DEVELOPMENT OF FOOD PRODUCTS WITH INCORPORATION OF GARDEN CRESS SEEDS (*Lepidium sativum*) FOR LACTATING WOMEN

BY

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DISSERTATION

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CERTIFICATE - I

This is to certify that **Miss. Priti Laxmanrao Rupnar** has satisfactorily prosecuted her course of research for a period of not less than two semesters and that her dissertation entitled,"**Development of Food Products with Incorporation of Garden Cress Seeds (*Lepidium sativum*) for Lactating Women** " submitted by her is the result oforiginal research work and is of sufficiently high standard to warrant it's presentation to the examination.

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

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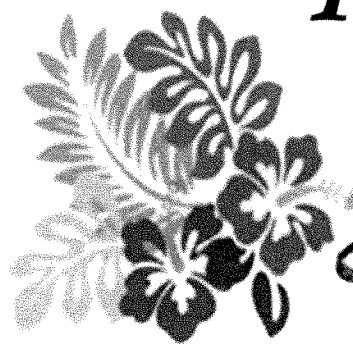


CHAPTER 1

INTRODUCTION

The period of lactation is a major source of concern in developing countries because of its positive impact on the health and nutrition of infants. Lactating women from developing countries are considered nutritionally vulnerable group because this period places a high nutritional demand on the mother. Inadequate maternal diet during this period will lead to poor secretion of nutrients in breast milk and this can have long term impact on the child's health (Jones *et al.*, 2010).

The nutrient intake of lactating women is one of most important determinants of woman's health, well-being and the ability for long-term successful breastfeeding. Human lactation is a natural process, which is well established to provide many health benefits for both mothers and their infants. Lactation also has many favourable effects on women, including reducing the incidence of type 2 diabetes, metabolic syndrome (Gunderson *et al.,* 2010; Stuebe *et al.,* 2005), cardiovascular disease (Schwarz *et al.*, 2009; Stuebe *et al.*, 2009) and cancer (Stuebe *et al.,* 2009). The nutrient intake of lactating women affects the nutrient content of breast-milk and maternal health (Lonnerdal 1986). As noted, many essential nutrients are secreted into breast milk and represent a significant proportion of nutrient intake in the maternal diet, including docosa hexaenoic acid (DHA) (Scopesi *et al.,* 2001; Guesnet *et al.,* 2011; Makrides *et al.,* 1996), most vitamins including vitamin B2 (Bates *et al.,* 1982), vitamin A (Haskell *et al.,* 1999) and vitamin D (Hollis *et al.,* 2004; Mulligan *et al.,* 2010). Thus, nutritional requirements for lactating women are higher compared to women who do not breastfeed (Society CN 2006 & 2008).

Over 200 ingredients of mother's milk, including hormones, enzymes, growth factors, antibodies as well as anti-inflammatory and immunomodulating substances (Takeda *et al.*, 2004; Lonnerdal and Lien, 2003; Ogbe, 2008), have been identified to significantly affect child's correct growth

and psychomotor development. Among indispensable constituents of breast milk, there are also vitamins A and E (Schweigert *et al.*, 2004). Their concentration in human milk is highly individual-specific depending on physiologic as well as environmental factors. In this respect, the diet of the lactating mother is of significant importance (Prentice, 1991).

Amount of milk secreted by lactating women in India is about 600-850 ml. per day. The additional energy intake during first six months of lactation is 600 Kcal/day, since Indian women continue to lactate beyond six months to one year (NIN, 2010).

Lactating mother's nutritional requirements should meet her own daily needs, provide enough nutrients for the growing infant and furnish the energy for the mechanism of milk production. Diet of lactating mother and her nutritional status during pregnancy affect to a certain extent quality and quantity of breast milk.

The physiological stress of lactation on the body is greater than that of pregnancy and the state of lactation demands additional nutritional support. Lactation involves drainage of nutrient in the form of milk and hence the possibility of incurring considerable nutrient expenditure by the women during the period of milk secretion. Milk secretion requires all most all the nutrient over and above her own requirements under normal condition especially with regard to energy. The additional requirement of energy is generally met from the deposits of the reserved of body fat prior to the lactation.

The physiological stress apart from menstruation is important cause of negative iron balance among lactating women in India. Therefore the women subsisting on diets marginally sufficient or insufficient in nutrients might develop anaemia during lactation. Malnutrition comprising of anaemia is considered as a major underlying cause for morbidity in lactating women. Repeated and prolonged lactation probably perpetuates anaemic condition in

lactating women. Therefore the need arises to make every effort to prevent the impending risk of anaemia through intervention programmes.

Garden cress seeds are a good natural source of vitamins and minerals for new mothers. Garden cress seeds is said to help to regulate the menstrual cycle, increase milk production and secretion in lactating mothers. These seeds are traditionally used as a complementary food in the post-partum period by women in India (Saravanan *et al.*, 2012).

The vernacular names of Garden cress Plant in India (Doke and Guha 2014)

Aadalu:	Telugu	Candriki:	Assamese
Chand Shura:	Sanskrit	Chandasura:	Oriya
Chansur:	Hindi	Common Cress:	English
Halim:	Urdu	Halim:	Bengali
Holan:	Punjabi	Haliv:	Marathi
Alian:	Kashmiri	Allibija:	Kannada
Allivirai:	Tamil	Asali:	Malayalam
Aseliyo:	Gujrati		

Garden cress seeds are small, oval-shaped, pointed and triangular at one end, smooth, about 3-4mm long, 1-2 mm wide, reddish brown in color. A furrow present on both surfaces extending up to two thirds downward, a slight wing like extension present on both the edges of seed. On soaking in water seed coat swells and gets covered with transparent, colorless, mucilage with mucilaginous taste. The seed length and width are 298 ± 3.2μm and 100 ±1.9 μm respectively (Gigi and Rashmi, 2014).

The garden cress seeds resemble some of the oil seeds morphologically with the dicotyledonous endosperm accounting to 80–85% of the seed matter, whereas the seed coat and the embryo account for 12–17% and 2–3% of the seeds, respectively. While the seed coat is of brick red to cream colored, the endosperm has yellow colour (Bhakare *et al.*, 1993; Gopalan *et al.*, 2000).

The seeds and leaves of the garden cress plant contain volatile oils. Garden cress seeds are bitter, thermogenic, depurative, rubefacient, antiscorbutic, antihistaminic and diuretic. They are useful in the treatment of asthma, coughs with expectoration, poultices for sprains, leprosy, skin diseases, dysentery, diarrhea, splenomegaly, dyspepsia, lumbago, leucorrhoea, scurvy and seminal weakness. Seeds have been shown to reduce the symptoms of asthma and improve lung function in asthmatic. The main chemical constituent of garden cress seeds are flavonoids, coumarins, glycosides, glucosinolate, glucotropaeolin, triterpenes, sterols and alkaloids (Archana and Anita, 2006).

The garden cress seeds are traditionally used in the diet of lactating women to induce milk secretion (Nadkarni, 1954) and in treating some of the inflammatory conditions like asthma, skin diseases and diabetes(Eddouks *et al.*, 2005; Archana and anita, 2006). Garden cress seeds are found to contain 18-24 % of fat (Gopalan, 2004) of which 34 % of total fatty acid is Alpha Linolenic Acid (ALA) (Mathews et al., 1993; Sumangala *et al.*, 2004). It contains good amount of lignans (29.4%) and antioxidants which can stabilize the n-3 Poly Unsaturated Fatty Acid (PUFA) in the seed oil. Garden cress seed oil has LA: ALA ratio in the range of 1:4- 2:3 which could give it nutritional advantages over the currently available ALA rich plant oils in altering the n-6/n-3 ratio in vivo. Despite of its medicinal value it is one of the best sources of ALA. Garden cress seed oil has not received much attention and in study the researcher has investigated the bioavailability and metabolism of ALA from garden cress seed oil in albino rats (Diwakar, 2008).

A tea spoon full of garden cress seeds boiled in 6 ounces of water for half an hour and the decoction with a table spoonful of honey is given as an effective medicine to increase breast milk and sexual disorders. Likewise, juice of the seed is also valued as medicine; 1 tea spoon obtained by grinding with 1 ounce of water given as a folk medicine to cure diarrhea, dysentery, bleeding piles, scanty urination due to liver disorders and irritation of the intestinal mucous membranes. Seeds roasted in ghee and mixed with sugar are

given as a tonic for general weakness in young girls and after child birth to increase breast milk (Pullaiah, 2006).

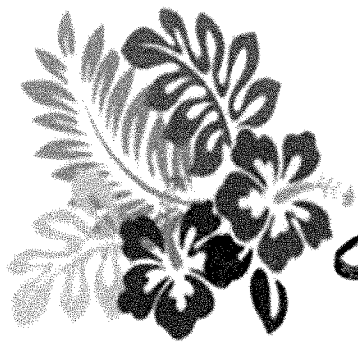
Garden cress seed is categorized as nuts and oil seeds by ICMR. 100gm of garden cress seeds contains protein 25.5g, fat 24.5g , carbohydrate 33.0g , calcium 377mg , phosphorous 723mg , iron 100mg , fiber 7.6g , carotene 27mg , thiamine 0.59mg , riboflavin 0.61mg and niacin 14.3mg (Gopalan 2000). Garden cress seed is the highest iron containing plant source ever known with better bioavailability (Yogesh 2010).

Garden cress seeds are special seeds used in special food preparations given to girls at menarche and after delivery in traditional Indian foods. It is rich in iron (100mg/100gm) and contains several nutraceutical compounds. The seed possess fair levels of protein, fat, dietary fiber and calcium and thus an important nutraceutical grain for nutrient enrichment (Sood and Sharada, 2002).

Garden cress (*Lepidum Sativum*) is one of such food stuff that abounds not only in nutrient but also in health enhancing phytochemicals. This has been the reason why tradition, folklore and indigenous medicine all advocated garden cress for finding succor from one or the other ailment (Agarwal, 2013). Number of products can be prepared with garden cress seeds but only porridge is used by lactating women. Therefore the present investigation is planned to develop food products with following objectives:

1. To study the food consumption pattern of lactating women
2. To develop food products with incorporation of garden cress seeds
3. To evaluate the organoleptic qualities of developed food products
4. To analyze nutrient content of highly accepted developed food products
5. To study the shelf life of developed food products.

