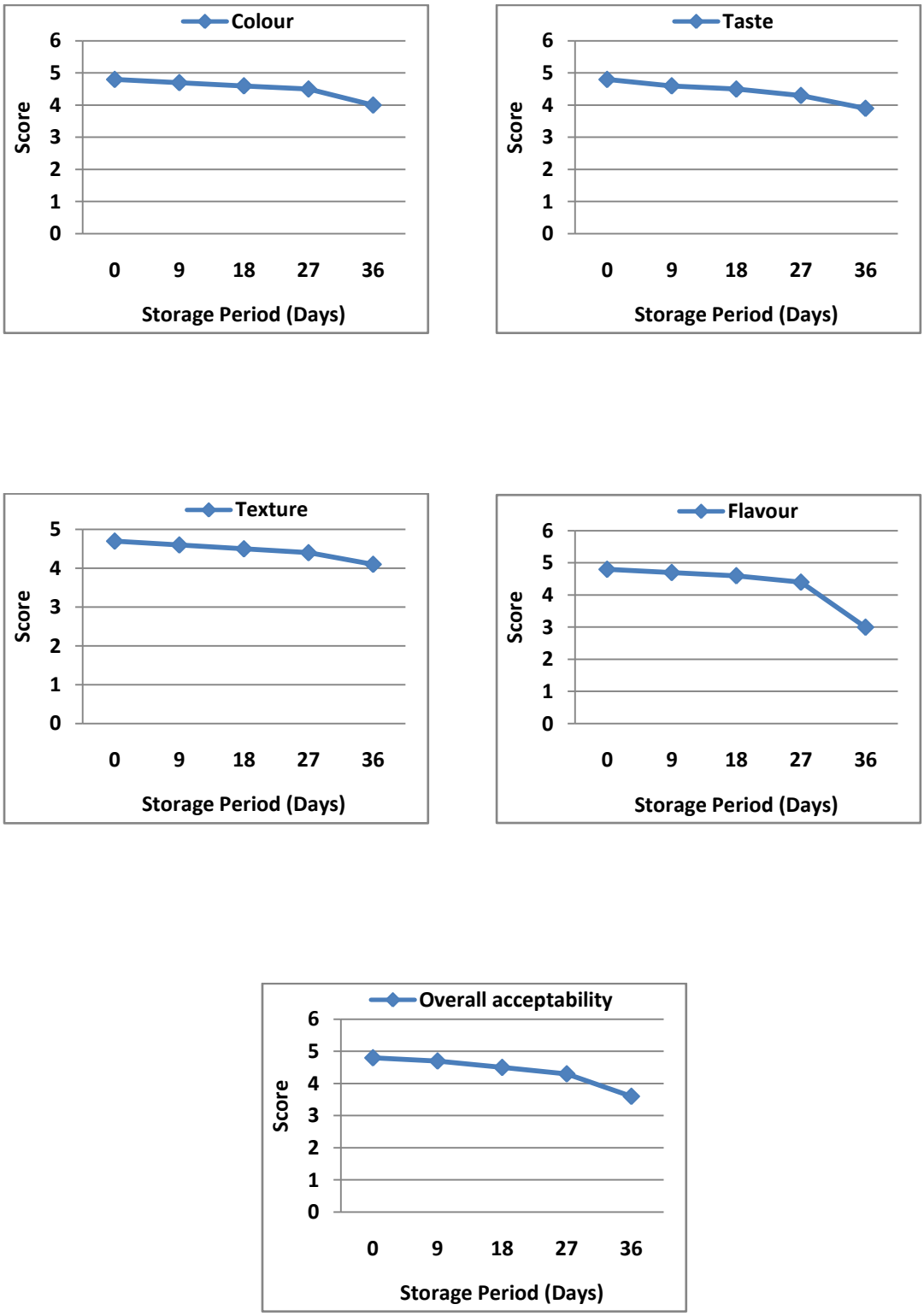


Fig. 2. Mean sensory scores of *bhakari* before and after storage

The calcium content of value added *bhakari* was increased from 25mg/100g to 40.5 mg/100g. About, 4.17 mg/100g of iron was present in value added *bhakari* whereas the iron content of basic *bhakari* was 1.81 mg/100g. Value added bhakari could not increase the values of micro mineral content i.e.copper, zinc and magnease significantly. The lesser amount of iron in jowar flour (4.1 mg/100g) might be responsible for lower iron content of basic *bhakari.* i.e. copper, zinc and manganese significantly.

With reduced fat content and increased protein, calcium and iron content, deoiled soya meal incorporated *bhakari* could be used instead of traditional *bhakari* by the people who have dietary restriction of carbohydrates and fat and want to have more protein, calcium & iron from same amount of *bhakari*. (The increase in calcium and iron content of value added *bhakari* was significant.)

4.3.3 Shelf Life Study of *Bhakari*

The mean sensory scores of bhakari before and after storage are given in Table. 5 and Fig. 2 Bhakari prepared with 30 per cent incorporation of deoiled soya meal was selected for storage study. It was stored in an air tight container at room temperature. Scores for colour (from 4.8 to 4.0), scores for taste (4.8 to 3.9) texture from (4.7 to 4.1) and flavour was (4 .8 to 3.6) showed a reduction after 30 hours of storage. Significant reduction on 27 hour of storage. The scores and overall acceptability from significantly (4.8 to 3.6) after 36 hrs.

Plate 6. *Chapati* prepared with incorporation of deoiled soya meal at different levels

Table 5. Mean sensory scores of *bhakari* before and after storage

Storage hours	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
0	4.8	4.8	4.7	4.8	4.8
9	4.7	4.6	4.6	4.7	4.7
18	4.6	4.5	4.5	4.6	4.5
27	4.5	4.3	4.4	4.4	4.3
36	4.0	3.9	4.1	3.0	3.6
CD	0.32	0.31	0.30	0.20	0.42
SE ±	0.11	0.11	0.10	0.075	0.15
F-value	8.6**	9.5**	4.8**	15.12**	10.66**

** Significant at 1 per cent

At the end of the storage period, though the difference in scores of all organoleptic parameters was significant, bhakari was well accepted by the judges on 36 hour also. Hence, it can be inferred that bhakari prepared with deoiled soya meal can be stored for about 36 hours.

4.4 Development of Value Added *Chapati*

Chapati is a inseparable part of Indian meal irrespective of State. *Chapati* was prepared by using the only wheat flour and by replacement of wheat flour with deoiled soya meal.

4.4.1 Sensory Evaluation of *Chapati*

The mean sensory scores of *chapati* revealed that there was slight higher shift in the scores of organoleptic parameters such as colour (from 4.6 to 4.8) and texture (from 4.7 to 4.8) due to value addition

Table 6. Sensory evaluation scores of *Chapati*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.6	4.7	4.7	4.8	4.8
II	5	4.6	4.6	4.6	4.6	4.6
III	10	**4.8**	**4.7**	**4.8**	**4.8**	**4.8**
IV	15	4.5	4.5	4.5	4.6	4.6
V	20	4.2	4.2	4.1	4.1	4.2
CD		0.36	0.32	0.43	0.42	0.34
SE ±		0.161	0.14	0.1	0.15	0.15
F-value		2.02 NS	2.47 NS	2.92 NS	3.99**	2.42 NS

** Significant at 1 per cent NS-Non Significant

The organoleptic scores of other parameters remained unchanged up to 20 per cent level of incorporation of deoiled soya meal in *chapati*. The further increase in the incorporation level of deoiled soya meal resulted in decrease in the sensory scores with respect to all sensory parameters. There was decrease up to 4.1 to 4.2 in the scores. Hence, 10 per cent incorporation of deoiled soya meal proved to be good for preparing *chapati*.

4.2.2 Nutrient Content of *Chapati*

Nutrient composition of *chapati* was estimated in laboratory and the results are indicated in Table 7.

Table 7. Nutrient content of *chapati* (per 100g)

Nutrients	Basic *chapati*	Value added *chapatti*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	7.13±1.62	9.93± 1.02	2.5NS	+2.8
Protein (g)	8.19 ± 0.07	16.94 ± 0.42	29.06**	+8.75
Fat (g)	1.32 ± 0.04	1.75 ± 0.04	1.05NS	+0.43
Total minerals (g)	1.05± 0.04	1.95 ± 0.05	0.99NS	+ 0.9
Fiber (g)	1.45±0.25	1.59 ± 0.25	0.56NS	+ 0.14
Carbohydrates (g)	81.35 ± 0.5	68.55 ± 0.5	25.6**	+12.8
Calcium (mg)	45±5	62.5± 2.5	4.42*	17
Iron (mg)	0.93±0.3	2.27±0.5	3.25*	+1.34
Copper (mg)	0.155± 0.05	0.20± 0.25	2.77NS	-0.04
Zinc (mg)	1.05±0.008	1.06±0.008	0.34NS	+0.1
Manganese (mg)	0.021 ± 0.18	0.65 ± 0.054	1.15NS	+0.14

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

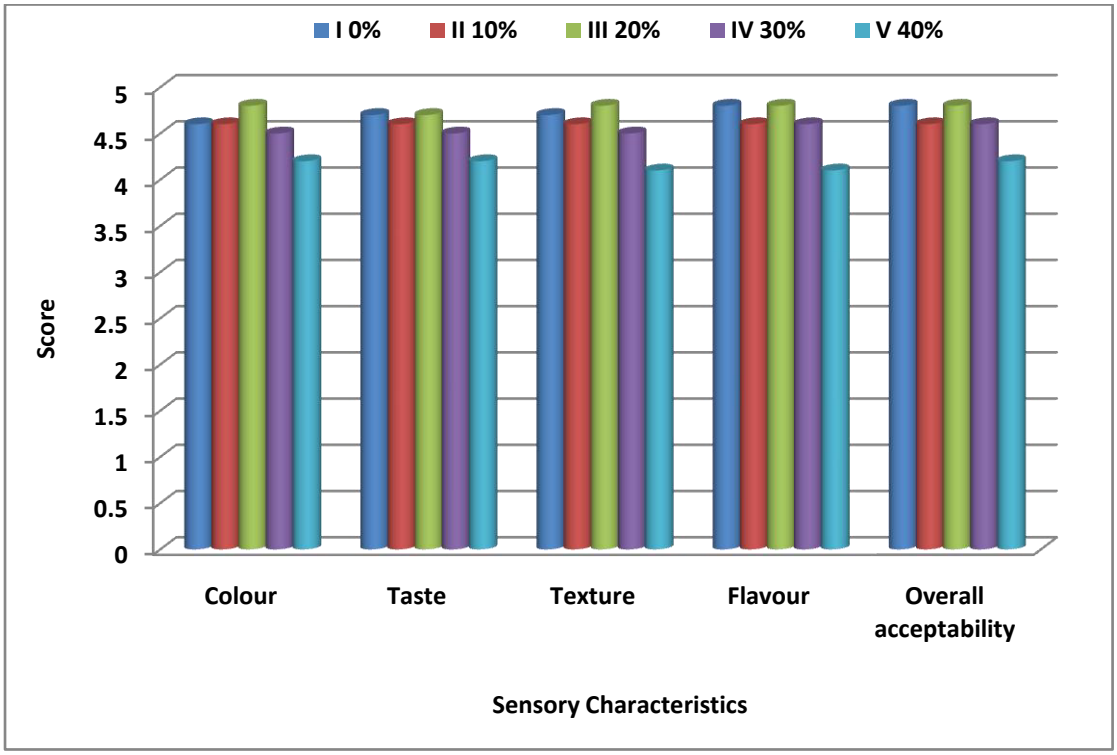
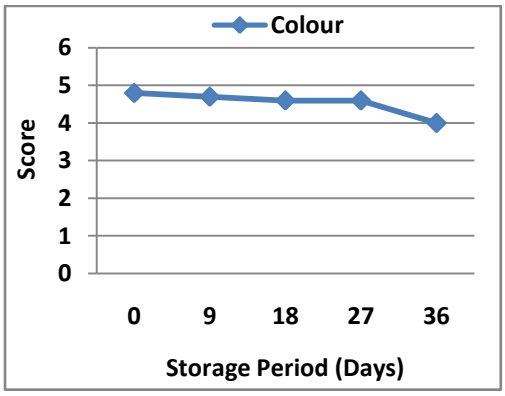
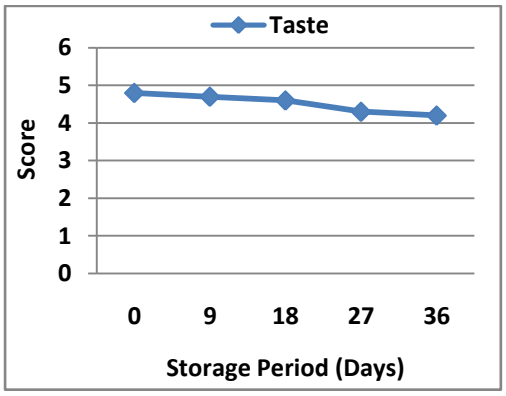
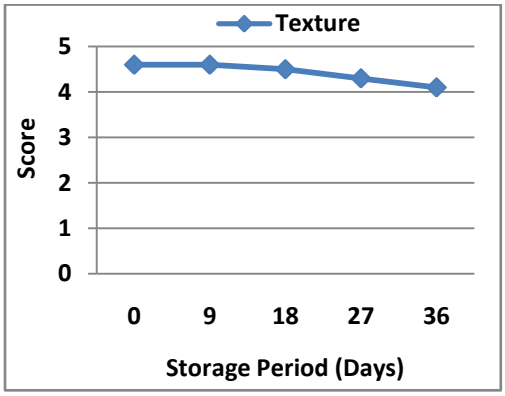
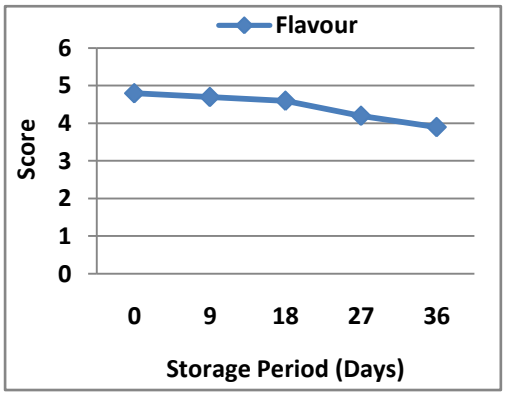


Fig. 3. Sensory evaluation scores of *Chapati*









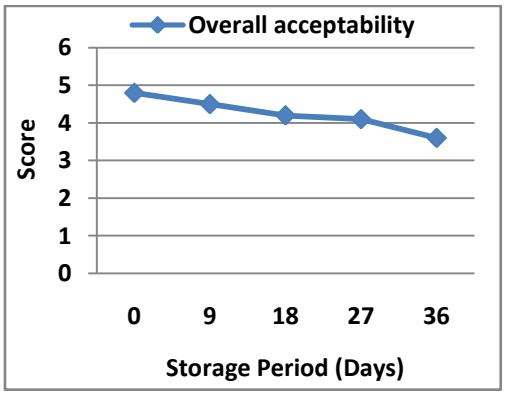


Fig. 4. Mean sensory scores of *chapati* before and after storage

Chapati was prepared with 10 per cent incorporation of deoiled soya meal and without incorporation of deoiled soya meal. The nutrient content of basic *chapati* and value added *chapati* revealed that the moisture content of the value added *chapati* was increased by 2.8 g (from 7.13 to 9.93 %). The protein content of value added chapati showed significant increase in value. The basic sample contained 8.19 per cent protein and value added sample contained 16.94 per cent of protein.

The fat content was increased from 1.32 g to 1.75 g/100g in *chapati*. Fiber content of value added *chapati* increased from 1.45 to 1.59 g/100g whereas mineral content was increased from 1.05 to 1.95 g/100g.

Carbohydrate content of deoiled soya meal incorporated *chapati* was by 68.55g which was significantly less than basic (81.35 g/100g). The calcium content of basic *chapati* was significantly lower (45) than value added *chapati* (62.5 mg/100g). Further, it was noticed that the iron content of value added *chapati* was significantly increased from 0.93 to 2.27 mg/100g.

Other minerals content such as copper, zinc and manganese did not show any statistical difference between basic and value added *chapati*. The copper content of basic and value added *chapati* was 0.155 and 0.20 mg/100g, zinc content was almost same for basic and value added chapati. Similar trend was noticed about zinc 1.05 and 1.0/100gm while manganese content was 0.065 and 0.21 mg/100g respectively.

From the findings, it can be suggested that value added *chapati* would be better than basic *chapati,* as it was a rich source of protein and contained higher amount of nutrients than basic *chapati*.

A similar study was conducted by Bhise and Kaur (2013). They noticed that the addition of texturized defatted sunflower, soyabean and flaxseed flour in *chapattis* resulted in significant improvement in crude protein, curd fiber, ash and protein digestibility. *Chaptis* made from 10 per cent textutrised defatted sunflower, soyabean and flax seed were given maximum overall acceptability scores as compared to higher levels.

.5.3 Shelf Life Study of *Chapati*

The mean sensory scores of chapati before and after storage are given in Table 8. and Fig.6. Chapati prepared with 10 per cent incorporation of deoiled soya meal was selected for storage study. It was stored in an air tight container at room temperature. Scores of all the sensory parameters showed a significant reduction on 36 hour of storage.

At the end of the storage period though difference in scores of all organoleptic parameters was significant chapati was well accepted by the judges at 36th hour also. Hence, it can be inferred that chapati prepared with deoiled soya meal can be stored for about 36 hours.

Table 8. Mean sensory scores of *chapati* before and after storage

Storage hours	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
0	4.8	4.8	4.6	4.8	4.8
9	4.7	4.7	4.6	4.7	4.5
18	4.6	4.6	4.5	4.6	4.2
27	4.6	4.3	4.3	4.2	4.1
36	4.0	4.2	4.1	3.9	3.6
CD	0.33	0.36	0.03	0.45	0.43
SE ±	0.11	0.13	0.012	0.15	0.15
F-value	7.2**	6.0**	3.0*	4.9**	10.24**

** Significant at 1 per cent

4.5 Development of Value Added *Chakali*

Chakali, a commonly consumed snack was prepared by without and with incorporation of deoiled soya meal and was evaluated organoleptically and nutritionally.

4.5.1 Sensory Evaluation Scores of *Chakali*

Various organoleptic parameters such as colour, taste, texture, taste and overall acceptability were studied for *chakali* prepared without and with incorporation of deoiled soya meal at varying levels and the results are tabulated and presented in Table 9 and illustrated in Plate 7and Fig.7.