Review of Literature



CHAPTER 2

REVIEW OF LITERATURE

Lactation places high demands on maternal stores of energy, protein, and other nutrients. These stores need to be established, conserved, and replenished. Virtually all mothers, unless extremely malnourished can produce adequate amounts of breast milk. The energy, protein, and other nutrients in breast milk come from a mother's diet or her own body stores. Women who do not get enough energy and nutrients in their diets risk maternal depletion. To prevent this, extra food must be made available to the mother. Breastfeeding also increases the mother's need for water, so it is important that she should drink enough water to satisfy her thirst. Maternal deficiencies of some micronutrients can affect the quality of breast milk. These deficiencies can be avoided if the mother improves her diet before, during and between cycles of pregnancy and lactation, or takes supplements.

Garden cress seed known as *Halim* in Hindi is an important source of iron, folic acid, calcium, vitamin C, E and A. It is a rich source of iron containing 100mg /100gm. It is useful in leprosy, skin disease, dysentery, dyspepsia, eye diseases, leucorrhoea, scurvy, asthma, cough, cold and seminal weakness (Gupta, 2011).

The available literature related to the present investigation is described here under the following heads.

1. Studies on nutritional status of lactating women.
2. Studies on composition of garden cress seed.
3. Studies on therapeutic value of garden cress seed.
4. Studies on processing and development of value added food products using garden cress seed.

2.1 Studies on nutritional status of lactating women

Studies carried out at the National Institute of Nutrition have shown that among low income group population there was no increase in

dietary intake during lactation. Lactating women continue to undertake habitual work. Studies on anthropometric indices in lactating women indicate that the mean body weight, mid-arm circumference and skin-fold thickness at triceps showed a progressive fall with increasing duration of lactation until 18 months in women whose infants were mainly on breast milk. The mean body weight of women whose infants were mainly on solid food but who received two or three breastfeeds a day was higher than that of women whose infants were mainly breastfed. If there was no intervening pregnancy these women regained their body weight once lactation waned (NNMB 1979-2002)

Robert *et al.,* (1988) conducted a study on nutritional and health status of 26 lactating women and their 2-6 months old infants in six villages of Kathmandu Valley of Nepal. Analysis of 24 h duplicate diet composites indicated that the mothers were consuming 2100 kcal energy/d. 62g protein (11.6 % of calories), 392g carbohydrates (73.3 % of calories), and 20.9g fat (8.6% of calories) and mean of 24 g fiber. Although anthropometric measurements indicated that the mothers had mild protein malnutrition and inadequate energy reserves, their infants exhibited low-normal weight and length for age. All the mothers had hepatitis A antibodies; 92 % has tropical eosinophilia, indicating intestinal parasites; 16% had cheilosis and angular stomatitis, indicating a possible B-vitamin deficiency; and 8% had elevated urinary nitrite, indicating urinary tract infection. Although the children appeared healthy but the mothers showed evidence of multiple infections and possible nutrient deficiencies.

Mary (2003) revealed that the nutrient demands of lactation are considerably greater than those of pregnancy. In the first 4–6 months of the postpartum period, infants double their birth weight accumulated during the 9 months of pregnancy. The milk secreted in 4 months represents an amount of energy roughly equivalent to the total energy cost of pregnancy. However, some of the energy and many of the nutrients stored during pregnancy are available to support milk production. The recommended intakes are based on the amount of milk produced during lactation, its energy and nutrient contents

and the amounts of maternal energy and nutrient reserves. Lactation is viewed as successful when the fully breast-fed infant is growing well and maintaining appropriate biochemical indexes of nutritional status. The quantity of milk consumed by the infant and the nutrient content of human milk under these circumstances are often used as proxies to assess maternal nutritional adequacy during lactation.

Duda *et al.*, (2009) conducted a study to assess the intake of vitamins A and E by Polish breast feeding mothers and the correlation between the intake of these vitamins and their concentration in the maternal milk. Dietary intake was assessed by triple 24 h diet recall questionnaire. Milk samples were collected and the content of vitamin A and E was determined. The mean intake of vitamin E (7.7±3.4 mg/day) covered 54.7% of the recommended value. The mean vitamin A content in daily food rations (DFR) - 1012±735 μg allowed cover 63.2% of the requirement. The mean concentration of vitamin A in milk was 57.07±29.3 μg/100 ml. There was a correlation of the content of vitamin A in milk and the intake of this vitamin (r = 0.371) and the intake of essential fatty acids (r = 0.455) also. The mean concentration of the vitamin E in the milk (413.1±194.4mg/100 ml), statistically significant correlated with its intake in DFR (r = 0.483). DFR of breastfeeding mothers, were characterized by insufficient supply of vitamins A and E. The dietary intake of these vitamins correlated with their concentration in maternal milk.

Sanusi and Falana (2009) participated in this descriptive and cross-sectional study to evaluate the effect of exclusive breastfeeding (EBF) practice on the nutritional status of lactating mothers. A total of 277 lactating mothers recruited from the well baby or immunization clinics at four selected health facilities. The data collected from semi-structured questionnaires, 24-hour dietary recall and weight and height measurements. The nutritional status of lactating mothers practicing exclusive breastfeeding (EBF) and those practicing non-exclusive breastfeeding (NEBF) was compared. The results showed that half (50.5%) of the respondents were practicing exclusive breastfeeding. The two groups had similar protein intake level, which was

significantly higher than recommended intakes. There was no difference in the nutritional status ($p>0.05$) of mothers practicing exclusive and non-exclusive breastfeeding as measured by anthropometry. It was concluded that the practice of EBF had no observable consequences on the nutritional status of mothers practicing it when compared to mothers practicing non-exclusive breast feeding, except for the higher dietary energy intake.

Ayaskar and Kulkarni (2009) in their study reported the nutritional and health status of pregnant and lactating women. It was concluded that to maintain nutritional status, consumption of all food stuffs in required quantity is necessary. Urban areas women were found to maintain their health status but in rural areas women's diet were deficient in leafy vegetables, milk, fruits and other vegetables, so they could not maintain their nutritional status.

Santos *et al.*, (2011) discovered that the Multi micronutrients supplementation was effective for the complete recuperation of anaemia and maintenance of adequate concentrations of zinc in 100% of lactating adolescents studied. In relation to plasma copper, supplementation was sufficient to prevent from deficiency in 100% of the group at the end of the trail. Nevertheless, mean concentrations were not different.

Saravanan *et al.*, (2011) carried out a study to identify the proportion of livelihood among the married women, caste wise in Salem district. From the result it is seen that half of the respondents get married before they become 21 years old, especially, the respondents of Scheduled Castes and Most Backward Caste. In urban areas, women's own education being high school and above and or possessing a sales/clerical or professional job has tremendous impact on risk reduction. The illiterates and primary level educated women became pregnant before 20 years of their age in contrast to women with higher education, who conceived only after 20 years of age.

The overall statistical figure shows that as literacy level increases there is a good linear positive relationship between lactating women and child's health.

Haijiao *et al.*, (2012) reported that lactating women on a self-selected diet did not meet the chinese RNI (Recommended Nutrient Intake) for many important micronutrients, which may influence the nutritional composition of breast milk and thus impact the potential health of mothers and infants. RNI should consider the regional dietary habits and culture.

Yasmeen and Asmat (2012) carried out the study on factors influencing the nutritional status of lactating women in Jammu, Kashmir and Ladakh regions. The study revealed inadequate dietary intake, especially micronutrient deficiency (hidden hunger) during lactation, tribal women were particularly vulnerable to under nutrition compared to women in rural and urban areas. (16.9%) women had chronic energy deficiency, (56.4%) of women from all the three regions were observed to have clinical signs of nutritional deficiency, (30%) of women had taken deficient calories Clinical signs of deficiency of nutrition were uniformly distributed among three regions ($p > 0.01$), whereas indicators like BMI and caloric intake showed significant difference ($P < 0.01$) between the three regions. 49% studied women were found to be anaemic.

Harnagle and Chawla (2013) discovered that 90.56% lactating mothers were not practicing fasting during the pregnancy and lactation periods, 92.45% were found to consume breakfast, lunch & dinner while 97% were taking meals with their husbands and children. 97.16% of lactating mothers cooked their meals separately while only 7% of lactating mothers admit to having consumed the leftover food of the previous days. 67.61% of Lactating mothers cooked their meals separately while, only 7% of Lactating mothers admit to having consumed the leftover food of the previous days. 67.61% took a varied menu in breakfast.

Miriam *et al.*, (2013) found that the nursing mothers were overweight, energy consumption was below the recommended and percentage of macronutrients was adequate and protein was elevated. The diet was classified as "needs improvement" according to the Health Eating Index (HEI).

The result showed that the overweight associated with a diet of poor quality indicated possible deficiencies of macronutrients.

Kiday *et al.*, (2013) concluded that the feeding practices, dietary intakes and nutritional status of the lactating women were short of the national and international recommendations. Therefore, sustained health and nutritional education is recommended to the women and their families and communities on increased food intake, proper dietary practices and dietary diversification during lactation in order to improve health and nutritional outcomes of lactating women.

Veerbhan *et al.*, (2013) conducted a cross-sectional prevalence based study on 400 mothers and their infants residing in the rural area of Jaipur within six months (Jan13 to June-13). According to socioeconomic classification, maximum mothers belongs to class III 155(38.75%), followed by 81(20.25%) mothers from socio-economic class V, 73(18.25%) mothers were from socio-economic class IV, 49(12.25%) were from socio-economic class II and 42(10.5%) mothers were from socio-economic class VI. Literacy wise,148(37%) mothers were illiterate, 95(23.75%) mothers were educated up to primary level followed by 74(18.5%) educated up to middle, 45(11.25%) educated up to secondary level, 16 (4%) mothers educated up to higher secondary and rest 22(5.5%) mothers were graduate and above. At the end it is concluded that socioeconomic status is an important factor affecting the care of infants in terms breast feeding, weaning and personal hygiene.

Ogechi (2014) explored the nutritional status and dietary intake of lactating women. The majority of lactating women were either overweight or obese. Intake of some essential macro and micro nutrients was lower than recommendations. Dietary intake consisted mainly of plant based foods (cereals, roots and tubers) with low availability which may not be adequate to support increased nutrient requirement during the lactation period.

Tasnim *et al.*, (2014) documented the nutritional status and breast feeding practice among mothers attending lactation management Centre. A total 106 mothers were interviewed. Among them 8.3% were adolescents. Most

of the infants were below 6 month old, and 58.7% were <30 days old. Exclusive breast feeding was reported by 52%. Regarding the type of feeding in the last 24 hours, 60% received only breast milk 32.4% and had breast feeding and artificial milk, and only 2.9% received complementary feeding breast feeding. The main reason for attending LMC was not enough milk (25%), breast problem (26%) and 21.2% stated lack of knowledge. About 70.9% had average body build, and only 4.9% have a body mass index < 18.5. There was no relation between body mass index of the mother and the exclusive breast feeding. Exclusively, breastfeeding was more among mothers who took antenatal care in last pregnancy.

The nutritional status and lifestyle of women in preconception, pregnancy and lactation determines maternal, fetal and child health. The aim of this cross-sectional study was to evaluate dietary patterns and lifestyles according to the perinatal physiological status in a large sample of Spanish women. The analysis revealed that diet quality should be improved in the three stages, but in a different manner. While women seeking a pregnancy only met daily recommendations, those who were pregnant only fulfilled fresh fruit servings and lactating women only covered protein group requirements. Food patterns and unhealthy behaviours of Spanish women in preconception, pregnancy and lactation should be improved, particularly in preconception (Marta *et al.*, 2014).

2.2 Studies on composition of garden cress seed.

The taxonomic classification of garden cress seed (George 1959).

Kingdom: Planate

Division: Magnoliophyta

Class: Magnoliopsida

Order: Brassicales

Family: Brassicaceae

Genus: *Lepidium sativum*

Mathews *et al.,* (1993) observed some physicochemical characteristics of *Lepidium sativum* (haliv) seeds. He noted that protein and fat

were concentrated in endosperm whereas dietary fibre, minerals and carbohydrate in the bran fraction. The high protein, fat, dietary fibre, calcium, phosphorous and iron contents in this seed bring out its high nutritive value which may be making it useful in post pregnancy diets in India.

Sumangala *et al.,* (2004) studied the chemical composition of garden cress seeds and its fraction and use of bran as a functional ingredient. Results revealed that the seeds were brownish in red in colour and oval in shape. The seed length and width were 289± 3.2μm and 100 ±1.9 μm respectively. One thousand kernel weights were 2.5± 0.13 g, volume 3.3 ± 0.15 ml and density 0.75 ± 0.016. The yield of endosperm rich fraction was 72% and that of bran rich fraction was 28%. Incipient moist conditioning reduced the pulverisability of the seed coat followed by milling and sieving which enabled to separate largely the endosperm and the bran portions.

Vose and Young (1978) prepared low fibre malt flour from barley by incipient moist Conditioning (5%) the malt followed by pulverizing and sieving. Further, Malleshi et al. adapted the same principle to other malted cereals to prepare low fiber flours. The same principle was used in the present study also to obtain relatively high yield of endosperm and bran fractions however, the purity was not hundred percent. The present study concludes that *L. sativum* seeds with high nutritional value can be exploited as a functional food ingredient. Among the fractions, bran isolated and processed could be used in developing a promising dietary fiber supplement. Endosperm can be used as source of protein rich in essential amino acids after extracting the fat.

Bigoniya *et al.*, (2011) discovered the Morphology of garden cress seeds. Garden cress seeds are small, oval-shaped, pointed and triangular at one end, smooth, about 3-4 mm long, 1-2 mm wide, reddish brown in color. A furrow present on both surfaces extending up to two thirds downward, a slight wing like extension present on both the edges of seed. On soaking in water seed coat swells and gets covered with transparent, colorless, mucilage with mucilaginous taste.

Sheel and Nidhi (2011) in their study reported that the main volatile constituents of garden cress seed are phenyacetonitrile (52.9%), benzyl isothiocyanate (26.2%) and 1, 8-cincole (12.3%), while those of roots and non-flowering aerial part were benzyl isothiocyanate (65.0% and 24.5%), α-pinene (11.8 and 13.9%) and hexade canoic acid (9.1% and 18.0%) respectively. Total lipid content of *L. sativum* is 13.8 on dry weight basis. Neutral lipid content was found to be predominant (86.7%), while the glycolipids, (7.7%) and phospholipids (5.8%) were present in low quantities.

Gafaar *et al.*, (2013) discovered that garden cress meal (*Lepidium sativum*) is a by-product remaining after the extraction of the oil from seeds. Protein represents the most abundant nutrient in this product, which contains 34.15% protein, 1.86% crude oil, 9.85% crude fiber, 5.89% ash and 48.25% nitrogen free extract (NFE), on a dry weight basis. The results of the biological experiment indicated that the isolate had a high PER (Protein Efficiency Ratio) value, being 1.35, as compared to a value of 1.46 in the case of rats fed on a diet containing 15% casein.

Ihsan *et al.*, (2013) studied the dry matter content, crude protein, ascorbic acid, minerals (N, P, K, Ca, Mg, Na, Fe, B, Cu, Na, Zn, Mn), the total phenolic content and the total antioxidant capacity of two garden cress cultivars, Izmir and Dadas. The results of mineral element analysis of both cultivars revealed that they had a high P, K, Ca, Mg and Na content. Both cultivars studied appeared to have exceptionally high levels of protein when compared with common vegetables. The mean ascorbic acid content of Dadas and Izmir cultivars was 54 and 74 mg 100 g. respectively.

The total phenolic content of the garden cress leaves varied from 0.573 (Dadas) to 0.774 (Izmir) mg GAE · g and from 6.332 (Dadas) to 7.401 (Izmir) mg GAE · g. Antioxidant activities by 2-diphenyl-1-picryhydrazyl (DPPH) free-radical-scavenging assays for EC_{50} were determined as 330.99 (Dadas) and 346.65 (Izmir) for fw, and 128.08 and 85.97 (Izmir) for dw, respectively. Based on the results of the experiment reported herein, they may serve as a potential dietary source of some mineral and natural phenolic

antioxidants. Results imply that garden cress as potential source for alternative dietary supplements of minerals and natural phenolic antioxidants.

Falana *et al.,* (2014) found that Garden cress contain significant amounts of iron, calcium and folic acid in addition to vitamin A and C. It contains higher amount of protein 25%: glutamic acid 19.3%, Leucine (8.21+-0.01%), Methionine (0.97+-0.02%). The major fatty acid is linolenic acid 30.2% with low amount of erucic acid 3.9% is also present. The major secondary compounds of this plant are glucosinolates. It yields on steam distillation 0.115% of a colorless volatile oil (cress oil) with a characteristic pungent odor. Cress oil contains variable properties of Benzylisoticocyante and Benzyl cyanide, with a peculiar disagreeable odor that is used in soap making. Also it is found to contain glucotropoeoline,4 methoxyglucobrassicin, sinapine, sinapic acid, calmodulin, sinapoyglucose, ester of caffeic, pcoumaric, ferulic, quinic acids, protein, minerals, vitamins, 5-4-dihydroxy- 7,8,3,5 tetramethoxyflavones, 5-3dihydroxy 7,8,4 trimethoxyflavones, and 5-3dihydroxy-6,7,4 trimethoxyflavones.

Abhishek *et al.*, (2014) evaluated the seed germination biology of *Lepidium sativum* Linn. *Lepidium sativum* commonly known as Chansur (H) and Garden cress (E) possess various medicinal values was selected for present investigation to report the seed and seed germination biology. Various factors were selected to investigate the germination profile. It was observed that freshly collected seeds showed poor germination behaviour. Likewise, the same condition was noted in older seeds. However, a great variation in germination behaviour and seedlings growth was observed in subsequent months and best germanium percentage was recorded in 7-10 months old seeds. The seeds of this species remained viable for a period of 19 months.

2.3 Studies on therapeutic value of garden cress seed.

Malak *et al.*, (2006) conducted the study on the garden cress seeds could be a factual galactogogue. The result of the study revealed that all parameters significantly exhibited a strong mammotrophic and lactogenic effects of garden cress seeds on non- primed mammary glands of adult virgin

rat. Garden cress seed most probably a real galactogogue and might be useful in induction of lactation.

Paranjape and Mehta (2006) studied the efficacy and of *Lepidum Sativum* in treatment of bronchial asthma. *L. sativum* seed powder was given at a dose of 1 gm. thrice a day orally to 30 patients of either sex in the range of 15-18 years with mild to moderate bronchial asthma. Efficacy of the drug in improving clinical symptoms and severity of asthmatic attack was evaluated by interviewing the patient and by physical and hematological examination at the end of the treatment the drug showed statistically significant improvement in various parameters of pulmonary functions in asthmatic subjects. Also significant improvement was observed in clinical symptoms and severity of asthmatic attacks. None of the patient showed any adverse effect with *Lepidum Sativum.*

Abdullah (2007) studied the effect of *Lepidum Sativum* seeds on fracture-induced healing in rabbits. The study, which lasted 12 weeks from the time of surgery, divided rabbits into control (no. = 3/C1, C2, C3) and test groups (no. = 3/T1, T2, T3). Soon after their recovery from general anesthesia, the control group was fed with a normal diet, but the test animals had a normal diet plus 6 g of *L sativum* seeds for the whole period of the study. The result of daily follow-up showed uneventful recovery, good healing of wounds, and weight gain in all rabbits. Documentation of fracture healing in the left femur of all groups was carried out and clinically based on the presence or absence of crepitus plus abnormal movements at the fracture sites, and radiologically from the site of callus formation. X-rays of the left femur at the fracture sites in all 6 rabbits were taken in a nearby hospital on 2 occasions – the first at 6 weeks and the second at 12 weeks postoperatively. Both groups showed good healing of fractures and intact intramedullary K-wires. The healing of fractures continued at 12 weeks and was almost complete in all groups. It was concluded that *L sativum* seeds showed a significant effect on fracture-induced healing in rabbits in vivo, which supports the observation noted in the community and in traditional folk medicine.