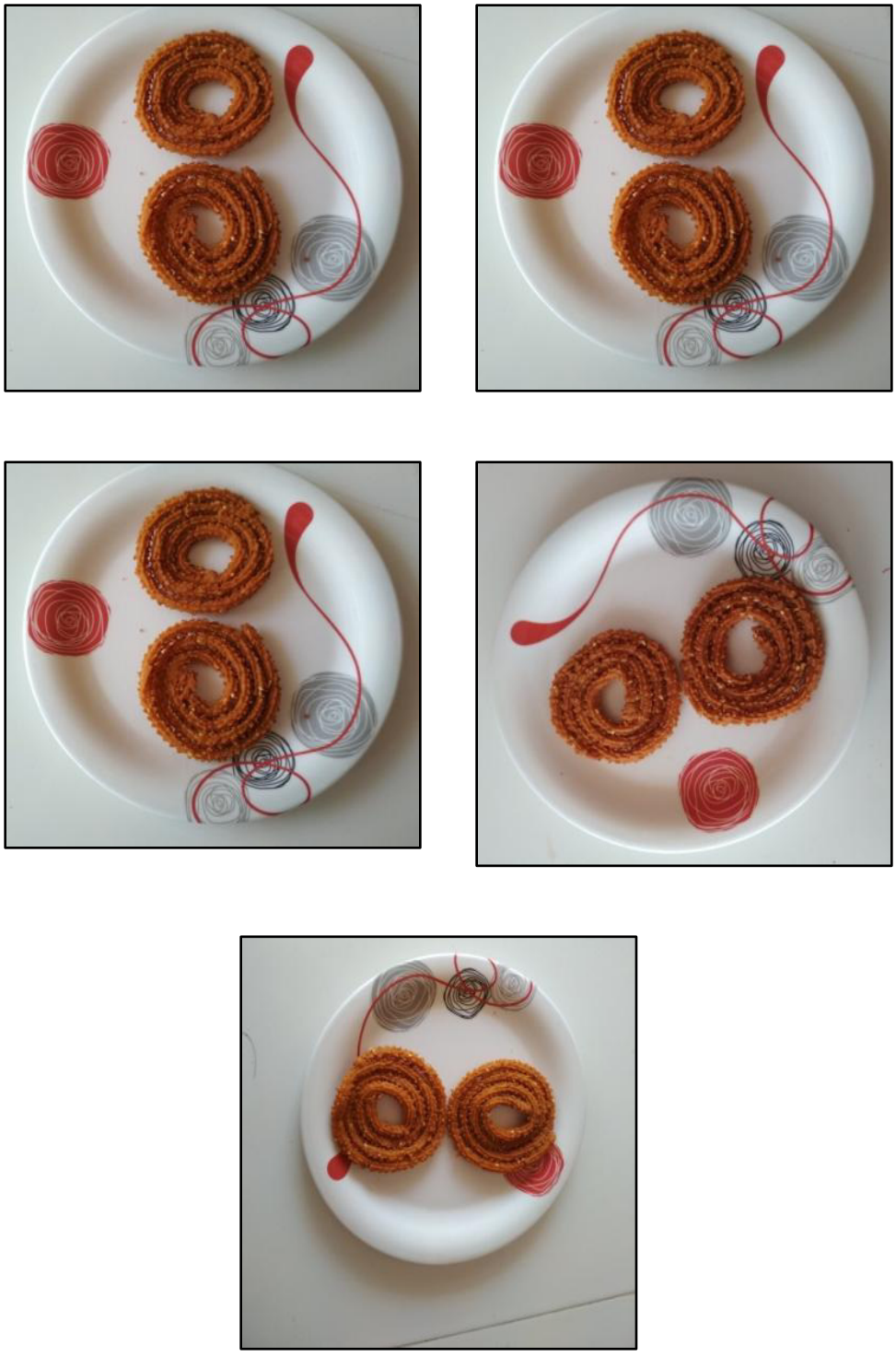


Plate 7. *Chakali* prepared with incorporation of deoiled soya meal at different levels

The data about sensory scores showed that the colour acquired a minimum score of 4.1 at 20 per cent incorporation level of deoiled soya meal and a maximum score of 4.8 at 15 per cent incorporation. Even, rest of the sensory parameters viz. taste, texture, flavour and overall acceptability also exhibited the similar pattern of maximum and minimum scores at the level of 15 per cent and 20 per cent incorporation level respectively.

Table 9. Sensory evaluation scores of *chakali*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.7	4.6	4.7	4.8
II	5	4.5	4.5	4.4	4.8	4.4
III	10	4.6	4.7	4.6	4.5	4.6
IV	15	**4.8**	**4.7**	**4.7**	**4.8**	**4.8**
V	20	4.1	4.2	4.1	4.3	4.3
CD		0.44	0.35	0.38	0.3	0.35
SE ±		0.15	0.15	0.16	0.15	0.15
F-value		2.8*	1.7 NS	2.02 NS	1.75 NS	2.10 NS

* Significant at 5 per cent NS –Non significant

From the Table, it can be noticed that the sensory parameters got the score above 4 for colour and texture (4.1), flavour and over all acceptability (4.3) and taste (4.2) at the level of 15 per cent incorporation of deoiled soya meal. Statistical analysis showed non significant difference in all sensory parameters expect colour when different variations were compared. There was a significant decrease in scores of all sensory characters for variation V from the rest of the variations. There seems to be numerical significant increase in the scores for colour, texture and flavour and from variation I to variation IV.

On the whole, it can be inferred that *chakali* prepared with 15 per cent incorporation of deoiled soya meal obtained slightly higher scores than basic for all parameters except over all acceptability and hence, it can be the best level to incorporate deoiled soya meal in *chakali* without any change.

4.5.2 Nutrient Content of *Chakali*

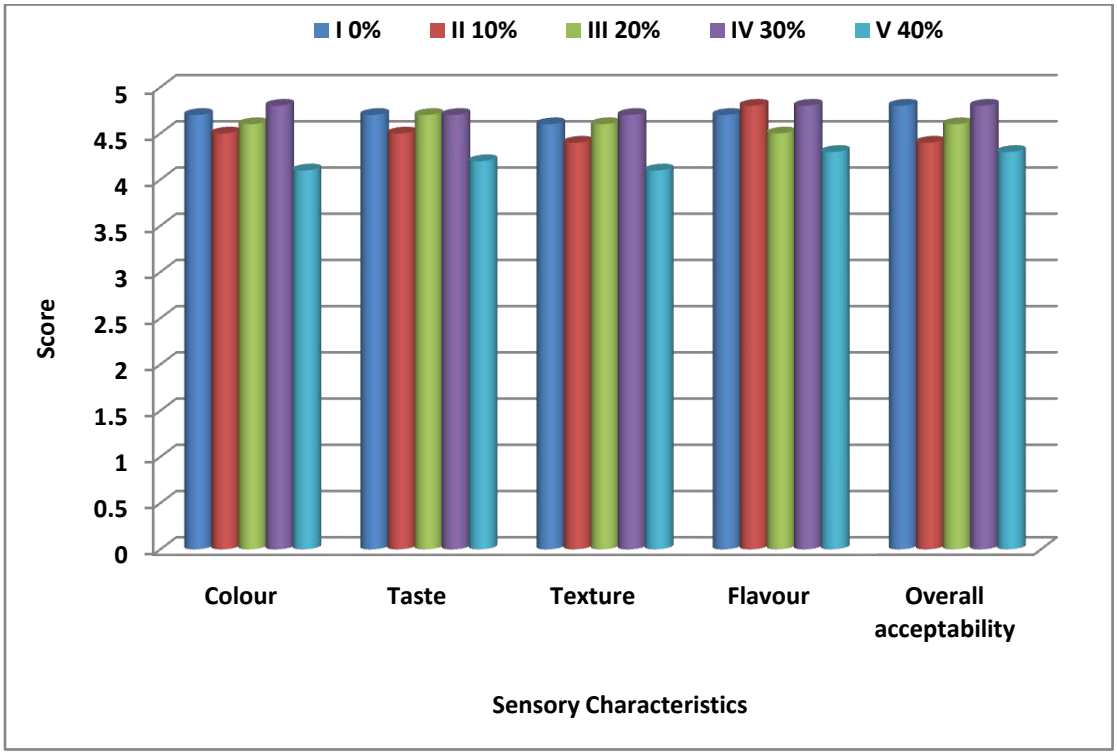


Fig. 5. Sensory evaluation scores of *chakali*

The data pertaining to nutrient content of *chakali* with and without value addition (Table 10) depicted that the moisture content was 7.9 and 8.4 per cent in basic and value added *chakali* respectively. The protein content of basic *chakali* was 12.88 per cent which was increased in value added *chakali* to 20.06 per cent. Other nutrients under study viz. fiber, calcium, iron, copper and magnease were significantly increased with incorporation of deoiled soya meal. On the contrary carbohydrates content of value added chakali was decreased non significantly.

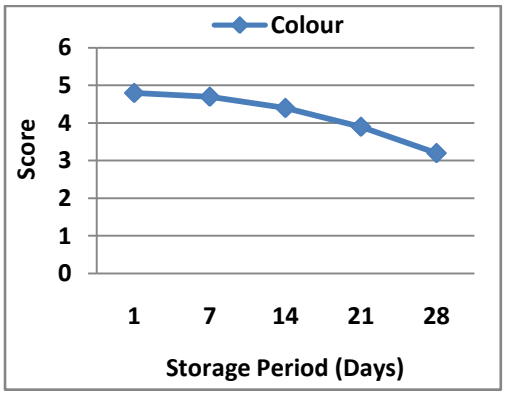
Table 10. Nutrient content of c*hakali* (per 100g)

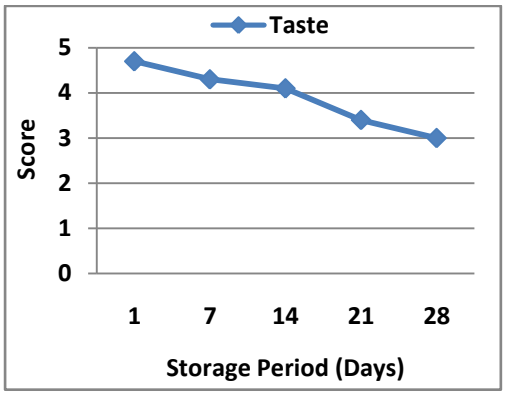
Nutrients	Basic *chakali*	Value added *chakali*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	7.9±1.01	8.4 ± 0.77	0.68^{NS}	+0.5
Protein (g)	12.88 ± 0.5	20.06 ± 0.04	20.86**	+7.4
Fat (g)	12.6 ± 0.3	12.43 ± 0.37	0.50^{Ns}	+0.17
Total minerals (g)	0.47 ± 0.02	3.15 ± 1.35	2.80^{Ns}	+2.68
Fiber (g)	2.47±0.04	3.75 ± 0.0	4.50*	+1.28
Carbohydrates (g)	64.69 ± 0.5	44.85 ± 0.5	39.68**	-19.84
Calcium (mg)	185±5	212± 2.5	3.11^{Ns}	+27
Iron (mg)	1.45±0.05	4.27±0.25	7.9**	-2.82
Copper (mg)	1.705± 0.05	2.535± 0.2	5.69*	+0.83
Zinc (mg)	0.3±0.05	0.36±0.048	0.16^{Ns}	+0.06
Manganese (mg)	0.155 ± 0.05	0.44 ± 0.05	8.16**	+0.29

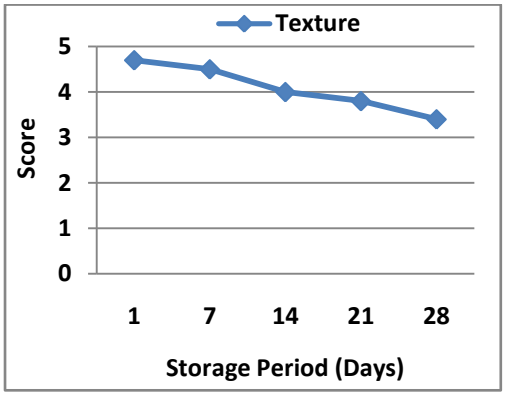
** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

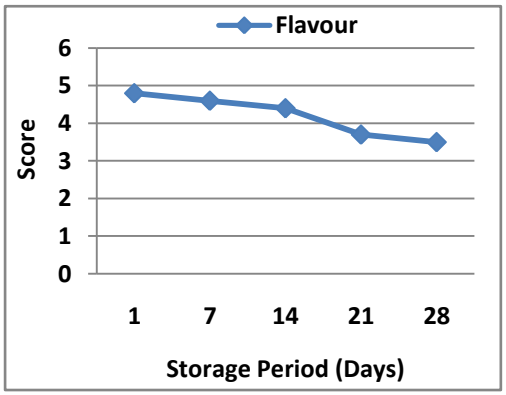
4.5.3 Shelf Life Study of *Chakali*

The Table 11 and Fig 6 reveal about mean sensory scores of *chakali* before and after storage. *Chakali* was prepared with 15 per cent incorporation of deoiled soya meal and stored in an air tight container at room temperature. The scores for colour were decreased from 4.8 to 3.2, taste from 4.7 to 3.0, texture from 4.7 to 3.4, flavour from 4.8 to 3.5 and overall acceptability from 4.8 to 3.3 (were decreased) at the end of the storage period and showed significant decrease in all parameters. The reduction in scores showed gradual decrease with increasing period. The score for the organoleptic parameter of









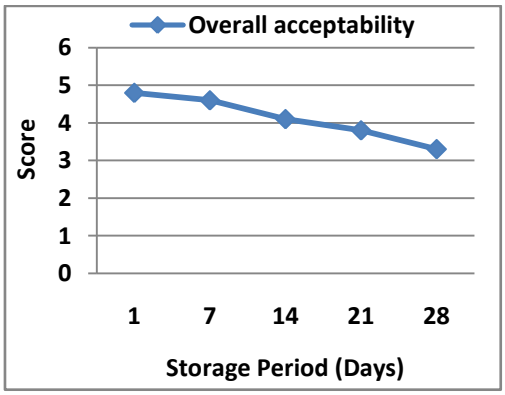


Fig. 6. Mean sensory scores of *chakali* before and after storage

chakali did not decrease significantly up to 7 days after that it reduced significantly. The 21st day's scores further reduced to the range of 3.9, 3.4, 3.8, 3.7, 3.8 for colour, taste, texture, flavour and over all acceptability.

Table 11. Mean sensory scores of *chakali* before and after storage

Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.7	4.7	4.8	4.8
7	4.7	4.3	4.5	4.6	4.6
14	4.4	4.1	4.0	4.4	4.1
21	3.9	3.4	3.8	3.7	3.8
28	3.2	3.0	3.4	3.5	3.3
CD	0.46	0.59	0.4	0.39	0.43
SE ±	0.16	0.21	0.17	0.13	0.15
F-value	16.48**	10.17**	8.7**	15.8**	15.3**

** Significant at 1 per cent

Though the scores for all sensory characters showed significant difference as the storage period was extended, the sensory scores indicated that *chakali* was well acceptable for the entire storage period. It may be because of the less oil content of the deoiled soya meal which replaced 15 per cent of bengal gram flour from the basic recipe. Hence, it can be concluded that developed *chakali* can be stored for about 28 days.

4.6 Development of Value Added *Fenugreek Leaves Paratha*

A breakfast recipe fenugreek leaves *paratha* was selected for incorporation of deoiled soya meal. It was prepared traditionally and modified with addition of deoiled soya meal.

4.6.1 Sensory Evaluation of *Fenugreek Leaves Paratha*

Data regarding the organoleptic parameters of *fenugreek leaves paratha* without and with incorporation of deoiled soya meal at varying levels such as 10, 20, 30 and 40 per cent are given in Table12 (Plate 8 and Fig.10).

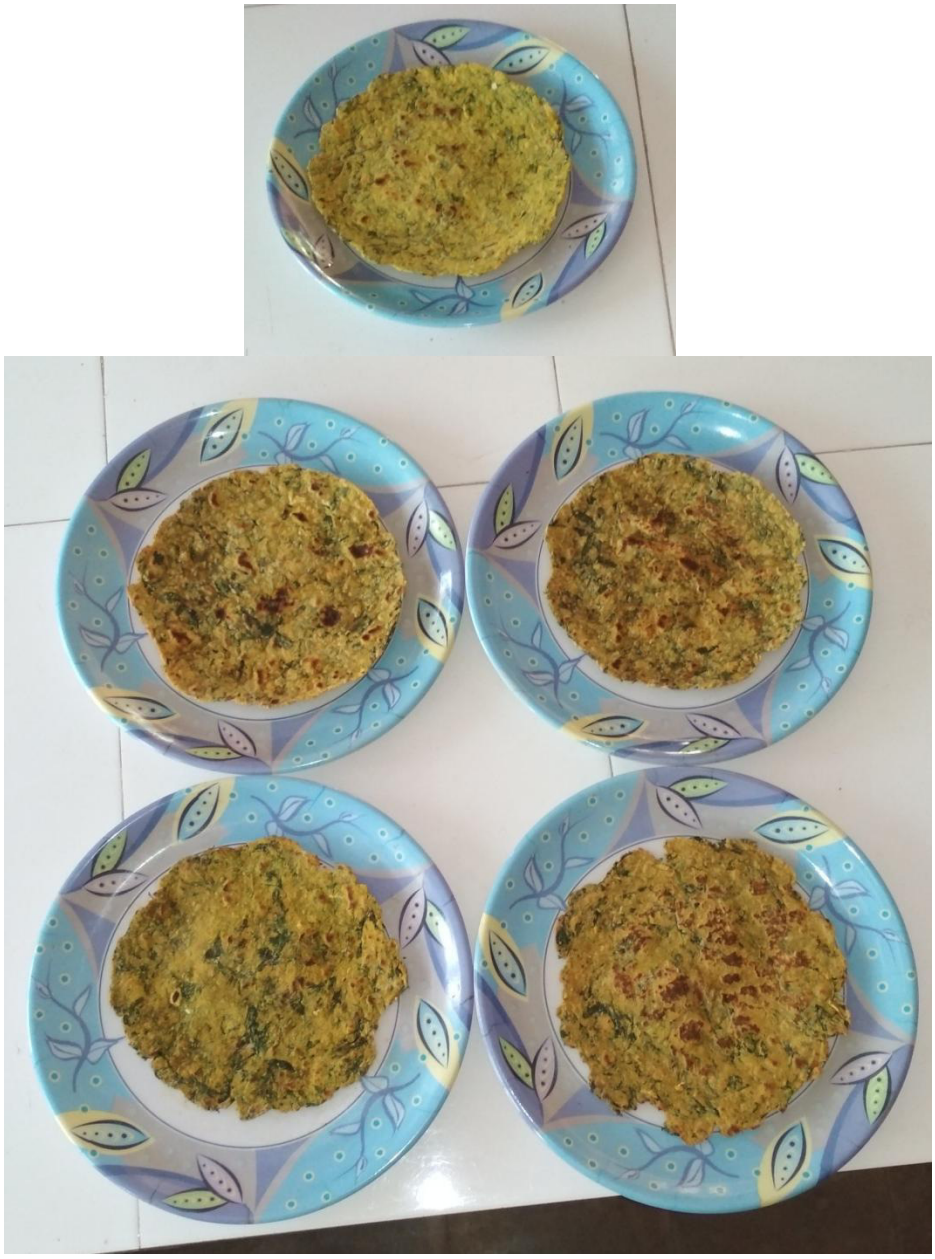


Plate 8 . ***Fenugreek leaves paratha*** **prepared with incorporation of deoiled soya meal at different levels**

The range of scores for the studied parameters viz. colour, taste, texture, flavour and overall acceptability for the *fenugreek leaves paratha* of variation I, II, III, IV and V were from 4.2 to 4.8; 4.1 to 4.8; 4.1 to 4.7; 4.0 to 4.7 and 4.1 to 4.8 respectively.

Table 12. Sensory evaluation scores of *fenugreek leaves paratha*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.6	4.7	4.8	4.8
II	10	4.6	4.5	4.6	4.5	4.6
III	20	**4.8**	**4.8**	**4.7**	**4.7**	**4.8**
IV	30	4.5	4.5	4.5	4.4	4.5
V	40	4.2	4.1	4.1	4.0	4.1
CD		0.34	0.41	0.43	0.47	0.42
SE ±		0.15	0.14	0.15	0.16	0.15
F-value		2.3 NS	2.8*	2.7*	2.9*	3.2*

* Significant at 5 per cent NS –Non significant

From the table12. it can be noted that variation III of *fenugreek leaves paratha* prepared with 20 per cent incorporation of deoiled soya meal obtained the scores at par with the scores obtained by the *fenugreek leaves paratha* prepared without incorporation of deoiled soya meal. As the level of deoiled soya meal increased above 20 per cent, scores for the organoleptic characters were decreased. Statistical analysis of scores of taste, texture, flavour and overall acceptability of *fenugreek leaves paratha* showed that there was significant difference in the values. However, the difference in the colour of prepared *paratha* of the different ingredient combinations (variation I to V) was not significant.