Diwakar *et al.*, (2008) investigated that Garden cress seed oil (GCO) is one of the richest sources of o-3 fatty acid and contains 29–34.5% of ALA. In this study, dietary supplementation of GCO on bio-availability and metabolism of a-linolenic acid was investigated in growing rats. Male wistar rats were fed with semi-purified diets supplemented with 10.0% sunflower oil (SFO 10%); 2.5% GCO and 7.5% SFO (GCO 2.5%); 5% GCO and 5% SFO (GCO 5.0%); 10% GCO (GCO 10%) for a period of 8 weeks. There was no significant difference with regard to the food intake, body weight gain and organ weights of rats in different dietary groups. Rats fed with GCO showed significant increase in ALA levels in serum and tissues compared to SFO fed rats. Feeding rats with 10% GCO lowered hepatic cholesterol by 12.3% and serum triglycerides by 40.4% compared to SFO fed group. Very low density lipoprotein cholesterol (VLDL-C) and low density lipoprotein cholesterol (LDL-C) levels decreased by 9.45% in serum of 10% GCO fed rats, while HDL remained unchanged among GCO fed rats. Adipose tissue showed incorporation of 3.3–17.4% of ALA and correlated with incremental intake of ALA. Except in adipose tissue, the EPA, DHA levels increased significantly in serum, liver, heart and brain tissues in GCO fed rats. A maximum level of DHA was registered in brain (11.6%) and to lesser extent in serum and liver tissues. A significant decrease in LA and its metabolite arachidonic acid (AA) was observed in serum and liver tissue of rats fed on GCO. Significant improvement in n-6/n-3 fatty acid ratio was observed in GCO based diets compared to diet containing SFO. It is concluded that supplementation of GCO increases serum and liver ALA, EPA, DHA and decreases LA and AA in rats. Therefore, the GCO can be considered as a potential, alternate dietary source of ALA.

Manohar *et al.*, (2009) reported antidiarrhoeal activity of the methanolic extract of *Lepidium sativum* in three experimentally induced diarrohoea models i.e. Castor oil induced diarrhoea, Prostaglandin E2 (PG-E2) induced enteropooling in rats and Charcoal meal test in mice. In Castor oil induced model *Lepidum sativum* extract (50,000 and 200 mg/kg p.o.) showed

significant dose dependent reduction of cumulative wet fecal mass. In PG-E2 induced enteropooling model, the same extract of (50, 100, 2000 mg/kg p.o) inhibited PG-E2 induced secretions. Similarly in Charcoal meal test *Lepidium sativum* extract (50,100 and 200 mg/kg p.o) decreased the movement of charcoal indicating its anti-motility activity It was observed that methanol extract of garden cress seeds possess significant antidiarrhoeal activity.

Yogesh (2010) presented the phytochemical study of the ethanolic extract of *Lepidium sativum* L. seeds. The study has revealed presence of glycoside, alkaloids, tannin (Phenolic compound), Flavonoids, and amino acids like glutamine, Cysteine, and Glycine. That may help to reduce gastrointestinal toxicity cause to recover of body weight and urinary volume. Finally it is concluded that the present study data conformed nephrotoxicity induced by cisplatin due oxidative stress and ethanolic extract of *Lepidium sativum* L. seeds may have nephroprotective, curative and in vivo antioxidant potential.

Najeeb *et al.*, (2011) studied the prokinetic and laxative activities of *Lepidium sativum* seed extract with species and tissue selective gut stimulatory action. Results revealed that the aqueous-methanolic extract of *Lepidium sativum* seeds (Ls.Cr) at 30 and 100 mg/kg showed atropine-sensitive prokinetic and laxative activities in mice, which were partially sensitive to atropine. In isolated gut preparations of mouse and guinea-pig, Ls.Cr (0.1–1 mg/mL) caused concentration dependent stimulatory effects both in jejunum and ileum, which was blocked in the presence of atropine. In rabbit jejunum, the stimulant effect of Ls.Cr remained unchanged in the presence of atropine, pyrilamine or SB203186, while in rabbit ileum; the stimulatory effect was partially blocked by atropine. The Ls.Cr was more efficacious in gut preparations of rabbit than in guinea-pig or mouse. The phytochemical analysis of the plant extract detected alkaloids, saponins and anthraquinones as plant constituents. Study concludes that the prokinetic and laxative effects of *Lepidium sativum* in mice, which were partially mediated through a cholinergic pathway. The in vitro spasmodic effect of the plant extract mediated through a

similar mechanism with species and tissue-selectivity, provides a rationale for the medicinal use of the seeds of *Lepidium sativum* in indigestion and constipation.

Sarkar and Ghosh (2011) conducted a study to find out the galactogogue effect of garden cress seed on thirty healthy lactating rats were equally divided into six groups, three kept as control for their respective treated groups given stock diet only and other three maintained on 20% seed powder mixed with stock diet for 7 days (Group I), 14 days (Group II), and 21 days (Group III) during their lactating period. The galactogogue effect of garden cress seed are evident from the enhanced of mammary glands i.e. increase weight of mammary gland, proliferation of alveoli and increased accumulation of secretary material in treated lactating rats compared to their corresponding control.

Shama *et al.,* (2011) discovered the antimicrobial activity of the petroleum ether, methanol and water extracts of *Lepidium sativum* seed extracts against six opportunistic pathogens namely *Staphylococcus aureus, Escherichia coli, Klebsiella pneumonae, Proteus vulgaris, Pseudomonas aeruginosa* and one fungus *Candida albicans* was assessed using the concentrations of 2.5, 5 and 10%. The antimicrobial activity of plant seeds extracts were compared with that of Gentamicin or Ketoconzol, as reference antibiotics. The petroleum ether extract of *Lepidium sativum* seeds in different concentrations (2.5-5-10%) were found to be active antimicrobials against all the test microorganisms with a strong antifungal activity at the concentration 2.5 and 10%. At the concentration of 5%, the methanolic extract of this plant had no activity against *Candida albicans. Staphylococcus aureus* and *Candida albicans* were resistant to 2.5 and 5% water extracts, whereas the latter was also resistant to 5% methanolic extract.

Amawi and Aljamal (2012) documented a study to investigate the effects of *Lepidium sativum* on the blood glucose and lipid profile in hypercholesterolemic rats. Forty adult albino male rats were classified into three groups. One was fed on standard diet and kept as control group. The rest

of rats were fed on standard diet with 4 % cholesterol for 2 weeks to be hypercholesterolemic, and then classified into 2 groups. Group I, hypercholesterolemic rats. Group II, alloxan treated animals. Both groups treated for 4 weeks with orally administered with *Lepidium sativum* extract (20 mg/kg). In comparison to control group, experimental group showed a significant lower value of plasma glucose 30%, cholesterol 22%, triglycerides 25%, LDL 23% and increase in HDL 32%. In conclusions, the findings of this study indicate that the administration of *Lepidium sativum* showed better lipid profile as well as decreases in the sugar level in hypercholesterolemic rats.

Shukla *et al.*, (2012) this study aimed at investigation of antidiabetic efficacy of *L. Sativum* Seed Total Alkaloid (LSTA). The major components of this alkaloid fraction are lepidine and semilepidine, a rare group of imidazole alkaloid. Antidiabetic profile of LSTA (50, 150 and 250mg kg) was assessed on alloxan induced diabetic rats upon 21 days continuous treatment. Biochemical parameters viz., glucose, total cholesterol, triglyceride, low density lipoprotein, high density lipoprotein, urea and creatinine were determined along with body weight and relative organ weight. LSTA at 250 mg kg showed 1.94% b. wt. gain on 21th day relative to 6.14 and 8.94% of control and diabetic group. LSTA at 250 mg kg dose significantly ($p<0.001$) suppressed blood glucose, cholesterol, triglyceride and urea level in diabetic rats. The results revealed that the LSTA at dose 250 mg kg showed potent hypoglycaemic activity. The L. *sativum* alkaloid have potential antidiabetic effect against alloxan-induced diabetes may be through reducing oxidative damage and modulating antioxidant enzymes. The possible mechanism by which LSTA brings about its anti-hyperglycaemic action may be by pontentiation of pancreatic secretion of insulin from the remaining islet ß cells.

Pramod *et al.*, (2012) showed that the seeds of Garden cress could be used as food supplement in human diet as it contains considerable amount of iron and calcium. Presence of high carbohydrates, macro and micro elements and antioxidant properties would increase its utilization. The very low anti nutritional factors in the tubers may not hamper its nutritional value.

Garden cress seeds evaluated in present study may be used to help the human body to reduce oxidative damage when the natural mechanism of antioxidant protection becomes unbalanced by factors such as ageing, deterioration of physiological functions may occur resulting in diseases like cancer, cirrhosis, various inflammatory diseases etc. and accelerating ageing. Due to high free radical scavenging potential leads to consumption of mixed or balanced diet may show rich nutritional as well as medicinal value of the Garden cress.

When cells become old or damaged, they die by apoptosis, necrosis or a combination of the two and are replaced with new cells. On the other hand, cancer cells are immortal as they are resistant to apoptosis. Chemotherapy kills cancer cells through apoptosis and/or necrosis. The induction of apoptosis and necrosis in MCF-7 and HFS cells by the aqueous extract of *L. sativum* seeds was monitored by analysis of morphological changes in the cells using light microscopy, DNA fragmentation assay, and florescent stains (Annexin V and PI) using flow cytometry and fluorescent microscopy. Results demonstrated the occurrence of both types of cell death in MCF-7 and HFS cells following addition of the extract to the culture medium. Apoptosis was induced when cells were treated with 25% and 50% extract, but necrosis was observed mainly after the cells were exposed to elevated concentrations (75%) of extract (Mahassni and Al-Reemi 2013).

Sivramkrishna and Sravani (2014) demonstrated the potential of *Lepidium sativum L* to significantly reduced gastric ulceration as indicated by the reduction in ulcer index in the Pylorus induced and Cold stress induced assays. Based on further findings using the pylorus ligation model, the extract was suggested to act by reducing the volume of gastric juice secreted, gastric free and total acidities. These results suggested that *Lepidium sativum L* possesses anti-secretory potency as well as acid neutralizing effect. It is also possible to suggest that the observed antiulcer activity associated with *Lepidium sativum L.* In the present study the control animals showed ulceration, redness, and hemorrhagic streaks, after pylorus ligation. There was also an increase in gastric volume, free acidity, total acidity and pH. Ethanolic

extract at the 200 mg dose and Ranitidine produced significant ($P<0.01$) reduction in ulcer score when compared to the control. The percentage protection against ulcers by Ranitidine, *Lepidium sativum L* ethanolic extract at 200mg dose and Ranitidine significantly ($P<0.01$) reduced the gastric volume when compared to control.

Dutta *et al.*, (2014) studied the herbal plants used as diuretics. It was concluded that in the core of nature there are so many plants which possess potent diuretic activity, garden cress seed is one of them. Herbal medications are free from side effects and toxicity unlike the allopathic medicines.