Hence, it can be inferred that *fenugreek leaves paratha* can be prepared with 20 per cent incorporation of deoiled soya meal having good acceptability with respect to all sensory attributes.

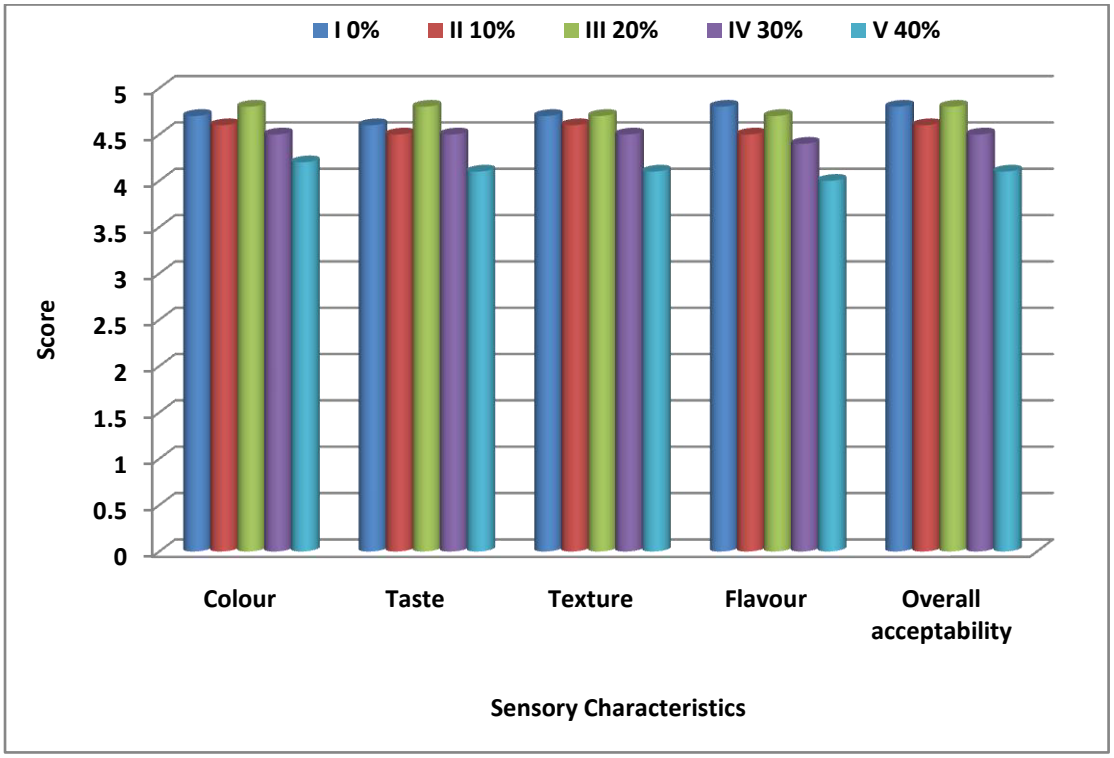


Fig. 7. Sensory evaluation scores of *fenugreek leaves paratha*

4.6.2 Nutrient Content of *Fenugreek Leaves Paratha*

The Table13. represents the proximate composition and mineral content of basic and value added *fenugreek leaves paratha.*

Table 13. Nutrient content of *fenugreek leaves paratha* (per 100g)

Nutrients	Basic *fenugreek leaves paratha*	Value added *fenugreek leaves paratha*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	18.06±1.77	19. 13± 0.89	0.75^{NS}	+0.87
Protein (g)	7.84± 0.2	16.8 ± 0.4	22.4**	+8.96
Fat (g)	5.85 ± 0.35	6.15 ± 0.35	0.85^{NS}	+1
Total minerals (g)	3.1 ± 1.77	6.65± 0.15	0.55^{NS}	+3.55
Fiber (g)	0.6±0.03	1.6± 0.91	0.42^{NS}	+0.94
Carbohydrates (g)	49.7± 0.9	41.35± 0.01	57.7**	-32.81
Calcium (mg)	275±5	307 ± 7.5	5.0*	-32
Iron (mg)	2.33±0.01	4.135±0.01	5.0*	+1.77
Copper (mg)	0.26± 0.8	0.028± 0.005	2.1^{NS}	-0.2
Zinc (mg)	0.255±0.1	0.035±0.1	2.7^{NS}	-0.22
Manganese (mg)	0.376 ± 0.05	2.14 ± 0.03	1.7^{NS}	+1.76

** Significant at 1 per cent * Significant at 5 per centNS- Non significant

The moisture content of value added *fenugreek leaves paratha* (19.13%) was higher than the basic *fenugreek leaves paratha* (18.06%). The protein content of value added *fenugreek leaves paratha* was increased significantly from 7.84 to 16.8 per cent due to value addition. The fat content of the value added *fenugreek leaves paratha* was 6.15 ± 0.35 g/100g while it was 5.85 ± 0.8 g/100g. The fiber content of deoiled soya meal *fenugreek leaves paratha* was increased from 0.6. per cent to 1.6 per cent. The total mineral content was increased by 3.55 per cent from 3.1 to 6.65 per cent in the value added *fenugreek leaves paratha.* The carbohydrate content was decreased significantly from 49.7 ± 0.9 g/100g to 41.35 ± 0.01 g/100g. The calcium content of basic *fenugreek leaves paratha* (275 mg/100g) was significantly lower than the experimental product (307 mg/100g). Copper value of value added fenugreek leaves *paratha* was reduced non significantly from 0.26 to 0.02 mg/100g where as, zinc value also decreased significantly from 0.25 to

0.03 mg/100g. The manganese content did not show any significant difference in both basic and value added *fenugreek leaves paratha*. Hence, it can be concluded that 20 per cent addition deoiled soya meal is helpful to elevate the level of protein, total minerals, fiber and iron of fenugreek leaves *paratha*.

4.6.3 Shelf Life Study of *Fenugreek Leaves Paratha*

The mean sensory scores of *fenugreek leaves paratha* before and after storage are given in Table 14 and Fig12. *Fenugreek leaves paratha* with 20 per cent incorporation of deoiled soya meal was selected for storage study. It was stored in an air tight container at room temperature.

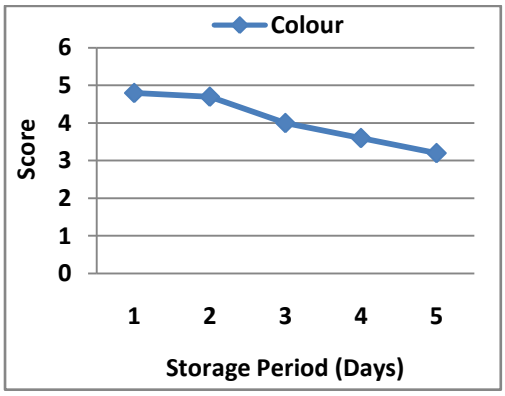
Table 14. Mean sensory scores of *Fenugreek leaves paratha* before and after storage

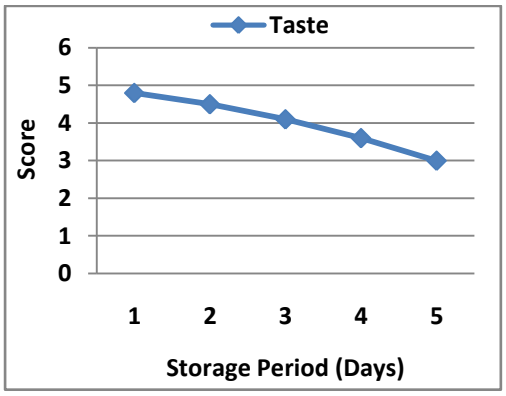
Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.8	4.7	4.8	4.8
2	4.7	4.5	4.3	4.7	4.6
3	4.0	4.1	3.9	4.1	3.6
4	3.6	3.6	3.4	3.4	3.2
5	3.2	3.0	2.5	3.0	2.9
CD	0.38	0.42	0.43	0.45	0.43
SE ±	0.13	0.14	0.15	0.16	0.15
F-value	20.62**	23.50**	19.8**	23.67**	30.831**

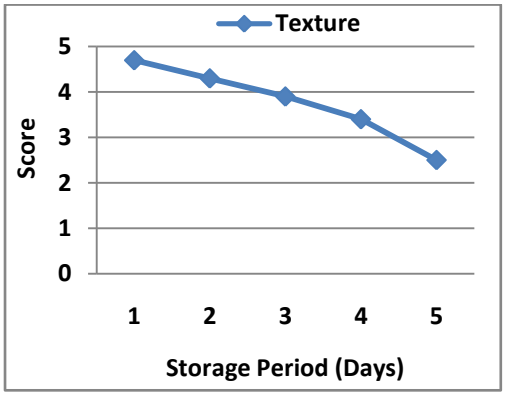
** Significant at 1 per cent

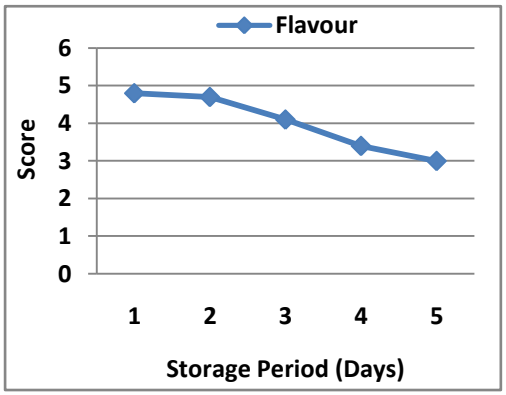
Scores for colour and flavour (from 4.8 to 4.7 in both parameters) did not show significant reduction on 2nd day of storage. Even the scores for remaining parameters were also decreased (taste from 4.8 to 4.5, texture from 4.7 to 4.3 and overall acceptability from 4.8 to 4.6) but did not show significant difference on 2nd day. The scores were further reduced on 5th day significantly for colour (from 4.8 to 3.2), taste (from 4.8 to 3.0) and overall acceptability (from 4.8 to 2.9).

At the end of the storage period, the difference in scores of all organoleptic parameters was significant. *Fenugreek leaves paratha* was well









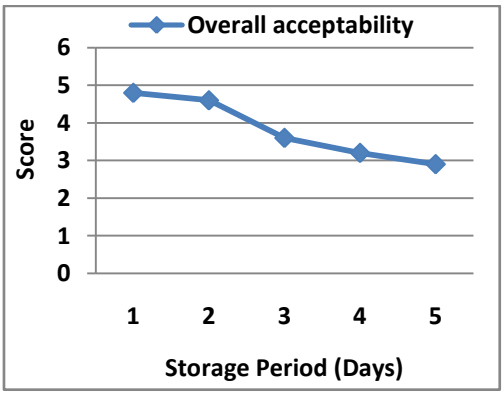


Fig. 8. Mean sensory scores of *fenugreek leaves paratha* before and after storage

Plate 9. *Kharapara* prepared with incorporation of deoiled soya meal at different levels

accepted by the judges on 5th day also. Hence, it can be inferred that *fenugreek leaves paratha* prepared with deoiled soya meal can be stored for about 5 days.

4.7 Development of Value Added *Kharapara*

A snack preparation *kharapara* used along with tea was selected for value addition. Deoiled soya meal was incorporated in the *kharapara* in varying levels from 5 to 20 percent.

4.7.1 Sensory Evaluation of *Kharapara*

Table15, Plate.9 and Fig.9 depict the data pertaining to the sensory parameters of *kharapara* prepared without and with incorporation of deoiled soya meal at varying levels such as 5, 10, 15 and 20 per cent.

Table 15. Mean Sensory evaluation scores of *kharapara*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.7	4.8	4.6	4.7
II	5	4.4	4.5	4.6	4.5	4.6
III	10	4.6	4.6	4.7	4.6	4.6
IV	15	**4.8**	**4.8**	**4.7**	**4.7**	**4.8**
V	20	4.0	4.1	4.2	4.1	4.3
CD		0.4	0.41	0.4	0.39	0.30
SE ±		0.14	0.14	0.15	0.17	0.13
F-value		3.9**	3.3*	2.9*	1.8 NS	2.0 NS

* Significant at 5 per cent NS-Non Significant

The data exhibited that, the sensory scores of *kharapara* did not change significantly up to 15 per cent incorporation of deoiled soya meal. Similar trend was observed with regard to the scores given by the judges for all the organoleptic parameters.

The score for colour varied between 4.0 and 4.8, for taste between 4.1 and 4.8, for texture between 4.2 and 4.8, for flavour between 4.1 and 4.7 and for overall acceptability between 4.3 and 4.8.

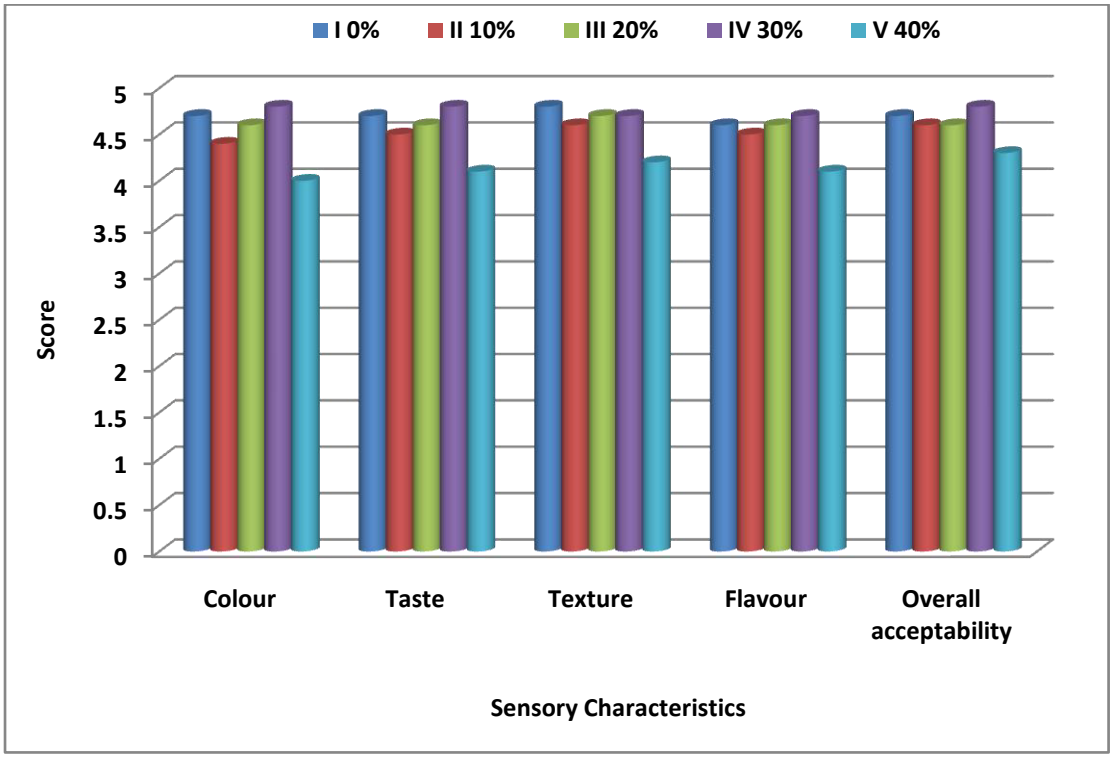


Fig. 9. Sensory evaluation scores of *Kharapara*

The scrutiny of data indicate that the *kharapara* prepared with 15 per cent incorporation of deoiled soya meal obtained maximum score for colour, taste, flavour and overall acceptability which were slightly higher than even basic *kharapra*. The score for texture was higher (4.8) for control sample while it was low for flavour (4.6) than the variation IV (15% incorporation of deoiled soya meal). The statistical comparison among the variations with regard to all the sensory parameters indicated that there is significant difference in the scores. However, the comparison between the variations depicted that the scores of variation I to IV did not vary significantly. Hence, it can be concluded that deoiled soya meal can be utilised up to 15 per cent for preparation of well accepted *kharapara*.

4.7.2 Nutrient Content of *Kharapara*

Kharapara was prepared without and with incorporation of deoiled soya meal at 15 per cent level of incorporation and analysed in lab for nutrient content. The data regarding nutrient content are presented in Table16.

Table 16. Nutrient content of *kharapara* (per 100 g)

Nutrients	Basic *kharapara* Mean ± SD	Value added *kharapara* Mean ± SD	't' value	Increase/ decrease in nutrient content
Moisture (g)	5.42 ±0.01	6.64 ± 0.03	0.77^{NS}	+0.29
Protein (g)	7.84 ± 0.28	15.73 ± 0.33	25.55**	+7.89
Fat (g)	10 ± 0.07	10.11 ± 0.01	0.01^{NS}	+0.11
Total minerals (g)	0.8 ± 0.08	1.2 ± 0.01	0.002^{NS}	+0.67
Fiber (g)	0.51±0.04	0.54± 0.03	0.42^{NS}	+0.27
Carbohydrates (g)	69 ± 0.5	59.28± 0.5	25.4**	-9.72
Calcium (mg)	100±2.5	115 ± 5	0.09^{NS}	+10
Iron (mg)	2.9±0.012	3.0 ±0.04	0.09^{NS}	+0.1
Copper (mg)	0.20± 0.081	0.22± 0.04	0.002^{NS}	+0.2
Zinc (mg)	0.64±0.63	0.69±0.0.004	0.01^{NS}	+0.1
Manganese (mg)	0.60 ± 0.40	0.62 ± 0.04	0.008^{NS}	- 0.02

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

The moisture content of value added *kharapara* was 6.64 per cent and basic *kharapara* was 5.42 per cent. The higher amount of moisture in value