Doke and Guha (2014) reviewed toxicology studies of Gc (Garden cress) seeds and revealed that Gc seeds can be considered as non-toxic and safe. Gc seeds shows many medicinal properties such as antidiabetic, hypocholesterolemic, antihypertensive, antidiarrheal, antispasmodic and laxative activities. It also has fracture healing hepatoprotective, diuretic, nephrocurative, nephroprtective, galactogogue, antinflammatory, antipyretic and analgesic potential. Health drink and food products incorporated with Gc seed or its fractions were sensorily acceptable.

Althnaian (2014) conducted a study to evaluate the effects of *Lepidium sativum* (LS) on liver histopathology and serum biochemistry in rats fed with high cholesterol diet. Total cholesterol, triacylglycerol and alanine transaminase (ALT) activity were increased significantly in the rats fed with high cholesterol diet as compared to control group. LS reduced total cholesterol and ALT; however, higher dose (6 g/kg diet) was found better than lower dose (3 g/kg diet) in reducing serum triacylglycerol. Histopathological findings revealed that liver of cholesterol-treated rats showed varying degrees of vacuolar degeneration, fatty changes, fatty cysts, and lobular disarray. Livers of the LS-treated rats revealed mild to moderate degree of recovery. Conclusively, high dose of LS is recommended as hypocholesterolemic and hypolipidemic agent in rats.

2.4 Studies on processing, development of value added food products using garden cress seed.

Gunstone (2004) revealed that, consumption of *Lepidium sativum* L. (LS) seeds increase weight gain as LS seeds are found to contain 18–24% of fat which 34% of total fatty acids is alpha linolenic acid. It contains good amount of lignans and antioxidants, which can stabilize the n-3 polyunsaturated fatty acids in its seed oil. LS oil has alpha linoleic acid which could give it nutritional advantages.

Varsha *et al.*, (2008) developed iron rich biscuits utilizing garden cress seed and rice flakes. It supplied 13.10mg. of iron. The per cent bio availability of iron of the biscuits was 12.00mg./100gm. The girls of experimental control group who received one tablet of iron and folic acid showed increment in haemoglobin by 9.17 per cent. The girls who received 60 gm. iron rich biscuits daily exhibited an increment of haemoglobin content by 6.31 per cent which was statistically significant. In case of girls who received both tablets as well as biscuits the increment of haemoglobin content was highest (17.7 per cent) which increased from 8.65 to 10.07 mg/ dl during intervention. The improvement in haemoglobin content of normal control group was non-significant and it was 4.01 per cent. The result indicated that the biofortified biscuits are very useful as iron supplement in the absence of iron and folic acid tablets for improving the health and nutritional status of adolescent girls.

Sheel and Nidhi (2011) found that garden cress (*Lepidium sativum* Linn.) seed have a rich amount of protein to the extent of 25% and fat (16%). Its bran has a high water holding capacity due to high dietary fibre content (74.3%). In human quest for relieving the masses from the scourge of low nutritional status through non- conventional scarcely explored foodstuff, some food products have been developed incorporating garden cress seed which not only support their nutritional status but also have a refreshing and rejuvenating effect.

Chhavi and Surbhi (2011) conducted a study to assess the effect of garden cress seeds and Amla intervention on haemoglobin level of non-pregnant women (18 – 25 years). Total 45 respondents were taken from G.D.M Girls hostel, Modinagar and divided into three group I, group II and group III. General profile, medical history, dietary habits, general awareness, physical activity, anthropometric measurement, biochemical analysis, clinical assessment, and dietary assessment with three day food recall and nutrient intake was done of all the respondents before intervention. 10g garden cress seeds were provided per day to experimental group I for 3 months which provided 10 mg iron per day, while 10 g garden cress seeds with 10g amla chutney were provided to experimental group II for 3 months. Anthropometry measurement, clinical analysis and biochemical assessment were done after intervention. The study concluded that inclusion of garden cress seeds alone and with vitamin C, which has high content of iron, on a daily basis effectively, increased haemoglobin level in those respondents who have low initial haemoglobin level. Little effect was also seen on anthropometric measurement and clinical assessment.

A study conducted on development of health drink enriched with processed garden cress (*Lepidum Sativum*) seeds by Mohite *et al.*, (2012) the edible whole seed is known to have health promoting properties hence, it was assumed that these seeds can serve as raw material for functional foods, sharing its peppery, tangy flavor and aroma. Since, it is rich in proteins, carbohydrates and certain essential minerals like calcium, iron and phosphorous along with crude dietary fiber (7.6%) it can be used as health drink with milk as its base. An attempt has been made by adding 5% sugar (w/v) in skimmed milk with 1% fat and different quantity of washed, boiled and powdered seeds of garden cress seed along with sodium salt of Carboxymethyl Cellulose (CMC) as suspending agent. The drink that was found most suitable, with an overall consumer acceptability of 8.75 was that containing 3% of the seed powder.

Saravanan *et al.*, (2012) developed the health mix using garden cress seed. Consumption of garden cress seeds decreases the risk of anaemia,

lowers the Glycemic response, risk of osteoporosis, and muscular pain in the body. Garden cress seeds are used to make different products namely Carotene Nutri Drink Mix and Beetroot Slush Beverage Mix was formulated and was subjected to sensory analysis, shelf life study and microbial analysis. Garden cress seed powder, milk powder, sugar powder, carrot powder, beetroot powder are used to prepare the products. The products were made into different variations. According to the sensory evaluation the products were finalized. Estimation of nutrient composition of three best recipes selected confirmed its high nutrient composition. The Carotene nutri drink mix contains 32.67mg of iron, 291.5mg of calcium. The beetroot slush beverage mix contains 32.57mg of iron, 176.2mg of calcium. The microbial analysis was done for a 15^{th} day.

Nidhi and sheel (2013) analyzed garden cress seed quantitatively as whole (WGCSP), husk removed (HRGCSP), husk (HGCSP), roasted (RGCSP) and microwave processed (MPGCSP) forms, for proximate principles, selected minerals and phenol content. Thereafter, a representative food product was developed in various versions incorporating each type of powders and evaluated for acceptability characteristic. The results revealed that all forms of garden cress seeds were good sources of macro (protein and fat) as well as micro (iron, calcium and phosphorous) nutrients. Processing is improved acceptability by denting anti-nutrients and off flavor components. All versions of *Mathri* the product developed were found moderately to highly acceptable. The product versions developed from all types of powder made the product rich in nutrients including energy, protein, iron, calcium and phosphorous along with antioxidants making it value added to treat various diseases, including protein energy malnutrition, anemia, diabetes mellitus, hypertension and cardiovascular disease.

Nidhi and Sheel (2013) reported that garden cress seeds are rich source of proteins, fat, iron, calcium and phosphorous. Processing through dehusking changed anti-nutritional level without much erosion in nourishability. In this way garden cress seeds, after being processed through as simple as dehusking could become helpful in preventing and curing various

diseases like PEM, anaemia, osteoporosis, osteomalacia and bone fracture through long term consumption as a food stuff of nutraceuticals nature. Incorporation of garden cress seed into food products like 'dahiwala bread' developed here, could benefit all age group individuals for nourishment and those at risk or suffering from anaemia, fracture and diabetes mellitus, and the other chronic degenerative disease to pursue prevention and management of diseases.

Rekha (2013) made attempts to assess the effect of garden cress seed supplementation on the iron deficiency anaemia in pre-pubertal girls. 240 pre-pubertal girls were selected with the help of equal interval method of randomization ratio. To study the effect of dietary supplementation four different types of treatment were considered. Difference in of improvement in anthropometric measurements and haemoglobin were indicative under observation. Majority (69.16%) of respondents had their Hb level in between 8-9.8 mg/dl which was greatly influenced by dietary iron and vitamin C. The quantity of daily iron intake in between 11-14mg/dl indicated the positive and effective supplementation on anthropometric status and Hb level in Medicinal supplementation group (MSG) followed by Medium income group (MIG) and Low income group (LIG).

Kotagi *et al.*, (2013) studied the nutrient enrichment of little millet (*panicum miliare*) flakes with garden cress seed. The result of study showed that the addition of garden cress seeds significantly increased the iron content by 7.18 per cent and recorded 65.83mg. iron per 100gm of MGC-RTE (millet garden cress seed ready to eat) flakes. Iron content of control millet flakes was 61.42mg. /100gm. One serving (30gm.) of MGC-RTE flakes provided 19.75mg. of iron which could provide more than about 40.00 and 65.00 per cent of suggested recommendations for different population groups of males and females, respectively.

Nathiya and Nora (2014) invented that the cereal and garden cress based cookies are an excellent source of protein and iron. These cookies when prepared at home would be a hygienic and cost effective alternative when

compared to expensive commercial cookies. The study was also showed that no bitter after taste was sensed in the cookies up to the addition of 30gm of garden cress seeds per 100gm of cookies dough. Therefore this amount (30gm/100gm) can be safely added to the cookies dough.

Hema and Manisha (2014) studied the effect of processing on nutraceutical properties of garden cress (*Lepidium sativum L.*) seeds. Results revealed that the Total Phenolic Content (TPC) of popped Garden Cress Seed (GCS) increased by 18.5%, and it decreased by 5% in germinated GCS extracts compared to native GCS, whereas the flavonoid contents decreased both in popped and germinated seed extracts. The tannin contents increased while popping by 6.81% whereas, it decreased by 20.45% during germination compared to native extracts (0.44mg CEQ/100g). DPPH radical scavenging and the iron reducing power activity increased while popping but decreased during germination compared to native counterpart. Fractionation of native and processed GCS extracts by HPLC showed presence of p-coumaric acid, proto-catechuic acid and gallic acid, with p-coumaric acid showing major portion followed by protocatechuic acid and gallic acid.

Rekha (2014) observed that there is positive effect of supplementation of garden cress seed on prepubertal girls on their height, weight, chest, arm & hip circumference. Hb level of the respondent girls estimated before and after intervention as indicator to evaluate the impact of iron supplementation. Hb level was found to be considerably increased in experimental groups. Results emerged clearly brought out significant difference between the groups as attributed to the effect of supplementation. Calculated value of "F" is (1257.417) greater than table value (3.03) at 5 percent probability. After studying the difference in the treatments mean with respect to critical difference value (0.1117) which indicated that Medicinal Supplementation Group (MSG) is found to be more effective and followed by Middle Income Group (MEG) and Low Income Group (LIG).

Gigi and Rashmi (2014) studied the snacks preferred by adolescents were modified to be nutritious by incorporation of Garden cress

seed. The snacks made were rich in iron, calcium and protein. The Garden cress seeds incorporated cheese *aliv* cookies scored high for appearance, texture and taste and were almost in par with the control. 10g Garden cress seed incorporated Cashew nut cookies got the highest mean acceptability. Corn flake Halim cookies got relatively high scores for all sensory attributes, Carrot Halim cookies also scored highest at the 10g level of incorporation of Garden cress seed. The texture of soya dates nutria cookies received much acceptance at 5g of Garden cress seed incorporated. 30g Garden cress seed incorporated Mini raisin muffin got high scores for taste. 20g Garden cress seed incorporated Carrot *Aliv* muffin scored high for texture, flavor and taste. Mango banana Halim muffin was soft and fluffy and the 20g level of incorporated Garden cress seed scored highest. Honey *Aliv* and fruity muffin scored better than the control. From this study it can be inferred that 60% of the prepared snacks, the highest accepted snacks were of 10g level of incorporation of Garden cress seed. Thus it can be concluded that the incorporation of Garden Cress Seeds in snacks preferred by adolescents offers a window of opportunity to improve the micronutrient composition of the snacks and in turn enhance the micronutrient intake of the diets consumed by adolescents.

Material and Methods

CHAPTER 3

MATERIALS AND METHODS

The present study was carried out on development of food products with incorporation of garden cress seeds for lactating women. The study was conducted in two phases. In first phase of the study survey of lactating women was conducted to know the food habits and food consumption practices with special reference to garden cress seed. In the second phase of study, products were developed by incorporating garden cress seed. The organoleptic characteristic of prepared products was evaluated to determine the most acceptable level of incorporation. The keeping quality of most accepted products was studied and nutrient content of highly accepted food product was analyzed. The details of the methodology followed and methods used in the present study are described here under different heads.

3.1 Survey

A survey was carried out to find out the food consumption pattern specially garden cress seed in lactating women in Parbhani a district in Maharashtra.

3.1.1 Selection of sample

A total sample of one hundred lactating women was randomly selected from Parbhani city. The samples comprised of 100 lactating women who have baby less than 6 months of age. The respondents were from different socioeconomic status.

3.1.2 Questionnaire Schedule

An interview schedule was prepared, covering different aspects i.e. General information of the selected lactating women (Appendix I) and Food consumption pattern with reference to consumption of garden cress seed, frequency of consumption, method of storage and opinion about nutrient security of garden cress seed (Appendix II).

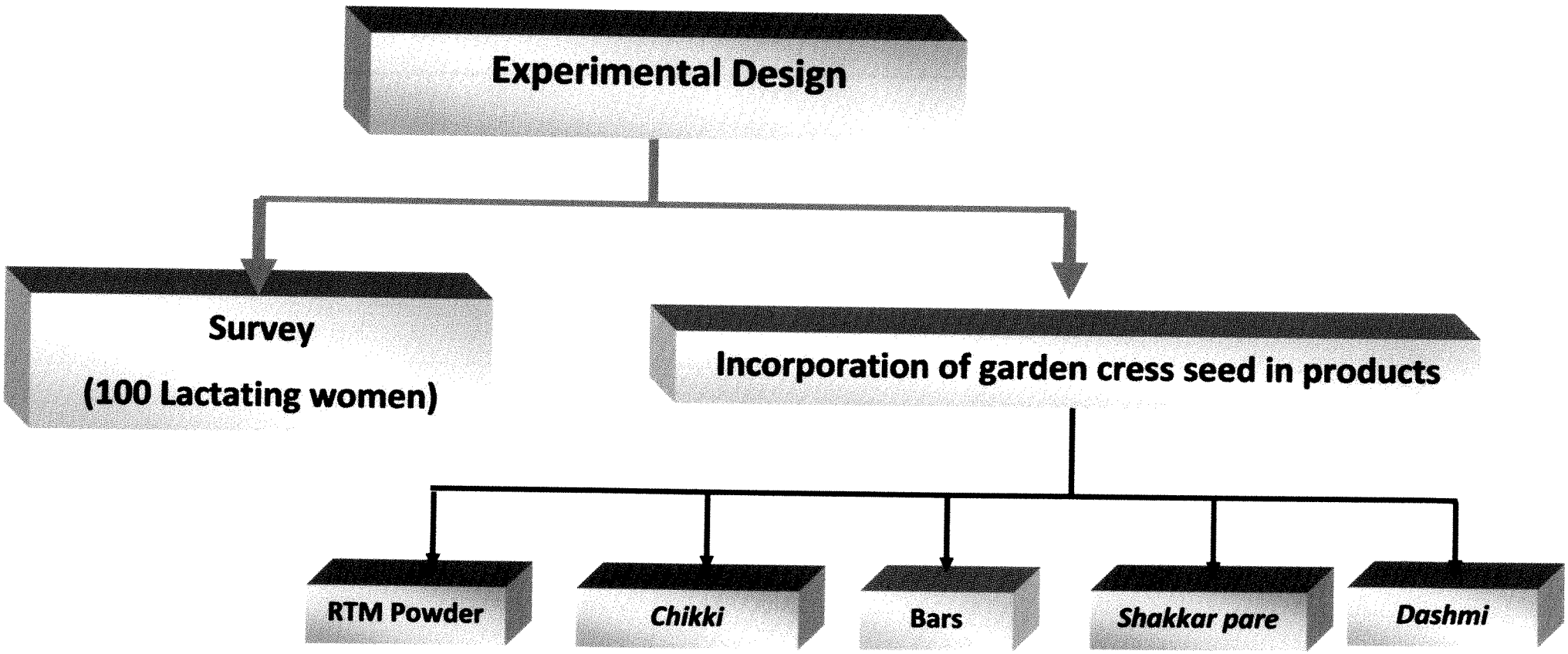


Fig. 1. Experimental design of research work

3.1.3 Collection of Survey data

The survey was carried out by making house to house visit and by personal interview method. The randomly selected lactating women were personally interviewed to collect the information included in the interview schedule.

3.2 Collection of material

Garden cress seed were procured from local market of Parbhani. The collected Garden cress seeds were cleaned by removing foreign material. Then the garden cress seeds were roasted and ground to a fine powder and shifted through scientific sieve of 40mesh. The garden cress seed powder was stored in air tight container and kept in room temperature to last till the end of experiment.

3.3 Selection of recipes

Lactation is the period in which nutrient requirement of women is higher than normal period. During lactation most of time is spend on taking care of infant, mother may not have enough time to take care of diet. Hence lactating women need some simple, but nutritious recipes which can be stored for at least one week or more than that to maintain good health. Depending upon their needs products like RTM powder, *chikki*, *shakkar pare*, *dashami* and bars (Appendix-IV) were prepared with incorporation of garden cress seeds.

3.4 Selection of level of incorporation

Garden cress seed powder was incorporated at 6, 8, 10, 12 and 14 per cent level in the selected recipes in RTM (Ready to Mix) powder (14%), *chikki* (8%), bars (8%), *shakkar pare* (10%) and *dashami* (10%). Thus, five variations of each product were prepared for further sensory analysis. Variation one was basic recipe which was prepared without incorporation of garden cress seed and it served as control. Variations II to V were experimental variations with varying levels of incorporation of garden cress seed.

Plate 1: Investigator conducting survey

Plate 2 : Investigator developing products

3.4.1 Organoleptic evaluation of prepared products

The organoleptic evaluation was followed to find out the maximum level of incorporation of garden cress seed in different preparations.

3.4.2 Selection of panel members

The sensory threshold test was carried out on 20 members to select panel members. Different concentrations of solutions for threshold test were prepared as described by Ranganna (1979) and were requested to evaluate the solution for strength of different tastes. Considering the accuracy in evaluation of taste, 15 panel members were selected out of 20 to act as judges for sensory evaluation of products.

3.4.3 Sensory evaluation

The samples with different levels of incorporation of garden cress seed were prepared. All the selected panel members were requested to evaluate the developed products. The judges were requested to score the recipes for different sensory characters namely colour, texture, taste, flavor and overall acceptability by using Ranking scale (Appendix III). Highly accepted variations were selected for further nutritional analysis.

3.5 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 garden cress seed was tested by 't' test (Panse and Sukhanteme, 1985).

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

The present study was carried out on development of food products with incorporation of garden cress seeds for lactating women. Products were prepared by incorporation of garden cress seeds at different levels of incorporation, evaluated organoleptically for acceptability and analyzed in the laboratory for their nutritional composition. The data for organoleptic evaluation and nutrition analysis were tabulated and analyzed statistically.

Before the development of value added products, a survey was conducted to study food habits and consumption of garden cress seed by the lactating women in Parbhani. The collected data was converted to percentage, tabulated, analyzed statistically and discussed here under various heads in this chapter.

4.1 Collection of data regarding general information and food habits of lactating women.

4.2 Organoleptic evaluation of developed products.

4.3 Nutrient analysis of developed products.

4.4 Keeping quality of developed products.

A survey of 100 lactating women was conducted randomly in Parbhani city. Their general information and food consumption pattern, with special reference to consumption of garden cress seed was studied with pre planned questionnaire by personally interviewing the lactating women.

4.1.1 General information of selected respondents

Table 1 presents the general information of selected subjects. The age group of selected subjects was ranging from 20 to 40 years. Most of the respondents (93%) were belonging 20 to less than or equal to 30 years of age while seven per cent were of the age more than 30 to 40 years.

Body mass index of lactating women was calculated by using height and weight and classified into different classes as undernourished, normal, overweight and obese as suggested by WHO. Majority of lactating women were belonging to normal class (71%) followed by overweight (20%), malnourished (9 %). The subjects from nuclear family were 74 per cent and 26 per cent were from joint family.

Maximum subjects (98%) were found to be literate and only two per cent were illiterate. The educational status of lactating women varied from primary school to college education. Primary school educated were 2.04 per cent, secondary school educated were 36.73 per cent, high school educated were 35.71 per cent and college educated were 25.51 per cent.

Family income of 19 per cent respondents was less than Rs. 10,000 per month, 46 per cent were having Rs. 10,000 to 15,000 per month, 35 per cent were having monthly income Rs. 15,000 to more than 20,000 per month.