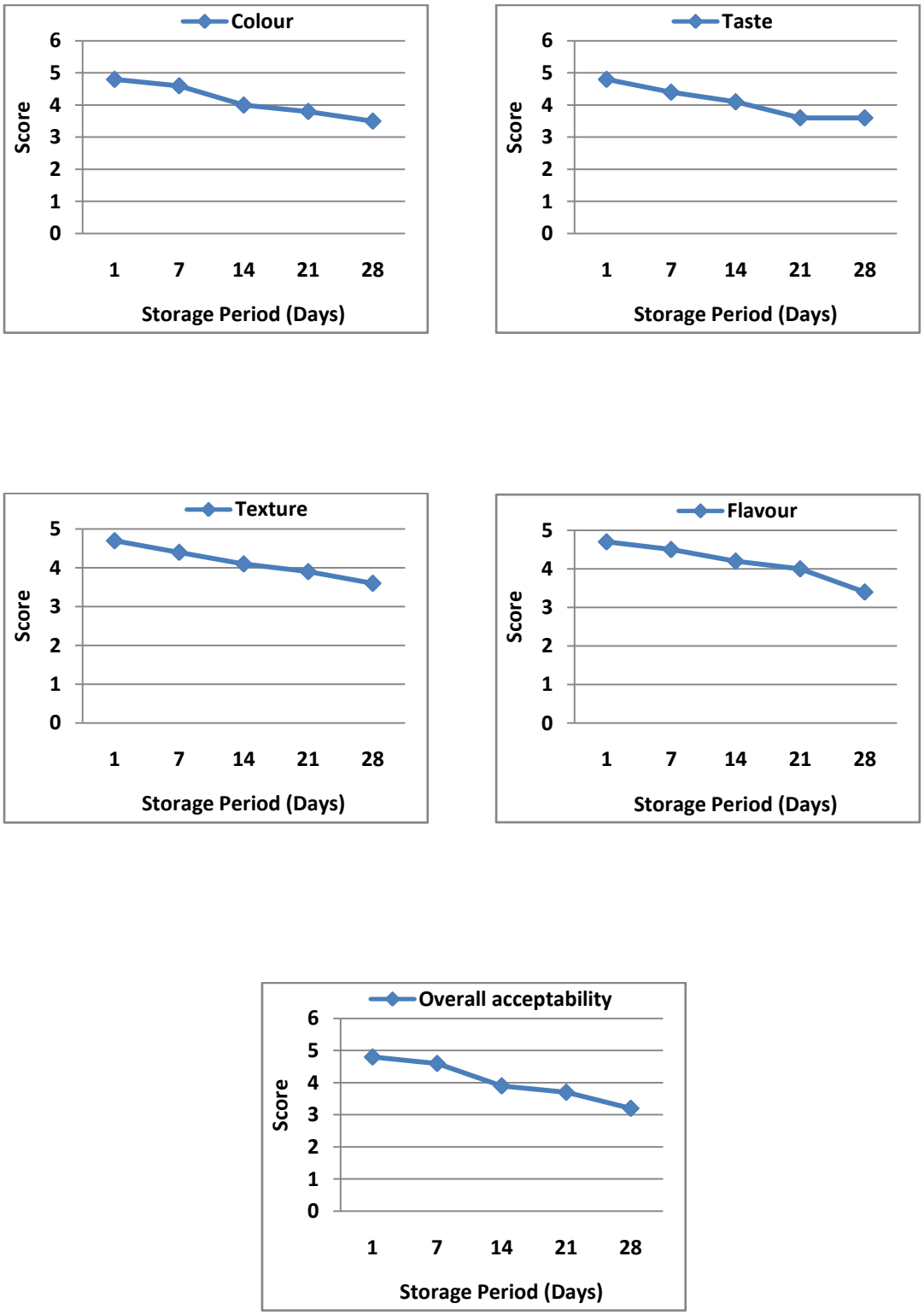


Fig. 10. Mean sensory scores of *kharapara* before and after storage

added *kharapara* may be because of higher moisture content of deoiled soya meal than refined wheat flour. The protein content of basic and value added *kharapara* was 7.84 ± 0.28 and 15.73 ± 0.33 g/100g respectively. The protein content was increased by 7.89 g due to value addition. The similar observation was made with regard to fat, total minerals, fiber, calcium and iron, where in the values of deoiled soya meal incorporated *kharapara* were increased than the samples prepared without incorporation of deoiled soya meal. The fat content was increased from 10 to 10.11per cent, total minerals from 0.8 to 0.82 per cent, fiber from 0.51 to 0.54 per cent, calcium from 100 to 115 mg/100g and iron from 2.9 to 3 mg/100g. There was significant reduction in carbohydrate content from 69 to 59.28 per cent. The content of copper and zinc did not change significantly because of incorporation of deoiled soya meal though there was slight numerical increase. Hence, it can be concluded that *kharapara* with 15 per cent incorporation of deoiled soya meal would be a best alternative to the basic *kharapara* to enrich nutrients with particular reference to protein.

4.7.3 Shelf Life Study of *Kharapara*

Kharapara prepared with 15 per cent incorporation of deoiled soya meal was stored in an air tight container at room temperature. Table 18 and Fig.10 explain the data about mean sensory scores of *kharapara* before and after storage.

Table 17. Mean sensory scores of *kharapara* before and after storage

Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.8	4.7	4.7	4.8
7	4.6	4.4	4.4	4.5	4.6
14	4.0	4.1	4.1	4.2	3.9
21	3.8	3.6	3.9	4.0	3.7
28	3.5	3.6	3.6	3.4	3.2
CD	0.389	0.35	0.46	0.49	0.46
SE ±	0.13	0.12	0.16	0.17	0.16
F-value	16.04**	16.01**	7.14**	8.74**	16.66**

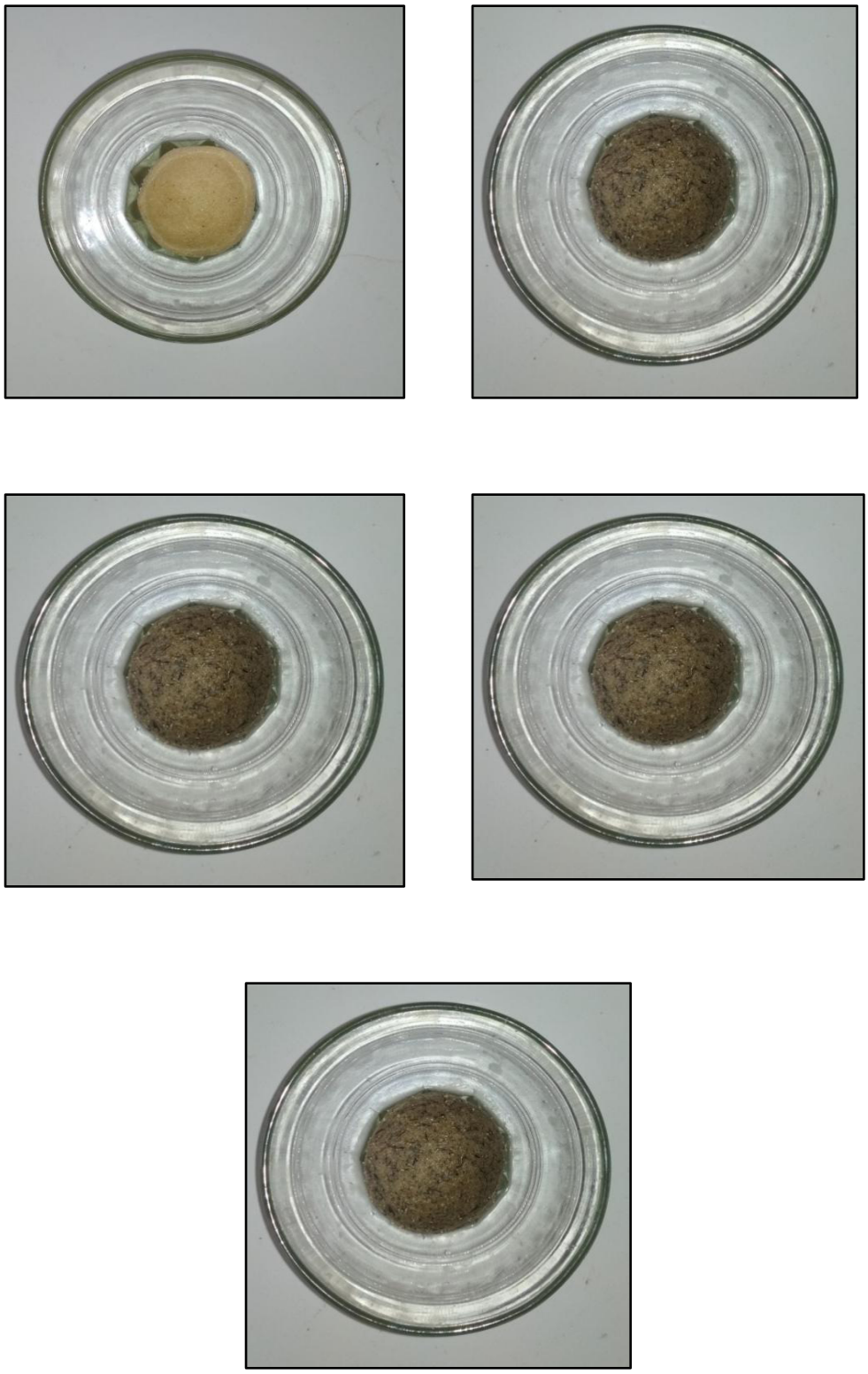


Plate10. ***Semolina laddu*** **prepared with and without incorporation of deoiled soya meal at different levels**

** Significant at 1 per cent

The score for the colour of *kharapara* decreased from 4.8 to 3.5 during storage. There was no significant difference in the score of colour up to 7 days (4.8 to 4.6). After that, it decreased significantly. Even the score of texture and flavour did not decrease significantly up to 7 days (from 4.7 to 4.4 and from 4.7 to 4.5 respectively) storage period. There after there was slide down in scores of all organoleptic characters during storage. Though scores even on 28th day the *kharapara* scored greater than 3 indicating 'good' that means it was still in acceptable state. Hence, from the findings it can be inferred that *kharapara* with 15 per cent incorporation of deoiled soya meal.

4.8 Development of Value Added *Semolina laddu*

A commonly prepard sweet prepration s*emolina laddu* was prepared by using traditional ingredients and with value addition of deoiled soya meal.

4.8.1 Sensory Evaluation of *Semolina laddu*

The data with regard to organoleptic parameters of *semolina laddu* prepared without and with incorporation of deoiled soya meal at varying levels (Table 18 Plate10 and Fig11.) revealed that the mean value of scores for colour ranged from 4.1 to 4.8. The highest score (4.8) was obtained by *semolina laddu* prepared without incorporation of deoiled soya meal followed (4.7) by *semolina laddu* prepared with 15 per cent incorporation of deoiled soya meal. The lowest score (4.1) for colour was obtained by laddu prepared with 20 per cent incorporation of deoiled soya meal. Statistical analysis showed that the difference in the score of colour was significant.

Table18. Mean sensory scores of *semolina laddu*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.8	4.7	4.8	4.7	4.7
II	5	4.6	4.4	4.4	4.5	4.5
III	10	4.6	4.5	4.6	4.6	4.6
IV	15	**4.7**	**4.7**	**4.8**	**4.7**	**4.7**
V	20	4.1	4.3	4.2	4.1	4.1
CD		0.4	0.31	0.39	0.39	0.35
SE ±		0.14	0.14	0.13	0.14	0.15
F-value		3.4*	1.5 NS	3.17*	3.2*	2.4 NS

* Significant at 5 per cent NS- Non Significant

The highest score of 4.7 for taste flavour and overall acceptability was obtained by basic *Semolina laddu and* prepared with 15 per cent incorporation of deoiled soya meal. The mean score for texture ranged from 4.2 to 4.8. The highest score (4.8) for texture was obtained by *semolina laddu* prepared without incorporation of deoiled soya meal and by *semolina laddu* prepared with 15 per cent incorporation of deoiled soya meal. For colour, flavour and overall acceptability. The lowest score (4.1) was obtained by *Semolina laddu* prepared with 20 per cent incorporation of deoiled soya meal.

By comparing the scores of *semolina laddu* prepared without and with varying levels of deoiled soya meal, it can be inferred that *semolina laddu* prepared with 15 per cent incorporation of deoiled soya meal had equal acceptability as *semolina laddu* prepared without incorporating deoiled soya meal. Statistical analysis showed significant difference in the acceptability of colour, texture and flavour of IV variation with remaining ones. IV variation with the remaining ones.

4.8.2 Nutrient Content *of Semolina laddu*

The moisture content of basic *semolina laddu* was 8.6 per cent which was increased by 1.7 g in value added *semolina laddu* (10.03%). The protein

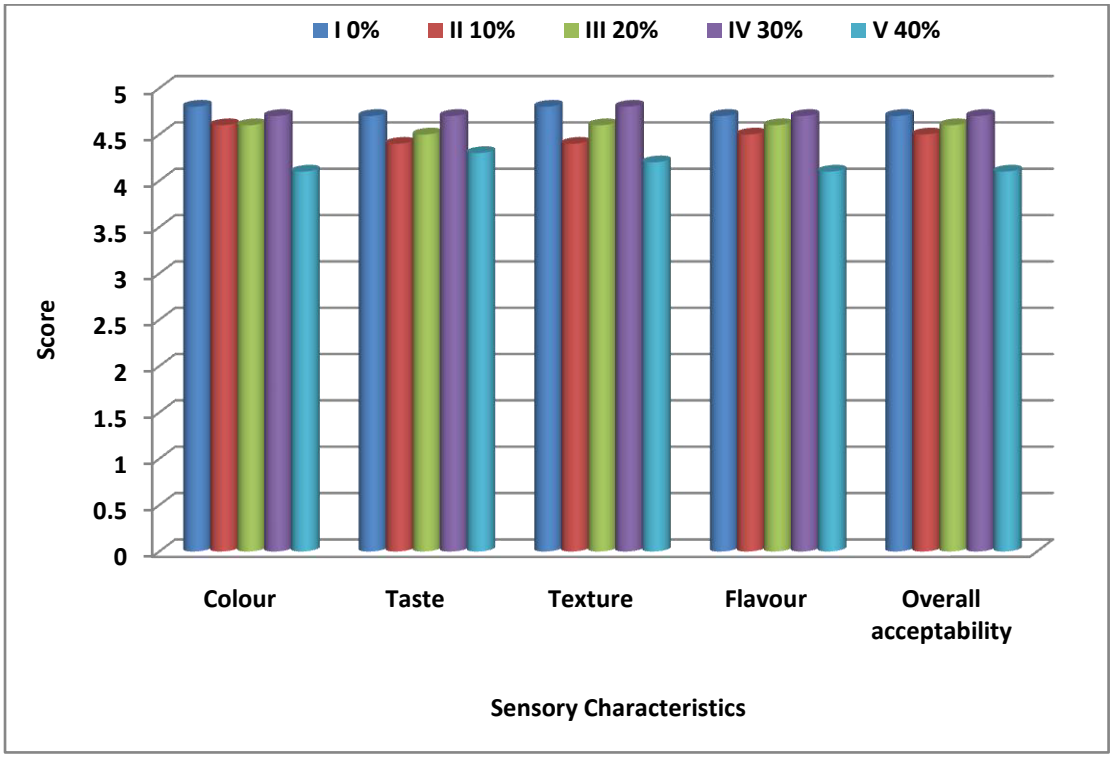


Fig. 11. Sensory scores of *Semolina laddu*

content of basic and value added *semolina laddu* was 8.19 ± 0.07 and 15.68 ± 0.28 g/100g respectively.

Basic *Semolina laddu* had 6.2 per cent fat while it was 7.95 per cent in value added *Semolina laddu.* The total minerals were 1.05 and 1.75 per cent respectively in basic and value added *Semolina laddu.* The fiber content was 0.81 and 0.54 per cent whereas the carbohydrate content was 75.86 and 64.83 per cent in basic and value added *semolina laddu* respectively. It was noticed that the calcium content of basic *semolina laddu* was lower (167.5 ± 2.5 mg/100g) than value added *Semolina laddu* (182.5± 2.5 mg/100g). The iron content of basic *semolina laddu* was 1.15 ± 0.05 mg/100g which was increased to 3.75 ± 0.5 mg/100g in value added *Semolina laddu.* The copper content of basic and value added *semolina laddu* was 0.39 and 0.75 mg/100g respectively. Zinc and manganese content were 0.20 and 0.27 mg/100g in basic *semolina laddu*. The corresponding values of value added *Semolina laddu* were 0.30 and 0.077 mg/100 g respectively.

Table 19. Nutrient content of *semolina laddu* (per 100 g)

Nutrients	Basic *Semolina laddu biscuits*	Value added *Semolina laddu*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	8.6±0.03	10.03 ± 0.96	0.25^{NS}	+1.7
Protein (g)	8.19 ± 0.07	15.68 ± 0.28	36.70**	+8.12
Fat (g)	6.2 ± 1.25	7.95 ± 1	0.22^{NS}	+1.3
Total minerals (g)	1.05 ± 0.05	1.75± 0.17	0.02^{NS}	+0.7
Fiber (g)	0.81±0.03	0.54± 0.04	0.42^{NS}	+0.27
Carbohydrates (g)	75.86 ± 0.5	64.8± 0.5	22.12**	-11.06
Calcium (mg)	167.5±2.5	182.5 ± 2.5	2.5	+15
Iron (mg)	1.15±0.05	4.75±0.5	0.4^{NS}	+3.55
Copper (mg)	0.39± 0.35	0.75± 0.25	0.5^{NS}	+0.35
Zinc (mg)	0.20±0.005	0.30±0.195	0.16^{NS}	+0.1
Manganese (mg)	0.27 ± 0.03	0.07 ± 0.04	0.03^{NS}	- 0.49

** Significant at 1 per cent * Significant at 5 per cent NS – Non significant

It can be observed from the findings that incorporation of deoiled soya meal at 15 per cent level in *semolina laddu* could elevate protein, total minerals, fiber and iron significantly. Protein was increased by 8.12 g, total

minerals by 0.7 g, fiber by 0.27 g, calcium by 15mg/100g and iron by 2.6 mg/100g. Carbohydrate content was decreased significantly (Table 19 and fig 17).

Mridula and Gupta (2008) also stated that incorporation of defatted soy flour in small quantity will improve the protein quality of cereal- based products without causing significant difference in the acceptability of the developed product.

4.8.3 Shelf Life Study of *Semolina laddu*

Table 20 and Fig 18 depict the mean sensory scores of *Semolina laddu* before and after storage. *Semolina laddu* prepared with 15 per cent incorporation of deoiled soya meal was selected for storage study and it was stored in an air tight container at room temperature.

Table 20. Mean sensory scores of *semolina laddu* before and after storage

Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.7	4.8	4.7	4.7
5	4.6	4.5	4.6	4.5	4.6
10	4.5	4.4	4.4	4.4	4.5
15	4.1	4.1	4.0	4.0	4.2
20	3.3	3.4	3.6	3.4	3.6
CD	0.3	0.3	0.4	0.3	0.4
SE ±	0.133	0.13	0.14	0.12	0.14
F-vale	19.84**	12.81**	9.8**	17.02**	8.86**

** Significant at 1 per cent

From Table 21. it can be noticed that there was a decrease in scores of organoleptic parameters in a linear way. As the days of storage increased, the scores got decreased. However, the scores did not reduce significantly up to 10 days for any of the sensory character. The scores reduced further after 15th days and showed a significant difference on 2oth day for all sensory characters and overall acceptability.

The texture of the s*emolina laddu* secured the higher score (3.6) on 20th day when compared to other sensory parameters (colour-3.3, taste-3.4 and

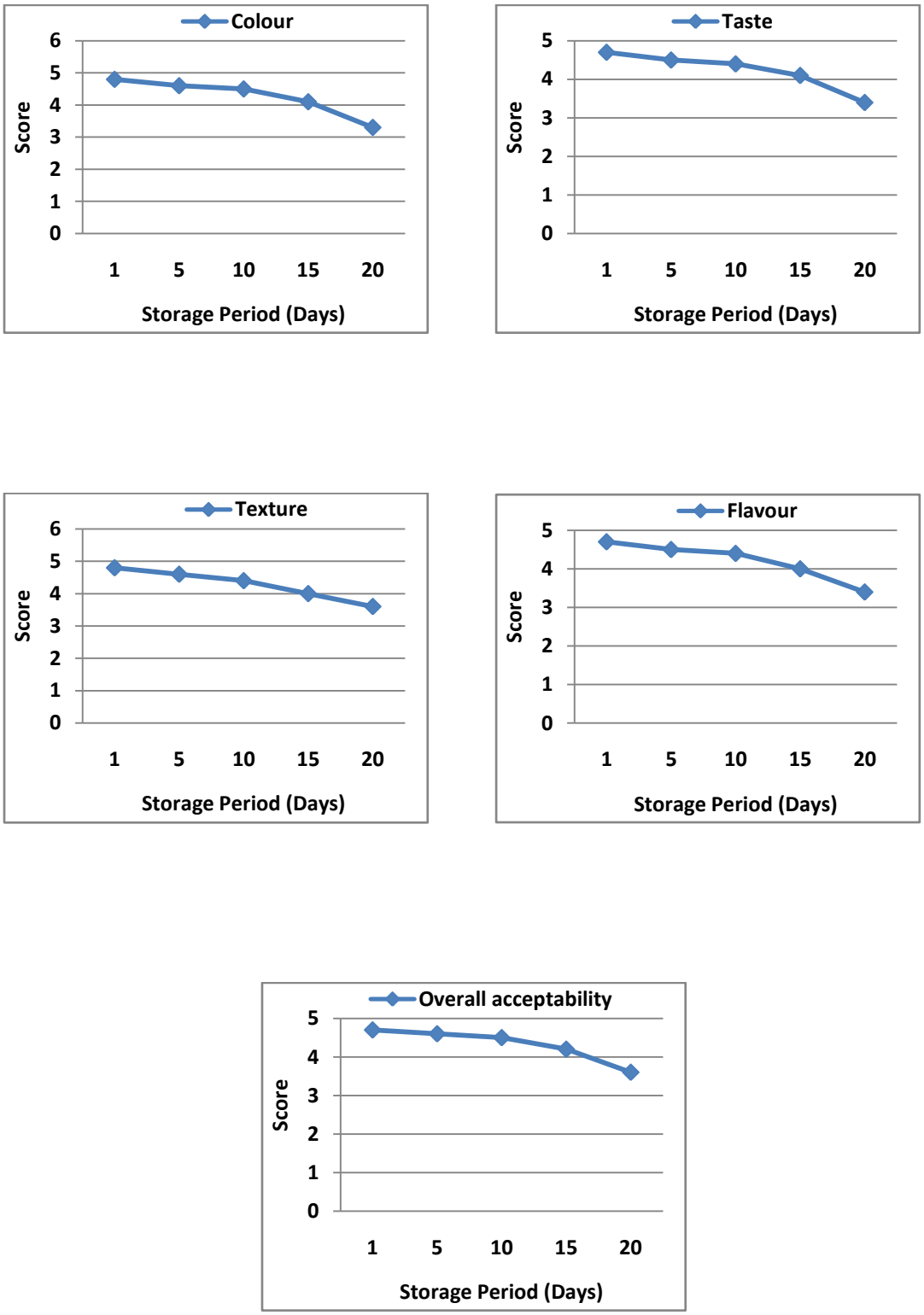


Fig. 12. Mean sensory scores of *semolina laddu* before and after storage

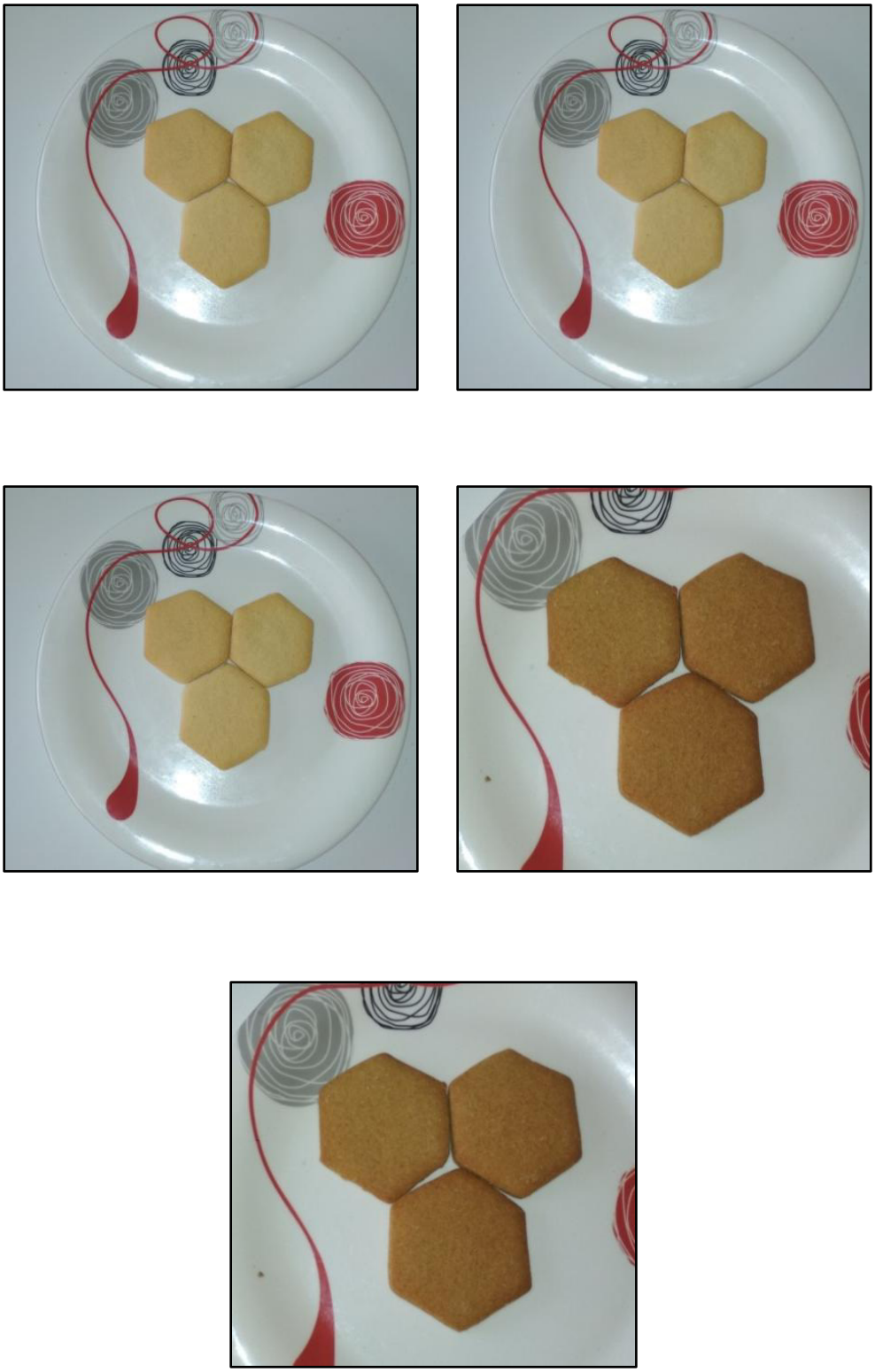


Plate. 12. Sweet biscuits prepared with and without incorporation of deoiled soya meal at different levels

flavour-3.40). However, the stored s*emolina laddu* did not develop rancidity and remained very well acceptable even on 20th day also. This may be due to low fat content of deoiled soya meal. Hence, it can be suggested that *semolina laddu* prepared with 15 per cent incorporation of deoiled soya meal can be stored up to 20 days at room temperature without much changes in sensory characters.

4.9 Development of Value Added *Salt Biscuits*

Biscuits are consumed across the world and are liked by all groups. Hence, two types of biscuits – salty and sweet were prepared by value addition and were evaluated.

4.9.1 Sensory Evaluation of *Salt Biscuits*

Salt biscuits were prepared by incorporating deoiled soya meal at different levels (5, 10, 15 and 20). The prepared *salt biscuits* were evaluated for various sensory characteristics. The data which gives clear idea about sensory scores of *salt biscuits* are presented in Table 22 and are illustrated in Plate11. and Fig 19.

The sensory scores for colour of *salt biscuits* for studied variations varied from 4.3 to 4.8. The biscuits prepared with 15 per cent incorporation of deoiled soya meal recorded highest score (4.8) for colour and minimum score (4.3) was obtained by *biscuits* prepared with 20 per cent incorporation of deoiled soya meal. Statistical analysis showed that the difference in the scores of colour was significant.

Table 21. Mean Sensory Evaluation scores of Salt biscuits

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.6	4.7	4.8	4.8
II	10	4.6	4.5	4.5	4.5	4.6
III	20	4.5	4.6	4.4	4.3	4.4
IV	30	**4.8**	**4.8**	**4.7**	**4.7**	**4.8**
V	40	4.3	4.2	4.1	4.1	4.0
CD		0.35	0.31	0.41	0.42	0.4
SE ±		0.15	0.13	0.14	0.15	0.15
F-value		1.39 NS	2.05*	2.77*	3.34*	3.8**

** Significant at 1 per cent NS-Non significant

Sensory scores of taste for all *salt biscuits* prepared without and with incorporation of deoiled coconut meal obtained score between 4.2 and 4.8 which denoted that all *biscuits* were very good in taste. The taste of *salt biscuits* prepared with 15 per cent incorporation of deoiled soya meal obtained a numerical higher score (4.8) than the control biscuits (4.6) and *biscuits* prepared with 10 per cent incorporation of deoiled soya meal.

The mean scores for texture obtained by salt *biscuits* for variation I, II, III, IV and V were 4.7, 4.5, 4.4, 4.7 and 4.1 respectively. The highest score (4.7) was given to texture of samples for variation IV. There was significant difference in the texture of *salt biscuits* prepared with and without incorporation of deoiled soya meal.

In case of flavour, variation IV of experimental *salt biscuits* reported maximum score (4.7). S*alt biscuits* prepared with 20 per cent incorporation of deoiled soya meal recorded lowest score (4.1). Statistical analysis of data showed that there was significant difference in flavour among the variations. Overall acceptability of *salt biscuits* with 30 per cent incorporation of deoiled soya meal the highest score (4.8) than *salt biscuits* prepared without incorporating deoiled soya meal and with 20 per cent incorporation of deoiled

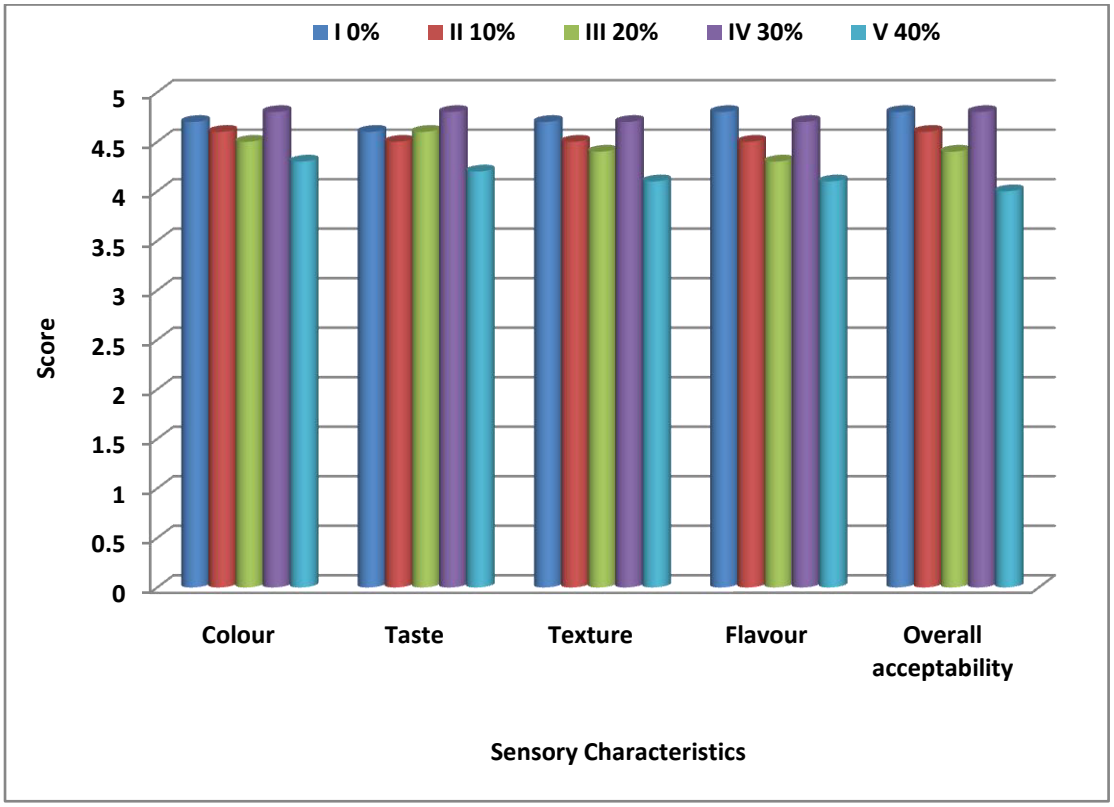


Fig. 13. Sensory evaluation scores of *salt biscuits*

soya meal (4.4). On the whole, it can be said that addition of deoiled soya meal at 30 per cent level exhibited better acceptability of value added *salt biscuits.*

4.9.2 Nutrient Content of *Salt Biscuits*

The nutrient content of basic *salt biscuits* and value added salt *biscuits* is given in Table 22. The moisture content of basic *salt biscuits was* (5.40%) in value added *salt biscuits it was* (6.20%). The protein content of basic salt biscuits was 5.9 per cent and the value added *salt biscuits* was 13.86 per cent. The protein content was increased by 7.87 g.

The fat content of value added *salt biscuits* was higher (16.25%) than basic *salt biscuits* (16.06%). This might be because of fat present in deoiled soya meal. Total mineral and fiber values of basic *salt biscuits* were 1.95 per cent and 0.30 per cent while the values for developed *salt biscuits* were 2.2 per cent and 2.41 per cent respectively. The carbohydrate content of value added *salt biscuit* was 47.02 g/100g.

Table 22. Nutrient content of *salt biscuits* (*per 100gm)*

Nutrients	Basic *salt biscuits*	Value added *salt biscuits*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	5.40±0.40	6.20 ± 0.97	0.42^{NS}	0.26
Protein (g)	5.99 ± 0.3	13.86 ± 0.4	22.26**	+7.87
Fat (g)	16.06 ± 0.8	16.25 ± 0.2	0.20 ^{NS}	+0.19
Total minerals (g)	1.95 ± 0.04	2.06 ± 0.45	0.25^{NS}	+0.1
Fiber (g)	0.3±0.1	1.4 ± 0.2	6.9**	+1.1
Carbohydrates (g)	57.63 ± 2	47.02 ± 0.49	7.2**	-10
Calcium (mg)	115±5	125 ± 5	2.0^{NS}	+10
Iron (mg)	1.72±0.04	2.11±0.34	1.56^{NS}	+1.18
Copper (mg)	0.48± 0.025	0.57± 0.05	2.27^{NS}	+0.09
Zinc (mg)	0.77±0.25	1.02±0.025	0.69^{NS}	+0.25
Manganese (mg)	0.22 ± 0.04	0.62 ± 0.04	0.11^{NS}	+0.4

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

The calcium and iron content of value added *salt biscuits* (125 ± 5 mg/100g and 2.11 ± 0.34 mg/100g respectively) was higher than basic *salt biscuits* (115 ± 0.85mg/100g and 1.72 ± 0.04 mg/100g respectively). Calcium

content of value added *salt biscuits* was increased by 10 mg whereas iron content was increased by 1.18 mg. This might be because of the presence of calcium and iron in higher amount in the deoiled soya meal. The values showed that there was significant increase in protein, fat, total minerals, fiber, calcium and iron. Other minerals such as copper zinc and manganese did not show any statistical difference in the values.

From the findings, it can be concluded that *salt biscuits* with 15 per cent incorporation of deoiled soya meal resulted in increased percentage of protein, fiber, total minerals, calcium and iron.

Marnett *et al*.,(1973) also reported increase in protein contents of breads by 35 percent when wheat flour was substituted with 12 percent DSF.

4.9.3 Shelf Life Study of S*alt Biscuits*

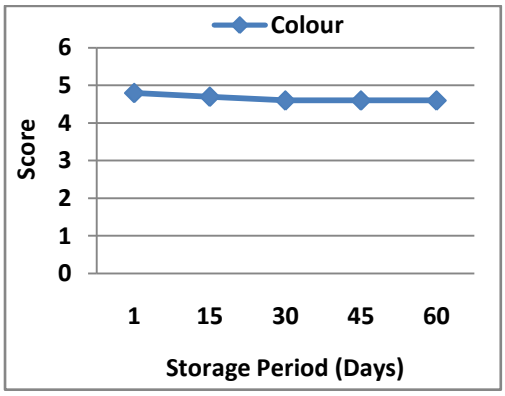
The mean sensory score before and after storage period of highly accepted salt biscuits is given in Table 23 and represented in Fig 21.

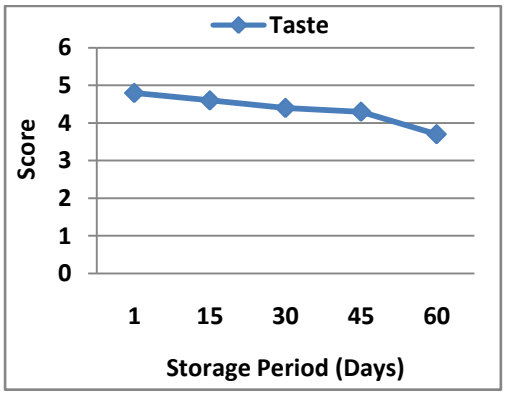
Table.23 Mean sensory scores of *salt biscuits* before and after storage

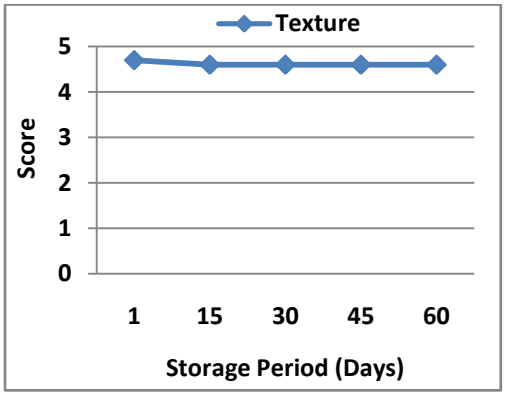
Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.8	4.7	4.7	4.8
15	4.7	4.6	4.6	4.7	4.7
30	4.6	4.4	4.6	4.5	4.6
45	4.6	4.3	4.6	3.9	4.4
60	4.6	3.7	4.6	3.4	3.6
CD	0.51	0.506	0.43	0.35	0.39
SE ±	0.18	0.17	0.15	0.12	0.13
F-value	1.4^{NS}	5.3**	1.02^{NS}	20.83**	12.27**

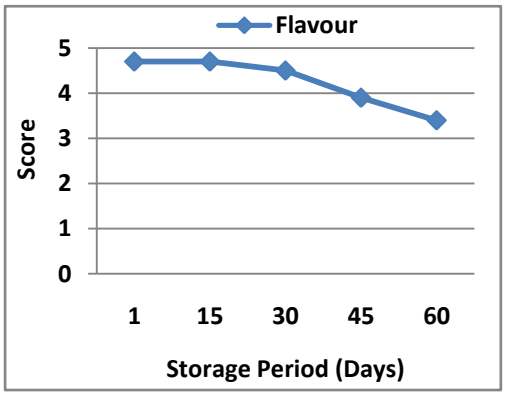
** Significant at 1 per cent NS – Non significant

From the organoleptic evaluation of different variations of *salt biscuits,* it was noticed that the salt biscuits prepared with 15 per cent incorporation of deoiled soya meal scored highest. Hence, they were selected for storage study. The *salt biscuits* were stored in an air tight container at room temperature for 60 days.