Table1. General information of selected lactating women (n= 100)

Sr. No	Particulars	Number	Percentage
1	**Age group**		
	20≤30	93	93
	>30-40	07	07
2	**BMI**		
	< 18.5 (Undernourished)	9	9
	18.5 – 25.0 (Normal)	71	71
	25.1-29.9 (Over weight)	20	20
	>30.0 (Obesity)	-	-
3	**Type of Family**		
	Nuclear	74	74
	Joint	26	26
4	**Literacy Level**		
	Illiterate	2	2
	Literate	98	98
	Primary	2	2.04
	Secondary	36	36.73
	High School	35	35.71
	College	25	25.51
5	**Monthly Income**		
	<Rs.10,000	19	19
	Rs.10,000 <15000	46	46
	Rs.15,000>20,000	35	35

4.1.2 Food habits of lactating women

Information about the food habits of lactating women is depicted in Table 2. Majority of the lactating women (56%) were vegetarian and only 44 per cent were non-vegetarian. Maximum (78%) of lactating women reported that they were having two meals per day and the remaining 22 per cent were following three meal patterns. Skipping meal because of one or more reasons were found in 22 per cent of subjects.

The reasons expressed by the lactating women for low consumption or skipping meal were ignorance by 36.36 per cent and busy house hold work by 63.63 per cent subjects. This practice of skipping meal resulted in deficient supply of nutrients subsequently which may result into poor nutritional status.

Table2. Food habits of lactating women (n=100)

Sr. No	Particulars	Number	Percentage
1.	**Food Habits**		
	a. Vegetarian	56	56
	b. Non vegetarian	44	44
2.	**Meal Pattern**		
	a. One meal per day	-	-
	b. Two meals per day	78	78
	c. Three meals per day	22	22
3.	**Skipping meal**		
	Yes	22	22
	No	78	78
4	**Reasons for skipping meal**		
	a. Ignorance	8	36.36
	b. Busy household work	14	63.63

4.1.3 Nutrient intake of lactating women

Table 3 explains the nutrient intake of selected lactating women in comparison with recommended dietary allowances. The subjects were consuming all nutrients below the recommendations revealing gross deficiency of nutrients. The mean nutrient intake of lactating women was energy 1995(kcal), protein 60(g), fat 25.3(g), calcium 978(mg) and iron 14.60(mg). Similar findings were noticed by Haijio *et al.*, 2012.

Table 3. Mean nutrient intake of selected lactating women

S. No.	Nutrients	Mean±SD	RDA
1	Energy (kcal)	1995±110.8	2920
2	Protein (g)	60±4.12	74
3	Fat (g)	25.33±2.50	30
4	Calcium (mg)	978±101.80	1200
5	Iron (mg)	14.60±3.65	21

4.1.4 Consumption practices, health benefit awareness and storage practices of Garden cress seeds by selected lactating women

Consumption practices, health benefit awareness and storage practices of garden cress seed by selected lactating women is reported in Table 4. From the table it is evident that among lactating women 59 per cent subjects were consuming garden cress seed occasionally. It was consumed in the form of *kheer* or porridge by 94.91 per cent subjects, 5.08 per cent were consuming in the form of *laddu.*

The information pertaining to health benefits awareness regarding consumption of garden cress seed revealed that all selected respondents expressed some or other health benefits of garden cress seeds. Majority of them said that it is good for bone, calcium rich, increase Hb and good for lactating women. On the whole, it was observed that markedly less per cent of lactating women were unaware about specific health benefits of garden cress seeds.

The information on storage practices of garden cress seed revealed that majority of lactating women were using steel containers (52.54%) followed by plastic container (47.45%) for storing garden cress seed. None stored it in aluminum box and polythene containers. The data regarding the period of storage indicated that, majority (55.93%) of them stored it for six months followed by 42.37 per cent for three months.

Plate 3: RTM powder prepared with incorporation of garden cress seeds

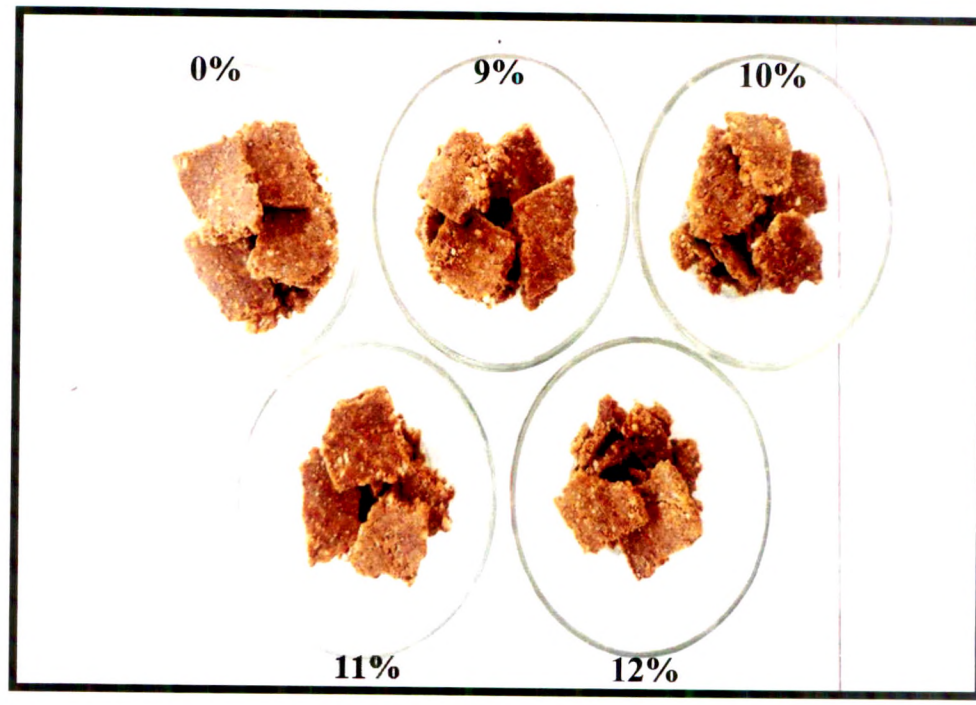


Plate 4: *Chikki* prepared with incorporation of garden cress seeds

Table 4.Consumption practices, health benefit awareness and storage practices of garden cress seed by selected lactating women (n=100)

Sr. No	Parameters	Number	Percentage
1.	**Consumption of GCS**		
	Yes	59	59
	No	41	41
2.	**Frequency of consumption**		
	a. Daily	-	-
	b. Occasionally	59	100
3.	**Products**		
	a. *Kheer* or porridge	56	94.91
	b. *Laddu*	3	5.08
4.	**Health benefits**		
	a. Good for bones	70	70
	b. Calcium rich	3	3
	c. Increase Hb	1	1
	d. Good in lactation	2	2
	e. Don't know	24	24
5.	**Method of storage**		
	a. Steel container	31	52.54
	b. Plastic container	28	47.45
	c. Aluminum box	-	-
	d. Polythene bag	-	-
6.	**Period of storage**		
	a. 3 months	25	42.37
	b. 6 months	33	55.93
	c. 9 months	01	1.69

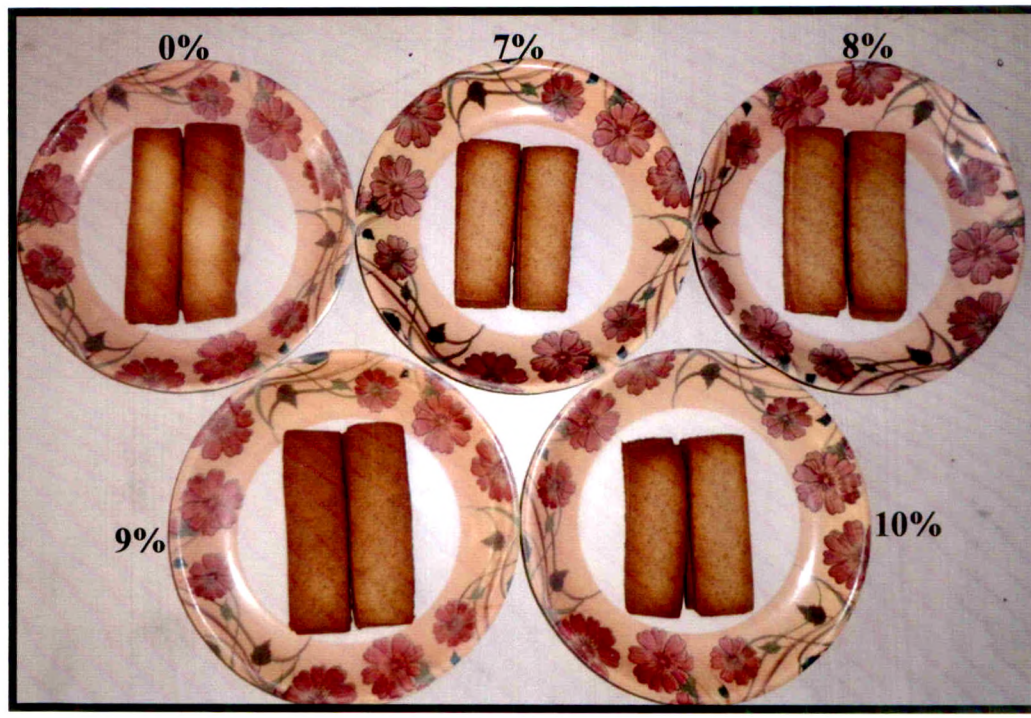


Plate 5: Bars prepared with incorporation of garden cress seeds

Plate 6: *Shakkar pare* prepared with incorporation of garden cress seeds

4.2 Organoleptic evaluation of products

4.2.1. Organoleptic evaluation of RTM Powder

RTM (Ready to Mix) powder (Plate 3) was prepared by incorporating garden cress seeds at different level (12 to 15 per cent) and was evaluated for sensory characteristics. The related data about sensory scores are given in Table 5 and represented in Fig.2.

The mean scores for colour of RTM powder prepared with 0, 12, 13, 14 and 15 per cent level of incorporation of garden cress seeds varied from 3.6 to 4.4. The RTM powder prepared without garden cress seed recorded highest score (4.4) and 12 per cent level incorporation recorded lowest score (3.6). The scores allotted for texture of RTM powder prepared with 0, 12, 13, 14 and 15 per cent of garden cress seed were 4.6, 4.0, 4.4, 4.7 and 4.2 respectively. The maximum score was obtained by 14 per cent level of garden cress seed incorporation which was at par to control. The minimum score was obtained by 12 per cent incorporation (3.6). In case of taste, 14 per cent level of incorporation of garden cress seed in RTM powder was most accepted because it acquired highest score (4.6).