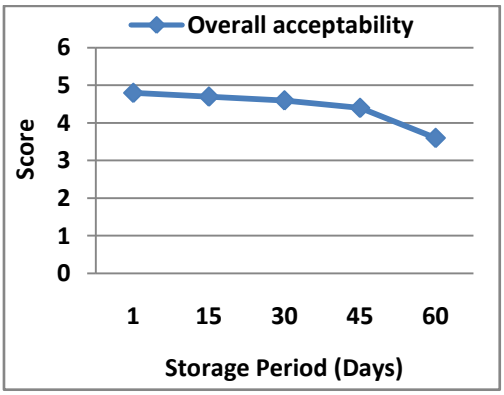


Fig. 14. Mean sensory scores of *salt biscuits* before and after storage

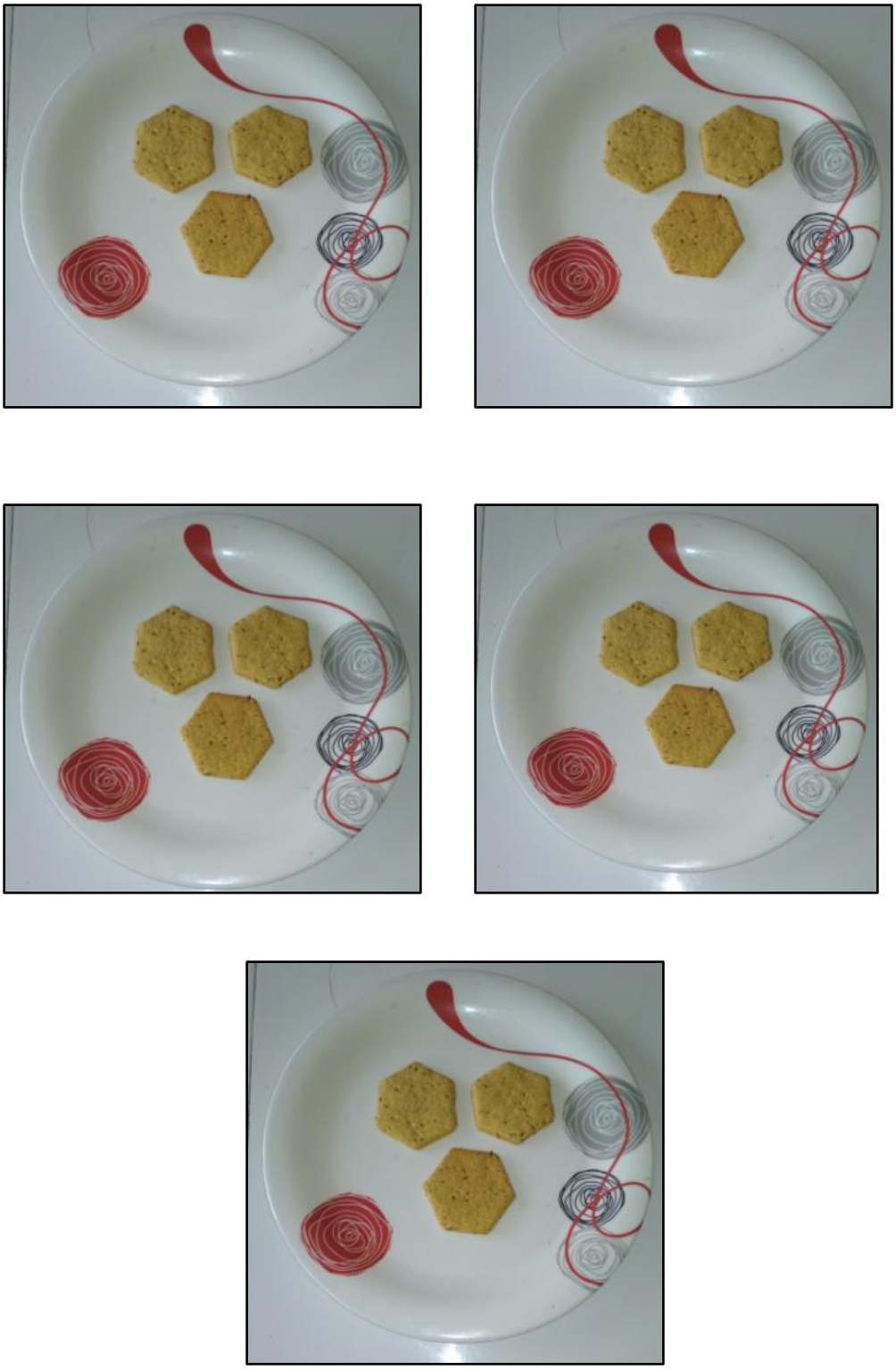


Plate 11. Salt biscuits prepared with incorporation of deoiled soya meal at different levels

There was no much difference in scores up to 15 days of storage in any of the sensory attributes. The score of colour and texture remained at par till the end of storage period. As the period of storage increased, there was reduction in the organoleptic scores of taste, flavour and overall acceptability. The scores reduced significantly on 60th day. Even though the score reduced, it was in the category of good (3-Good) on five point ranking scale on last day of storage.

From the findings, it can be inferred that *salt biscuits* with 15 per cent incorporation of deoiled soya meal can be stored up to 60 days in an air tight container at room temperature without any drastic change in sensory parameters.

Sekhon (2014) developed DSF incorporated (5 to 30%) pretzel snack and observed that the overall acceptability decreased significantly during the storage period (90 days).

4.10. Development of Value Added *Sweet Biscuits*

Most of the people prefer sweet biscuits . Therefore value added *sweet biscuits* were developed which could be suitable for age groups specially children and elderly.

4.10.1 Sensory Evaluation of *Sweet Biscuits*

The mean scores for organoleptic characteristics of *sweet biscuits* prepared without and with varying levels of incorporation of deoiled soya meal are given in Table 24 and are represented in Plate12 and Fig 15

Table. 24 Mean Sensory evaluation scores of *sweet biscuits*

Variations	Level of incorporation of deoiled soya meal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.7	4.7	4.8	4.6	4.7
II	5	4.5	4.6	4.6	4.5	4.6
III	10	4.6	4.5	4.6	4.6	4.5
IV	**15**	**4.8**	**4.8**	**4.7**	**4.8**	**4.8**
V	20	4.2	4.1	4.1	4.2	4.3
CD		0.35	0.43	0.44	0.31	0.29
SE ±		0.15	0.15	0.15	0.14	0.13
F-value		2.2 NS	2.9*	2.8*	2.3 NS	1.8 NS

* Significant at 5 per cent NS- Non significant

The mean sensory scores of colour of *sweet biscuits* for variation I, II, III, IV, V were 4.7, 4.6, 4.5, 4.8, and 4.2 respectively. *Sweet biscuits* prepared with incorporation of 15 per cent of deoiled soya meal obtained highest score (4.8) for colour followed by *sweet biscuits* prepared without deoiled soya meal. The lowest score (4.2) for colour was obtained by *sweet biscuits* prepared with 20 per cent incorporation of deoiled soya meal. Statistical analysis showed that the difference in the score of colour was non significant.

The mean score of texture varied from 4.1 to 4.8 in which the highest score (4.8) was obtained by *sweet biscuits* prepared without addition of deoiled soya meal followed by *sweet biscuits* prepared with 15 per cent incorporation of deoiled soya meal (4.7). The least score for texture (4.1) was obtained by sweet biscuits prepared with 15 per cent incorporation of deoiled soya meal.

The maximum score (4.8) for taste, flavour and overall acceptability was obtained by *sweet biscuits* prepared with 15 per cent incorporation of deoiled soya meal. The mean scores for taste ranged from 4.1 to 4.8 while for flavour and overall acceptability of *sweet biscuits* the scores ranged from 4.2 to 4.8 and 4.3 to 4.8 respectively.

Variation IV got highest scores in all sensory parameters except for texture. Statistic al analysis showed significant difference for taste & texture.

With the increase in the incorporation of deoiled soya meal from 5 to 15 per cent, the scores for the sensory parameters did not change significantly. Hence, it can be inferred that 15 per cent incorporation of deoiled soya meal in *sweet biscuits* was considered as most suitable level.

4.10.2 Nutrient Content of *Sweet Biscuits*

The data about proximate composition and mineral content of *sweet biscuits* is depicted in Table 25 .

From the data, it is noticed that the moisture content of the basic *sweet biscuits* was 5.67 ± 0.6 g/100g whereas, for value added it was 6.28 ± 0.4 g/100g. The protein content of basic sweet biscuits was 6.51 ± 0.49 g/100g while for value added *sweet biscuits* it was 14.36 ± 0.16 g/100g. Data indicated that the protein content of value added *sweet biscuits* was increased significantly (7.85g) due to incorporation of deoiled soya meal.

Table 25. Nutrient content of sweet biscuits (per 100g)

Nutrients	Basic *sweet biscuits*	Value added *sweet biscuits*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	5.67± 1.78	6.28± 1.77	0.52 NS	1.00
Protein (g)	6.51 ± 0.49	14.36 ± 2	20.97**	+7.85
Fat (g)	17.16 ± 0.035	17.13 ± 0.05	0.06 NS	+0.03
Total minerals (g)	1.04 ± 0.05	3.9 ± 0.25	0.63 NS	+2.86
Fiber (g)	0.7±0.5	1.25± 0.05	0.10 NS	+0.55
Carbohydrates (g)	58 ± 0.5	49.43± 0.5	1.59 NS	-8.57
Calcium (mg)	115±2.5	145.5 ± 2.5	7.34**	+30
Iron (mg)	1.48±0.05	2.85±0.5	1.37 NS	+1.37
Copper (mg)	0.67± 0.025	2.03± 0.25	0.027 NS	+1.36
Zinc (mg)	0.38±0.005	0.65±0.195	0.053 NS	+0.27
Manganese (mg)	0.077 ± 0.54	0.077 ± 0.011	0.001 NS	- 0.1

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

Fat content of basic *sweet biscuit* was 17.16 per cent. The corresponding value of fat in case of value added *sweet biscuit* was 17.13 per cent.

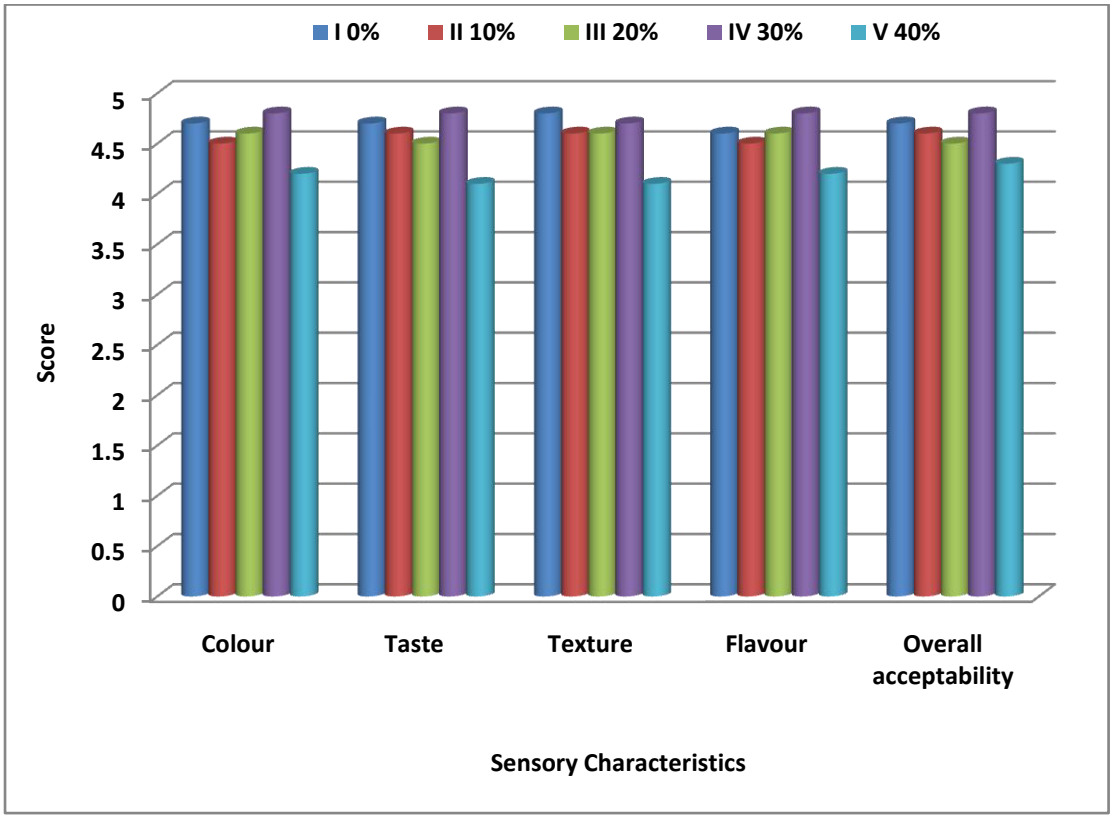


Fig. 15. Sensory evaluation scores of *sweet biscuits*

Total minerals were 1.04 ± 0.05 g/100g and 3.9 ± 0.25 g/100g in basic and value added *sweet biscuits* respectively. The total minerals were increased by 2.86 g which is almost 2 times increase due to value addition. The similar trend of increase in values was noticed with regard to fiber, calcium and iron due to incorporation of deoiled soya meal. The fiber was increased from 0.75 to 1.25 g, calcium from 115 to 145 mg and iron from 1.48 to 2.85 mg per 100g. The increase in calcium content was statistically significant. The zinc content was increased from 0.38 to 0.65 mg/100g but it was not significant.The carbohydrate content reduced significantly (8.57) due to incorporation of deoiled soya meal.

The scrutiny of the data depicted that 15 per cent incorporation of deoiled soya meal found to be a better choice for enhancing the nutrient content of *sweet biscuits* by many folds.

4.10.3 Shelf Life Study of *Sweet Biscuits*

Highly accepted variation of sweet biscuits with 15% incorporation of deoiled soya meal was kept for storage study up to 60 days. The mean scores of sensory parameters during storage are given in Table 26 (Fig.16).

Table 26. Mean sensory scores of *sweet biscuits* before and after storage

Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.8	4.7	4.8	4.8
15	4.8	4.6	4.6	4.6	4.6
30	4.7	4.4	4.6	4.5	4.4
45	4.7	3.9	4.6	4.2	4.2
60	4.7	3.6	4.6	3.4	3.4
CD	0.44	0.32	0.41	0.40	0.42
SE ±	0.15	0.11	0.14	0.14	0.15
F-value	1.11 ^{NS}	19.3**	1.07 ^{NS}	14.84**	13.25**

The score of colour decreased from 4.8 to 4.7; taste from 4.8 to 3.6; texture from 4.7 to 4.6; flavour & overall acceptability respectively at the end of storage period. There was no significant difference in the sensory scores of

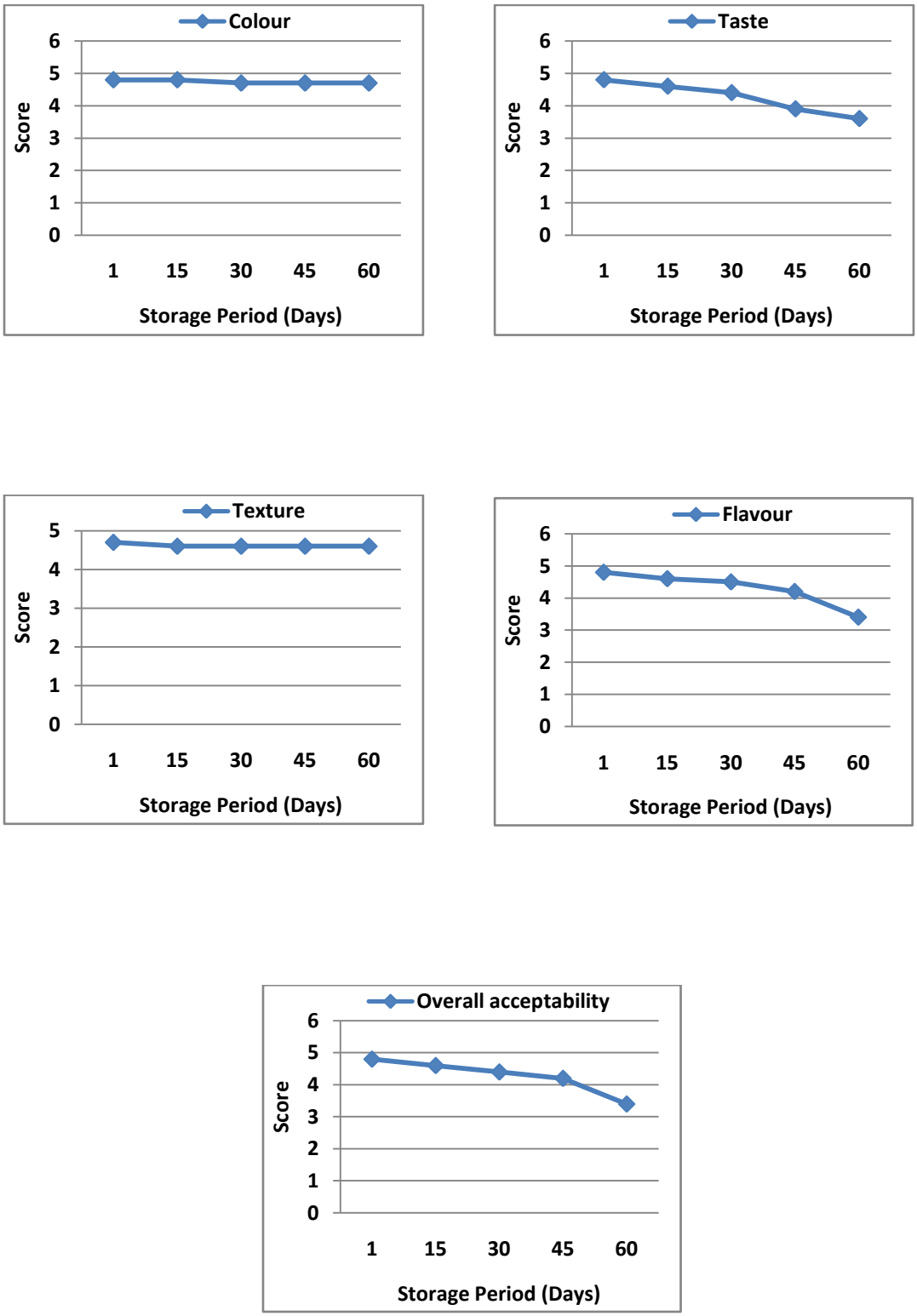


Fig. 16. Mean sensory scores of *sweet biscuits* before and after storage

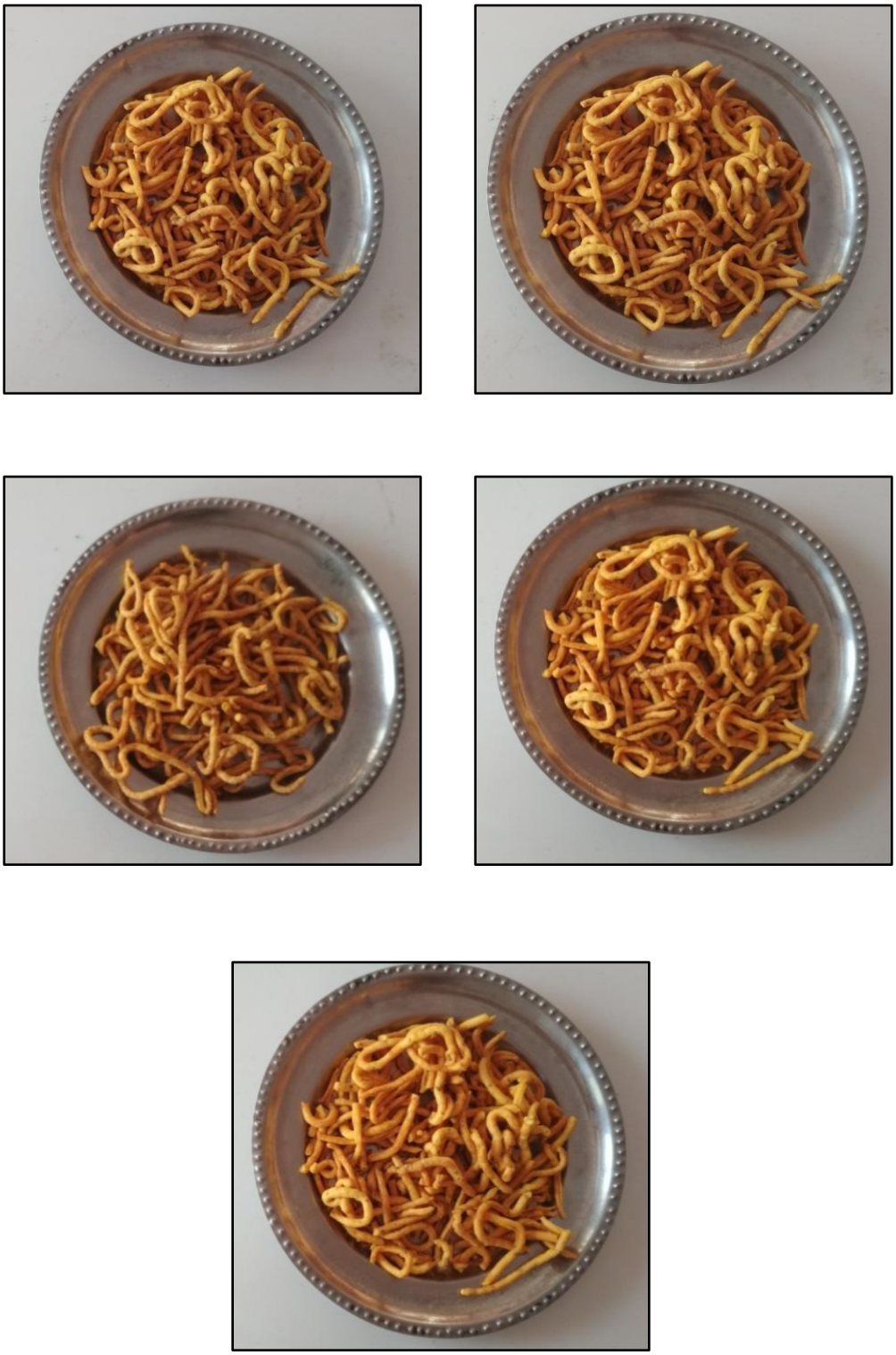


Plate.14 Shev prepared with incorporation of deoiled soya meal at different levels: I-0%, II-10%, III-20%, IV-30% and V-40%

colour and texture up to 60 days of storage. On 60th day there was significant reduction in scores of taste, flavour and overall acceptability. Through significant difference was noticed. The storage did not affect the sensory qualities much as the product was scored more than 3 on 60th day also. Therefore, it can be inferred that with minimum changes in scores of sensory parameters, *sweet biscuits* prepared with 15 per cent incorporation of deoiled soya meal can be stored at room temperature for about 2 months.

Amit *et al*., (2014) noted that the scores of 20 per cent DSF substituted cookies packed in HDPE for colour, flavour, texture, taste, appearance and overall acceptability decreased during storage. However no undesirable change was noticed in sensory quality attributes of cookies by them during 3 months storage.

4.11 Development of Value Added *Shev*

Shev is a preparation served as snack or along with a full course meal as a supplementary dish. It is a prepared across the country and very much liked by people. Hence, it was chosen for value addition.

4.11.1 Sensory Evaluation of *Shev*

Shev was prepared without and with incorporation of deoiled soya meal at varying levels such as 5, 10, 15 and 20 per cent. The mean sensory scores are given in Table 27 and are illustrated in Plate13 and Fig 17

Table 27. Mean Sensory evaluation scores of s*hev*

Variations	Level of incorporation of deoiled soyameal (%)	Mean sensory scores				
		Colour	Taste	Texture	Flavour	Overall acceptability
I	0	4.8	4.7	4.6	4.8	4.7
II	5	4.1	4.5	4.5	4.5	4.5
III	10	4.6	4.5	4.4	4.6	4.6
IV	15	4.7	4.6	4.5	4.6	4.7
V	20	**4.8**	**4.7**	**4.8**	**4.8**	**4.7**
CD		0.45	0.35	0.39	0.29	0.32
SE ±		0.16	0.15	0.17	0.12	0.14
F-value		3.0*	1.5 NS	1.6 NS	0.99 NS	1.4 NS

* Significant at 5 per cent NS- Non significant

The mean sensory scores of colour of *Shev* ranged from 4.1 to 4.8. The *shev* prepared without incorporation of deoiled soya meal and *shev* prepared with incorporation of 20 per cent of deoiled soya meal obtained a score of 4.8 for colour. The lowest score was obtained by *shev* prepared with 5 per cent incorporation of deoiled soya meal. The statistical analysis showed significant difference in the colour of *shev*. In case of texture and flavour, the highest score (4.8) was obtained by *shev* prepared with 20 per cent incorporation of deoiled soya meal. The lowest score for taste was obtained by *shev* prepared with 5 and 10 per cent incorporation of deoiled soya meal. The *shev* prepared with 20 percent deoiled soya meal obtained maximum score for taste (4.7). over all acceptability of shev was highest in the samples with 20 percent incorporation while it was least in 5 percent incorporation. The statistical analysis of sensory parameters indicated that except for colour there was no significant difference in the remaining sensory attributes. From the above findings, it can be inferred that *shev* prepared with 20 per cent incorporation of deoiled soya meal was accepted well than other variations.

4.11.2. Nutrient Content of *Shev*

The proximate composition and minerals were analysed for basic and value added *shev* and the results obtained are tabulated and presented in Table 28.

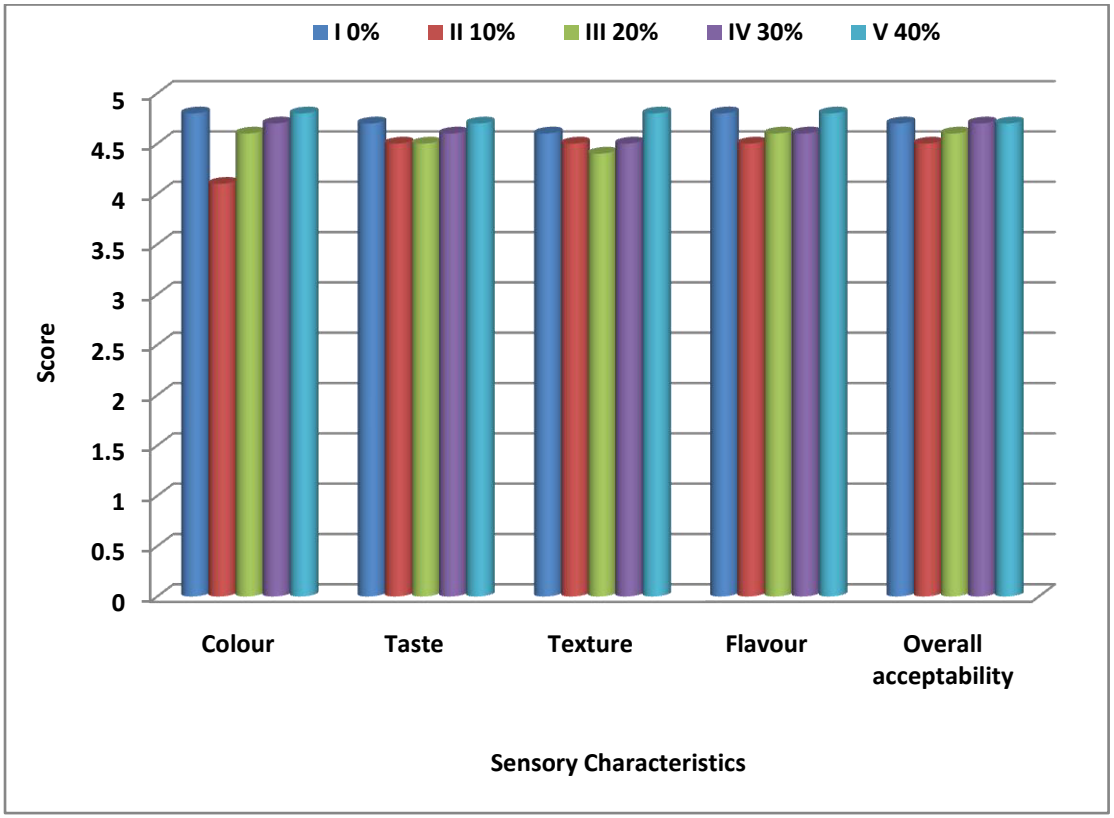


Fig. 17. Sensory evaluation scores of *Shev*

Table 28. Nutrient content of *shev* (per 100g)

Nutrients	Basic Shev	Value added *Shev*	't' value	Increase/ decrease in nutrient content
	Mean ± SD	Mean ± SD		
Moisture (g)	7.8±1.13	7.86 ± 1.13	0.065^{NS}	+0.06
Protein (g)	17.78 ± 0.42	26.85± 0.28	14.63**	+9.2
Fat (g)	10.75 ± 1.25	10.025 ± 0.72	0.7^{NS}	-0.73
Total minerals (g)	2 .00± 0.15	3.22± 1.33	0.66^{NS}	+1.22
Fiber (g)	1.34±0.1	2.41± 0.27	0.42^{NS}	- 0.71
Carbohydrates (g)	61.24 ± 0.5	55± 0.5	11.36**	-11.06
Calcium (mg)	325±25	360 ± 10	1.83^{NS}	+35
Iron (mg)	1.24±0.025	1.70.±0.005	25.5**	+0.46
Copper (mg)	0.17±0.05	0.38± 0.01	0.21^{NS}	+0.2
Zinc (mg)	0.23±0.05	0.24±0.05	0.2 ^{NS}	+0.01
Manganese (mg)	0.17 ± 0.025	0.33 ± 0.004	8.77**	+0.7

** Significant at 1 per cent * Significant at 5 per cent NS- Non significant

The moisture, protein, fiber and mineral content of value added *shev* were increased from 7.8 to 7.86 per cent; from 17.78 to 20.70 per cent; from 1.34 to 2.41 per cent and from 2.00 to 3.22 per cent respectively after value addition. The carbohydrate content of value added *shev* was decreased from 61.24 per cent to 55 per cent. The increase in values of protein and iron was statistically significant. Calcium content of basic s*hev* was lower (325 ± 2.5 mg/100g) than the value added *shev* (360 ± 10 mg/100g). Hence, the value got decreased in the experimental samples of shev as the Bengal gram was replaced with deoiled soya meal at 20 per cent level. The iron content of value added she was increased from 1.24 to1.7 mg/100g. There was no significant increase in copper, zinc and manganese in deoiled soya meal incorporated *shev.*

From the above findings, it can be suggested that 20 per cent incorporation of deoiled soya meal would increase the protein, fiber and minerals of *shev.*

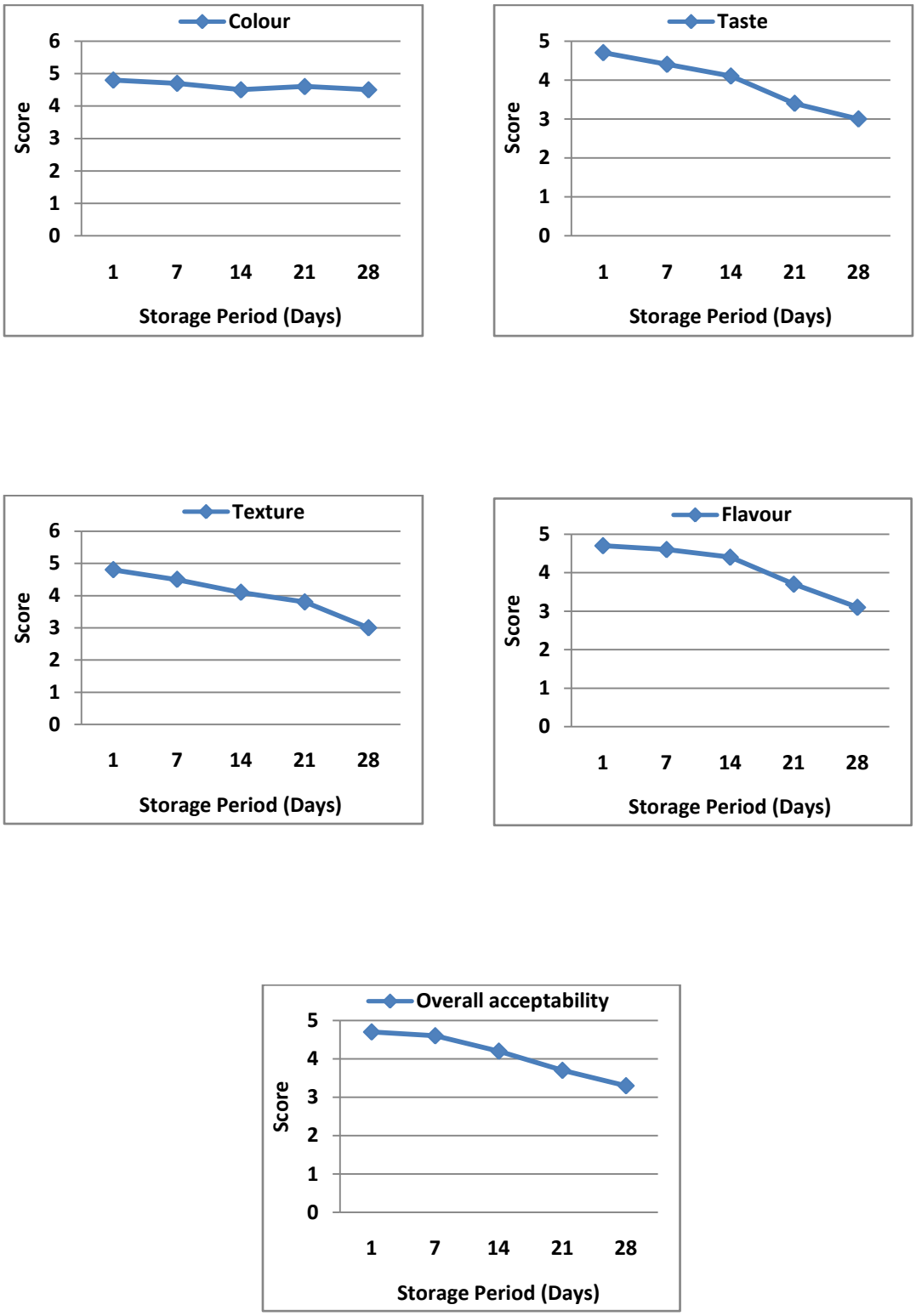


Fig. 18. Mean sensory scores of *Shev* before and after storage

4.11.3 Shelf Life Study of *Shev*

Table 29. Mean sensory scores of *shev* before and after storage

Storage period (Days)	Mean sensory scores				
	Colour	Taste	Texture	Flavour	Overall acceptability
1	4.8	4.7	4.8	4.7	4.7
7	4.7	4.4	4.5	4.6	4.6
14	4.5	4.1	4.1	4.4	4.2
21	4.6	3.4	3.8	3.7	3.7
28	4.5	3.0	3.0	3.1	3.3
CD	0.32	0.59	0.49	0.30	0.30
SE ±	0.11	0.21	0.17	0.10	0.11
F-value	1.58^{NS}	10.42**	16.09**	20.81**	25.46**

** Significant at 1 per cent

The mean scores given by judges to *shev* during the storage period are presented in Table 29. The data revealed that all sensory parameters except colour (from 4.8 to 4.5), taste (from 4.7 to 3.0), texture (from 4.8 to 3.0), flavour (from 4.8 to 3.1) and overall acceptability (from 4.7 to 3.3) showed a significant reduction on 28th day of storage. When compared with the initial score, the final day scores were decreased significantly but the product was well accepted by the Judges until the end of storage period. The scores of the *shev* remained above 3 even on the 28th day of storage which is referred as good on five point ranking scale. Hence, even though the changes are statistically significant, the *shev* can be stored up to 28 days with very well acceptance.

The overall scrutiny of data generated under the study inferred that though in some of the products statistically significant difference was noticed for some organoleptic parameters it was between highest and lowest observation. The scores of basic variation and the most accepted variation did not differ significantly. This findings prove that value added products prepared under study were acceptable as basic ones. Hence, it can be concluded that deoiled soya meal can be very well utilized for preparing well accepted products with higher nutritive value. The developed products are rich in nutrients with particular reference to protein, fiber, total minerals, calcium, iron, copper, zinc and manganese. Hence, it is suggested that instead of basic

preparations value added products can be prepared to get more amount of nutrients from the same amount of food.

Summary and Conclusion

CHAPTER-V

SUMMARY AND CONCLUSION

A study entitled 'Utilization of deoiled soya meal for development of value added food products' was under taken. The investigation was carried out in two phases. During phase I a survey was conducted to elicit information on consumption of deoiled soya meal. During phase II different food products were prepared by incorporating deoiled soya meal and their acceptability was evaluated. The nine different products namely *bhakari, chapati, chakali, fenugreek leaves paratha, kharapara, semolina laddu, shev, salt biscuits and sweet biscuits*were prepared with incorporation of deoiled soya meal at various level. The highly accepted variations among selected products were analyzed for nutrient composition. The methods used and the results emerged out of the experiment were presented and discussed in previous chapters and are summarized below.

A survey of randomly selected 100 households was conducted in Parbhani city. The information regarding general aspects of households and consumption pattern of deoiled soya meal was collected with the help ofpre tested questionnaire by personally interviewing the homemakers.

General information of homemaker from selected households found that most of the respondents (64%) were belonging to 30-45 years of age while 36 per cent were of the age 25 to 30 years . The subjects from nuclear family were74 per cent and 26 per cent were from joint family.Majority of selected respondents were housewives belonging to middle age, nuclear families and were having monthly income between 10 to 40 thousand rupees.

Awareness about nutritional importance and health benefits of deoiled soya meal was amongonly 7 per cent and unawareness among 93 per cent home makers. The information on value addition revealed that 94per cent of housewives did not know about the value addition. Only 6 per cent housewives knew about it.

As the deoiled soya meal was a rich source of nutrients in II phase of experiment various above listed products were prepared with incorporation of deoiled soya meal at 5 to 30 per cent level. The control sample was prepared without incorporating deoiled soya meal. Sensory evaluation of the prepared products was carried out by 15 semi trained Judges.

It was noticed that 10 and 30 per cent deoiled soya meal incorporated *chapati* and *bhakari* respectively were most accepted.

Sensory scores of *bhakari* prepared with incorporation of deoiled soya meal were compared with scores of value added *bhakari.* it was noticed that the scores of value added *bhakari* were more than the basic *bhakari* except for taste and flavour. The protein content of basic and value added *bhakari* was 8.19 and 18.9 per cent respectively. The protein content of deoiled soya meal incorporated *bhakari* was increased by 10.71 g. The fiber and total mineral content of experimental variation sample were increased by 0.36 and 0.9 g respectively. Calcium and ironincreased from 25 to 40 mg/100g, and from 1.81 to 4.17 mg/100g respectively. *Bhakari* prepared with deoiled soya meal can be stored for about 36 hours.

The sensory scores of flavour and overall acceptability were same for basic *chapati* and value added *chapati.*In the *chapati* prepared with incorporation of deoiled soya meal protein content was increased from 8.19 to 16.94 percent, calcium was increased significantly (from 45 to 62.5%), iron was slightly increased (from 0.93 to 2.27 %).C*hapati* prepared with deoiled soya meal can be stored for about 36 hours.

Chakali prepared with 15 per cent incorporation of deoiled soya meal obtained slightly higher scores than basic for all parameters except overall acceptability and hence, it can be the best level to incorporate deoiled soya meal in *chakali* without any change. There was an increase in iron content (from 1.45 mg to mg/100g) in the deoiled soya meal incorporated *chakali.* The statistical comparison of basic *chakali* and value added *chakali* indicated that there was significant increase in moisture (from 7.9 to 8.4 %), protein (from

12.88 to 20.06 %), fiber (from 2.47 to 3.75 %), total minerals (from 0.47 to 3.15 %) and calcium (from 185 to 212 mg/100g) due to value addition. Developed *chakali*can be stored for about 28 days.

Organoleptic evaluation of *fenugreek leaves paratha* leaves revealed that 20 per cent of deoiled soya meal could be an appropriate level to incorporate in *fenugreek leaves paratha* with very well acceptance. The value added *fenugreek leavesparatha* were given higher scores than basic samples for all sensory parameters. *Fenugreek leaves paratha* with 20 per cent addition of deoiled soya meal is helpful to elevate the level of protein, total minerals, fiber and iron. Shelf life study indicated that the *fenugreek leaves paratha* prepared with incorporation of deoiled soya meal can be stored for 5 days.

Fifteen per cent of deoiled soya meal was incorporated in the preparation of *semolina laddu.* The overall acceptability of basic *semolina laddu* and value added *semolina laddu* was found to be equal (4.7). From the nutrient analysis, it was noticed that there was an increase in the level of protein (from 8.19 to 15.68%), fiber (from 0.81 to 0.54 %), total minerals (from 1.05 to1.75 %) and iron (from 1.15 to 3.75mg/100g) in value added *semolina laddu.* Itcould be stored up to 20 days at room temperature without any loss of organoleptic characters.

The salt biscuits prepared with 15 per cent incorporation of deoiled soya meal were ranked higher than the basic salt biscuits in all organoleptic parameters. Nutrient analysis of basic saltbiscuits and value added salt biscuits revealed that value added *salt biscuits* found to have high amount of protein (13.86 g/100g), fiber (0.3 g/100g), total minerals (1.95 g/100g), calcium (125 mg/100g) and iron (2.11 mg/100g). Deoiled soya meal incorporated *salt biscuits* could be stored up to 60 days in an air tight container at room temperature without any drastic change in sensory parameters.

Organoleptic evaluation scores of *sweet biscuits*indicated that the scores of 15 per cent deoiled soya meal incorporated samples scored higher (4.8) except for taste and texture which scored lower than basic (4.7). Nutrient

analysis of basic and value added sweet biscuits proved that the iron content of experimental variation (2.85mg/100g) was increased than the basic sample (1.48 g/100g). Incorporation of deoiled soya meal increased the level of other nutrients also. *Sweet biscuits* prepared with 15 per cent incorporation of deoiled soya meal could be stored up to 2 months with minimum changes in sensory attributes.

Twenty per cent of deoiled soya meal was incorporated in *shev*.*Shev*prepared with deoiled soya meal had higher acceptance than the basic recipe. Organoleptic scores proved this by having higher scores for deoiled soya meal incorporated*shev* for all parameters. The score for the colour of both basic and value added *shev*was equal (4.8). However, the overall acceptability score was same for deoiled soya meal incorporated *shev*. The scores for value added *shev*were better than the basic sample except for colour and over all acceptabilitywhich scored equal to the basic *shev*.

Nutrient analysis of *shev*showed a significant difference in the protein and iron content. There was significant increase in the protein content of deoiled soya meal incorporated *shev* (20.70 %) than basic *shev* (17.78 %). There was an increase in fiber (from 1.34 g to 2.41 g), total minerals (from 2.00 g to 3.22 g), calcium (from 325 mg to 360 mg) and iron (from 1.24 mg to 1.70 mg). The soya meal incorporated *shev* can be stored up to 28 days without affecting the sensory characteristics.

From the study it can be concluded that

1. There was least awareness (only 7%) regarding deoiled soya meal in community.
2. Deoiled soya meal is not at all consumed by population.
3. People are not aware about the nutritive value of deoiled soya meal.
4. Very well accepted products viz.*bhakari, chapati, chakali, fenugreek leaves paratha, kharapara, semolina laddu, shev, salt biscuits and sweet biscuits* can be prepared by utilizing deoiled soya meal.

5. The nutritional value of products can be increased by incorporation of deoiled soya meal at the level of 10 to 30 per cent.
6. Deoiled soya meal can be very well utilized for value addition.

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Thesis Abstract

Utilization of Deoiled Soya Meal For Development of Value Added Food Products

Abstract

A study was conducted to elicit the information on consumption pattern and utilization of deoiled soya meal for value addition of food products. Commonly consumed nine products namely *bhakari, chapati, chakali, fenugreek leaves paratha, kharapara, semolina laddu, shev, salt biscuits and sweet biscuits* were prepared without and with incorporation of deoiled soya meal at the level of 5 to 40 percent. The products were evaluated organoleptically. The highly accepted variations among selected products were analyzed for nutrient composition. The products were stored to study their shelf life. The findings indicated that awareness about nutritional importance and health benefits of deoiled soya meal was only 7 per cent. None of the household consumed deoiled soya meal. Most accepted variations of the developed products were with deoiled soya meal at the levels of 10 percent in *chapati*; 30 percent in *bhakari*; 15 percent in *chakali, semolina laddu, kharapara,* salt biscuits & sweet biscuits and 20 percent in *fenugreek leaves paratha&shev.* There was significant increase in protein, total minerals, fiber, calcium and iron content of deoiled soya meal incorporated products. It is concluded that the deoiled soya meal can be very well utilized for value addition. The nutritional profile of food products can be increased by incorporation of deoiled soya meal at the level of 10 to 30 per cent. Deoiled soya meal is helpful to elevate the level of protein, total minerals, fiber, calcium and iron in food products.

APPENDIX-I

Interview Schedule to Study the Food Consumption Pattern of Soya Meal Incorporated Products

General information

1. Name:

2. Gender:

3. Age:

4. Address of household:

5. Mobile number:

6. Type of family:

a. Joint b. Nuclear c. Extended

7. Number of family members and size of family:

a. Small (1-4) b. Middle (4-8) c. Large (Above 8)

8. Monthly family income:

Group I - (below Rs.10000)	
Group II - (Rs.10000 -20000)	
Group III - (Rs.20000-30000)	
Group IV - (Rs.30000-40000)	
Group V - (above Rs.40000)	

9. Occupation of homemakers

1. Service	
2. Teacher	
3. Lecturer	
4. Labour	
5. Farmer	
6. House wife	
7. Other a. b. c.	

II Information regarding consumption of Soya Meal incorporated Products

10. Food habits: 1.vegeterian

2. Non vegetarian

11. Do you know about deoiled Soya Meal?

Yes /No

If, yes what is it?

12. Do you know the nutrient content of soya meal?

Yes /No

If, yes what is the nutritive value?

13. Do you know the nutritional importance and health benefits of deoiled soya meal?

Yes /No

14. Do you consume soya meal incorporated products?

Yes /No

If, yes a) which products do you consume and what is frequency of consumption

S. No.	Name of the Soya Meal Product	Daily		Weekly		Monthly		occasionally		Never	
		Yes /No	Amount (g)	Yes/ No	Amount (g)	Yes /No	Amount (g)	Yes/ No	Amount (g)	Yes/ No	Amount (g)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

b) Which soya meal incorporated products you like most?

15. Who eat more soya Meal incorporated products in your family?

a. Family b. Adults c. Both

16. Which soya meal incorporated products they consume

Family members	**Name of the soya meal products**
Children	
Adults	
Older people	

17. Do you know the nutritional importance and health benefits of deoiled soya meal?

Yes / No

If yes, what is it?

18. Do you know about the value addition?

Yes /No

If yes, what is it?

19. Do you know why value addition should be done?

Yes /No

If yes, why it is done?

20. Do you know the price of deoiled soya meal?

Yes /No

If yes, what is it?

APPENDIX- II

Preparation of Recipes

1. *Bhakari*

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Jowar flour	50	45	40	35	30
Deoiled soya meal	-	5	10	15	20

Procedure

1. Took the jowar flour and made dough with little addition of little water .
2. Divided dough into equal sized balls.
3. Spread it with the palm by applying dry flour on the rolling board.
4. Roasted on shallow pan.

2. Chapati

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Wheat flour	48	43	38	33	28
Oil	1	1	1	1	1
Salt	1	1	1	1	1
Deoiled soya meal	-	5	10	15	20

Procedure

1. Added salt into the wheat flour and prepared dough.
2. Divided dough in same sized balls.
3. Rolled balls and roasted on shallow pan.

3. *Chakali*

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Bengal gram dal	45	40	35	30	25
Raw rice	22	22	22	22	22
Jowar	12	12	12	12	12
Cumin seed	2	2	2	2	2
Oil	9.4	9.4	9.4	9.4	9.4
Gingelly seed	7	7	7	7	7
Red chilli powder	1	1	1	1	1
Turmeric	0.5	0.5	0.5	0.5	0.5
Salt	1.5	1.5	1.5	1.5	1.5
Deoiled soya meal	0	5	10	15	20

Procedure.

1. Roasted and powderd the rice, bengal gram dhal and jowar.
2. Mixed all ingredients and add little hot oil in mixture.
3. Prepared dough by using required amount of water.
4. Made chaklies with the help of chakali mould
5. Put the dough into the chakali mould and press on to a paper to form pattern.
6. Deep fat fry the pressed pattern chakali till brown color is obtain on both sides.

.

4. *Fenugreek leaves paratha*

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Wheat flour	50	45	40	35	30
Fenugreek leaves	20	20	20	20	20
Oil	1.5	1.5	1.5	1.5	1.5
Garlic	0.5	0.5	0.5	0.5	0.5
Cumin seed	0.5	0.5	0.5	0.5	0.5
Omum	0.5	0.5	0.5	0.5	0.5
Besan	5	5	5	5	5
Red chilli powder	1	1	1	1	1
Turmeric	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Deoiled soya meal	0	5	10	15	20

Procedure

1. Washed the fenugreek leaves under running tap water.
2. Choped the fenugreek leaves finely .
3. Mixed the whole wheat flour and besan. Added cumin seed, omum the chopped fenugreek leaves, red chilli powder, garlic and mixed well.
4. Prepared smooth dough & made parathas.
5. Pour some water and knead to smooth dough & make paratha.
6. Roasted by applying oil on both the surfaces.

5. Kharapara

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Refined wheat flour	88	83	78	73	68
Oil	4	4	4	4	4
Cumin seed	5	5	5	5	5
Salt	3	3	3	3	3
Deoiled soya meal	0	5	10	15	20

Procedure

1. Sieved the refined wheat flour. Added salt, oil, cumin seed and water made the dough.
2. Roll the thin chapatti is and placed one on the top of them with application of oil and refined wheat flour.
3. Made the roll of chapattis and cut into 3 to 4 pieces.
4. The cut piece of roll was rolled to chapatti and was cut into kharapara shape.
5. Fried the kharapara in oil till light brown color.

6. Semolina Laddu

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Semolina	50	45	40	35	30
Sugar	20	20	20	20	20
Fat	9	9	9	9	9
Milk powder	10	10	10	10	10
Nigar seed	10	10	10	10	10
Cardamom	1	1	1	1	1
Deoiled soya meal	0	5	10	15	20

Procedure

1. Roasted the semolina in a pan .
2. Added sugar powder, roasted nigar seed powder, milk powder ,deoiled soya meal and cardamom powder mixed thoroughly with semolina.
3. Mixed well and made laddus.

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7. *Salt Biscuits*

Ingredients (g)	Basic	Variation II	Variation III	Variation IV	Variation V
Refined wheat flour	50	45	40	35	30
Fat	19	19	19	19	19
Sugar	7	7	7	7	7
Baking powder	1	1	1	1	1
Salt	1	1	1	1	1
Omum	1	1	1	1	1
Cumin seed	1	1	1	1	1
Milk	20	20	20	20	20
Deoiled soya meal	0	5	10	15	20

Procedure

1. Sieved the refined wheat flour and baking powder together thrice.
2. Creamed the fat and sugar till light and fluffy.
3. Added salt in it.
4. Added refined wheat flour/ deoiled soya meal,milk, cumin seed and omum to creamed fat and made dough.
5. Made the small balls of equal size rolled it and made desired shapes with the help ofmold.
6. Baked at 250° F to 275° F for 15 minutes.

8. *Sweet Biscuits*

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Refined wheat flour	50	45	40	35	30
Sugar	20	20	20	20	20
Fat	18	18	18	18	18
Milk	10	10	10	10	10
Cardamom	1	1	1	1	1
Baking powder	1	1	1	1	1
Deoiled soya meal	0	5	10	15	20

Procedure

1. Sieved the refined wheat flour and baking powder together thrice.
2. Creamed the fat and sugar till light and fluffy.
3. Added refined wheat flour/ deoiled soya meal and milk to creamed fat and made dough.
4. Made the small balls of equal size, rolled the and made desired shapes with the help of mold
5. Baked at 250° F to 275° F for 15 minutes.

9. *Shev*

Ingredients (g)	Variation I	Variation II	Variation III	Variation IV	Variation V
Bengal gram flour	88	83	78	73	68
Omum	1.5	1.5	1.5	1.5	1.5
Cumin seed	1.5	1.5	1.5	1.5	1.5
Oil for mixing	5	5	5	5	5
Red chilli powder	1	1	1	1	1
Turmeric	1.5	1.5	1.5	1.5	1.5
Salt	1.5	1.5	1.5	1.5	1.5
Deoiled soya meal	0	5	10	15	20

Procedure

1. Heated the oil, added bengal gram flour and rubed it.
2. Added cumin seeds powder, omum powder, turmeric powder, red chili powder and salt in bengal gram flour and mixed well
3. Prepared stiff dough by using water
4. Heated oil pressed batter dough through mold into hot oil.
5. Fried till golden brown colour.

APPENDIX III

Five Point Ranking Scale

Sensory Analysis

Name of product: Date:

Name of panel member:

Variations	Colour	Texture	Taste	Flavour	Overall acceptability
I					
II					
III					
IV					
V					

5- Excellent

4- Very good

3- Good

2- Fair

1- Poor Signature

Ref: Amerine M.A., PongbornR.M. andRoesslerE.D. (1965). Principles of Sensory Evaluation of foods. Academic Press, New York.

APPENDIX IV
Nutrient Analysis

1.Determination of moisture content

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

Procedure

Three samples from each developed product were accurately weighed in an amount of 5.0g each in weighing bottle (previously heated to 90°C to 100°C and cooled in a desicator). The bottles were loosely covered with lids and heated in dry air oven for 3 hours at 105°C. after 3 hours bottles were removed from oven, allowed to cool in desicator and weighed accurately. Then again bottles were heated in oven for 1 hour and weighed accurately. Then again bottles were heated in 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

$$\text{Moisture content of the sample (\%)} = \frac{W_1 - W_2}{W} \times 100$$

Where,

W_1 = Initial weight of bottle with sample before drying.

W_2 = 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

Catalyst mixture

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

40 per cent sodium hydroxide solution

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

Methyl red indicator

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.

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 sulphric acid solution was diluted up to 1000 ml with distilled water.

Procedure

One gram of defatted powdered sample of each developed product was weighed on a butter paper, in triplicate and placed in 500 ml kjeldhal flask. An amount of 5.0 g 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 in to 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 was 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.

Protein (%) = Nitrogen (%) X 6.25

Where,

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

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 flasks 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 butter paper from each selected product.Each weighed sample was

placed in thimbles and plugged with fat free cotton. Then the thimbles with the weighed sample were placed in the syphon portion of soxhlet apparatus. The volume of 160 ml of analytical grade petroleum either and diethyl ether mixture (1:1) was placed in each round bottom flask of the soxhlet apparatus and it was connected to the soxhlet syphon and condenser. The condenser was plugged with moistened cotton. It was refluxed for 5-7 times at $60^{O}C$. Then ether was distilled off and flaks were placed on hot plate for 3 hours at $105^{O}C$ for drying, cooled in a dedicator and weighed. Fat content of sample was calculated by using the formula.

$$\text{Fat content (\%)} = \frac{W_2 - W_1}{X} \times 100$$

Where,

W_2 = Weight of round bottom flask with fat

W_1 = Weight of empty round bottom flask

X = Weight of sample

4. Estimation of total minerals

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

Procedure

Exactly 2.0 g sample was taken in three silica crucibles which were heated previously at $100^{O}C$ 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 $600^{O}C$. Thereafter crucibles were allowed to cool in desicator 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

$$\text{Total mineral content of the sample (\%)} = \frac{W_3 - W_1}{W_2} \times 100$$

Where,

W_3 = Weight of crucible with ash

W_1 = Weight of crucible

W_2 = 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 reagents

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.

0.313 N sodium hydroxide solution

A weighed amount of 1.25 g 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 stir the solution which helped for smooth boiling. Then the mixture was filtered through a muslin cloth and residue was washed with hot water to make it free from acid. The material was then transferred to the same beaker carefully; 200 ml of 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 free from alkali. Then residue was transferred to crucible which was dried in an oven overnight at $80^{O}C$ and weighed accurately (W_1). The crucible was heated in a muffle furnace at $600^{O}C$ for 2-3 hours, cooled in a desiccator and weighed again accurately (W_2). The difference between the two weights ($W_1 – W_2$) was considered as the weight of crude fibre in the moisture and fat free sample. The content of crude fibre in sample was calculated by using following formula

$$\text{Crude fibre content (\%)} = \frac{100 - (\text{Moisture} + \text{fat}) \times \text{weight of Fibre}}{\text{Wt. of sample taken}} \times 100$$

6. Determination of carbohydrate 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 g of the sample.

Carbohydrate = 100 - (Moisture + protein + fat + ash + crude fibre)

7. Determination of calcium content

Calcium content of selected samples was estimated by EDTA method.

Preparation of Reagents

4 N sodium hydroxide

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

Ammonium purpurate indicator

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

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

2 g 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 estimation

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

$$\text{Ca (me/lit)} = \frac{\text{R x Normality of EDTA x 1000 X5}}{\text{Aliquot (ml) taken}} \quad \text{(a)}$$

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

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

Where,

R = volume (ml) of EDTA used in titration

7. Determination of iron

The trace elements (iron) from the ash solution of the samples 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.

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

Where,

R – reading on atomic absorption Spectrophotometer

ppm = mg/1000g

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

8. Estimation of micro minerals (copper, zinc and manganese)

Wet digestion by nitric acid & microwave and Atomic Absorption Spectrophotometer (AAS)

This procedure is suitable for digestion of a wide range of biological materials and food samples for analysis of Ca, Mg, Zn, Cu and Mn. Use of sealed-chamber digestion vessels in which pressure increases occur during heating have resulted in short digestion time and reduced reagent use.

Materials and reagents

- ✓ Commercial microwave oven with acid fume vent
- ✓ PFA digestion vessel
- ✓ 50 ml digestion tubes
- ✓ Acid fume hood
- ✓ Conc. Nitric acid

Method

1. Weigh 0.3 g of food sample into 50-mL digestion tube
2. Add 5 mL of concentrated nitric acid
3. Place the digestion tube in the PFA digestion vessel and put it into microwave oven
4. Set the temperature for 150 °C for 30 minutes and then increase the increase the temperature to 180 °C and keep it for 60 mts or until the sample clears

5. Remove the digestion tube from the vessel ones the vessel got cooled
6. Filter the digested sample and makeup the volume upto 100 ml using distilled water
7. The aliquot of the solution were fed to atomic absorption spectrophotometer through a capillary and readings were obtained.

$$\text{Cu/Zn/Mn in ppm} = \frac{R \times 10}{\text{Wt. of sample}}$$

Where,

R – reading on atomic absorption Spectrophotometer

ppm = mg/1000g

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