The maximum score (4.2) of flavor was obtained at 14 per cent level of incorporation. The mean scores for overall acceptability of RTM powder varied from 3.8 to 4.9. Maximum score was shown by RTM powder prepared with 14 per cent of garden cress seeds (4.9). Statistical analysis showed that, there was significantly difference in all sensory parameters. On the whole, it can be said that addition of garden cress seed up to 14 per cent in RTM powder did not affect sensory qualities.

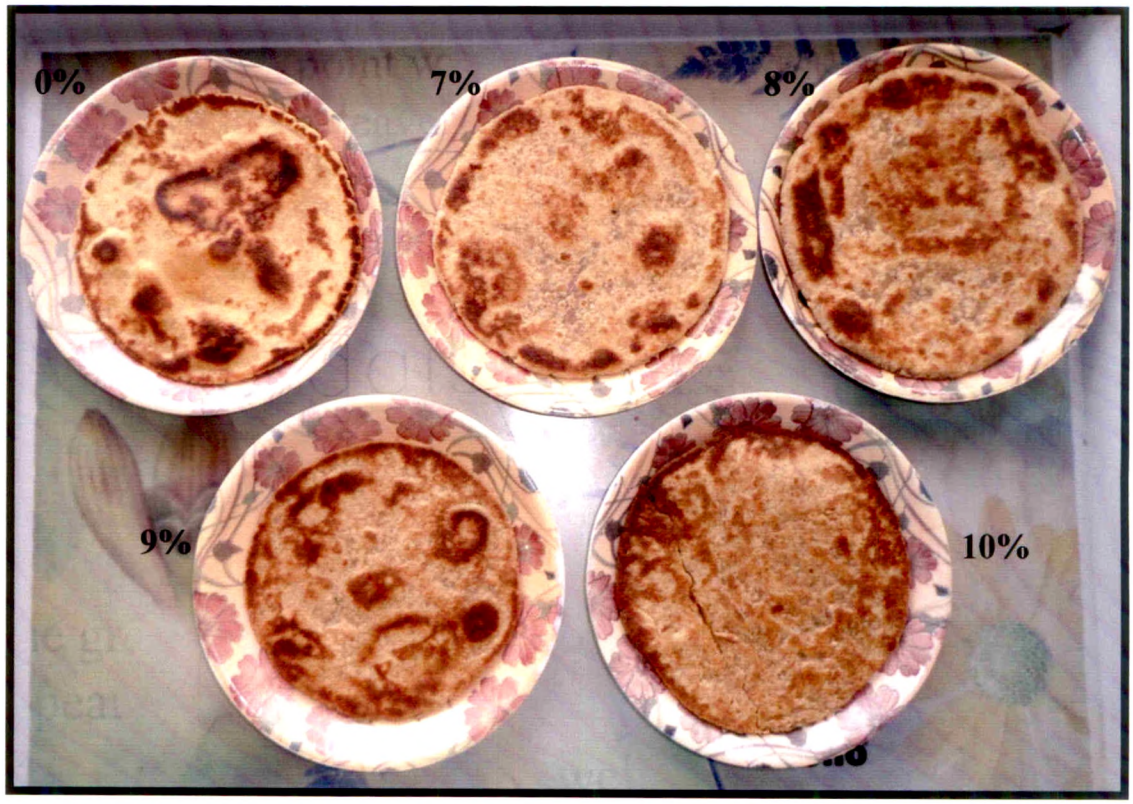


Plate 7: *Dashami* prepared with incorporation of garden cress seeds

Table 5. Sensory scores of RTM Powder

Variations	Level of garden cress seed incorporation (%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavor	Overall acceptability
I	0	**4.4**	4.6	4.4	4.0	4.4
II	12	3.6	4.0	3.7	4.0	3.8
III	13	3.8	4.4	4.3	4.1	4.4
IV	**14**	4.3	**4.7**	**4.6**	**4.2**	**4.9**
V	15	3.9	4.2	4.0	4.1	4.1
CD		0.81	0.80	0.79	0.77	0.78
SE ±		0.29	0.29	0.28	0.28	0.28
F-value		1.31^{NS}	0.95^{NS}	1.52^{NS}	0.088^{NS}	2.07^{*}

NS: Non significant

* Significant at 5 per cent

4.2.2 Organoleptic evaluation of *chikki*

Chikki was prepared by incorporating garden cress seed at different levels (0, 9, 10, 11 and 12), (Plate 4). The prepared *chikki* was evaluated for various sensory characteristics. The data about sensory scores of *chikki* are presented in Table 6 and illustrated in Fig.3.

The sensory scores for colour of *chikki* for variations varied from 4.2 to 4.6. The *chikki* prepared with garden cress seed incorporation at 10 per cent level recorded highest score (4.6) and minimum score (4.2) was obtained by *chikki* with 12 per cent addition of garden cress seed. Statistical analysis showed that the difference was significant. The mean scores for texture obtained by *chikki* with 0, 9, 10, 11 and 12 per cent of garden cress seed incorporation were 4.7, 4.3, 4.8, 4.2 and 4.3 respectively.

As the highest score (4.8) was given to texture of samples with 10 per cent level of garden cress seed, it can be said that it was superior over all other samples in terms of texture. There was significant difference in the taste of *chikki* prepared with and without garden cress seeds. Among the variations with garden cress seeds 10 per cent incorporation had highest score (4.8)

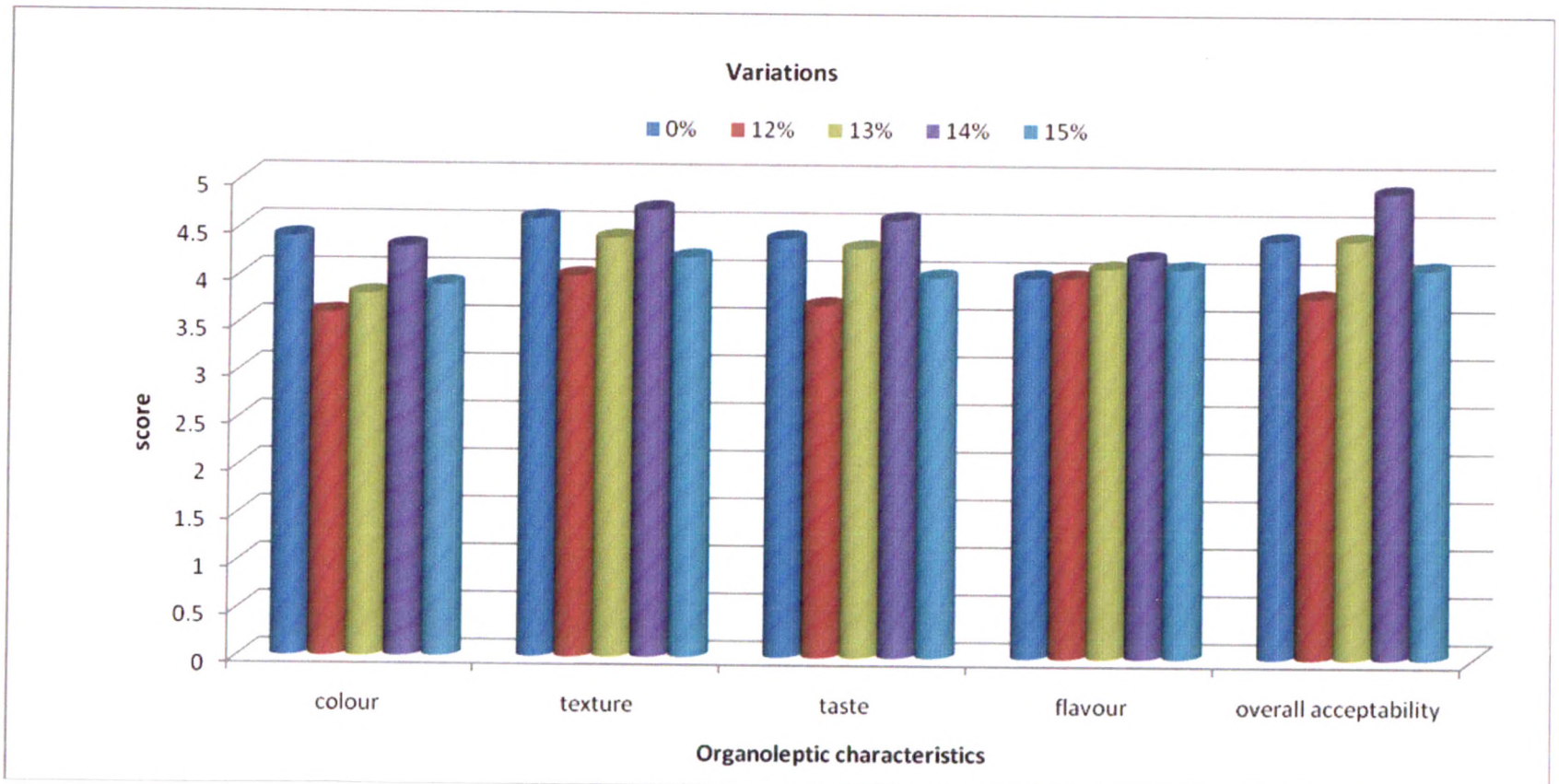


Fig.2. Sensory scores of RTM Powder

whereas minimum score (3.6) was with 12 per cent incorporation of garden cress seeds.

The study carried out by Gigi and Rashmi, 2014 also shows that ten per cent garden cress incorporated snacks were highly accepted.

In case of flavor, *chikki* with 10 per cent incorporation reported maximum score (4.4) followed by *chikki* without garden cress seeds and minimum scores (3.7) with 12 per cent of incorporation of garden cress seeds. Statistical analysis showed that there was significant difference in flavor among the variations.

Over all acceptability mean scores of 10 per cent incorporation garden cress seed was scored highest 4.9. On the whole, it can be said that incorporation of garden cress seed up to 10 per cent in *chikki* has good over all acceptability.

Table6. Sensory scores of *chikki*

Variations	Level of garden cress seed incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavor	Overall Acceptability
I	0	4.5	4.7	4.6	4.2	4.0
II	9	4.3	4.3	3.7	4.0	4.1
III	**10**	**4.6**	**4.8**	**4.8**	**4.4**	**4.9**
IV	11	4.4	4.2	3.9	4.1	4.1
V	12	4.2	4.3	3.6	3.7	3.95
CD		0.59	0.72	0.43	0.62	0.62
SE ±		0.21	0.26	0.15	0.22	0.22
F-value		1.85^{NS}	0.77^{NS}	1.42^{NS}	0.65^{NS}	2.1^{*}

NS: Non significant

* Significant at 5 per cent

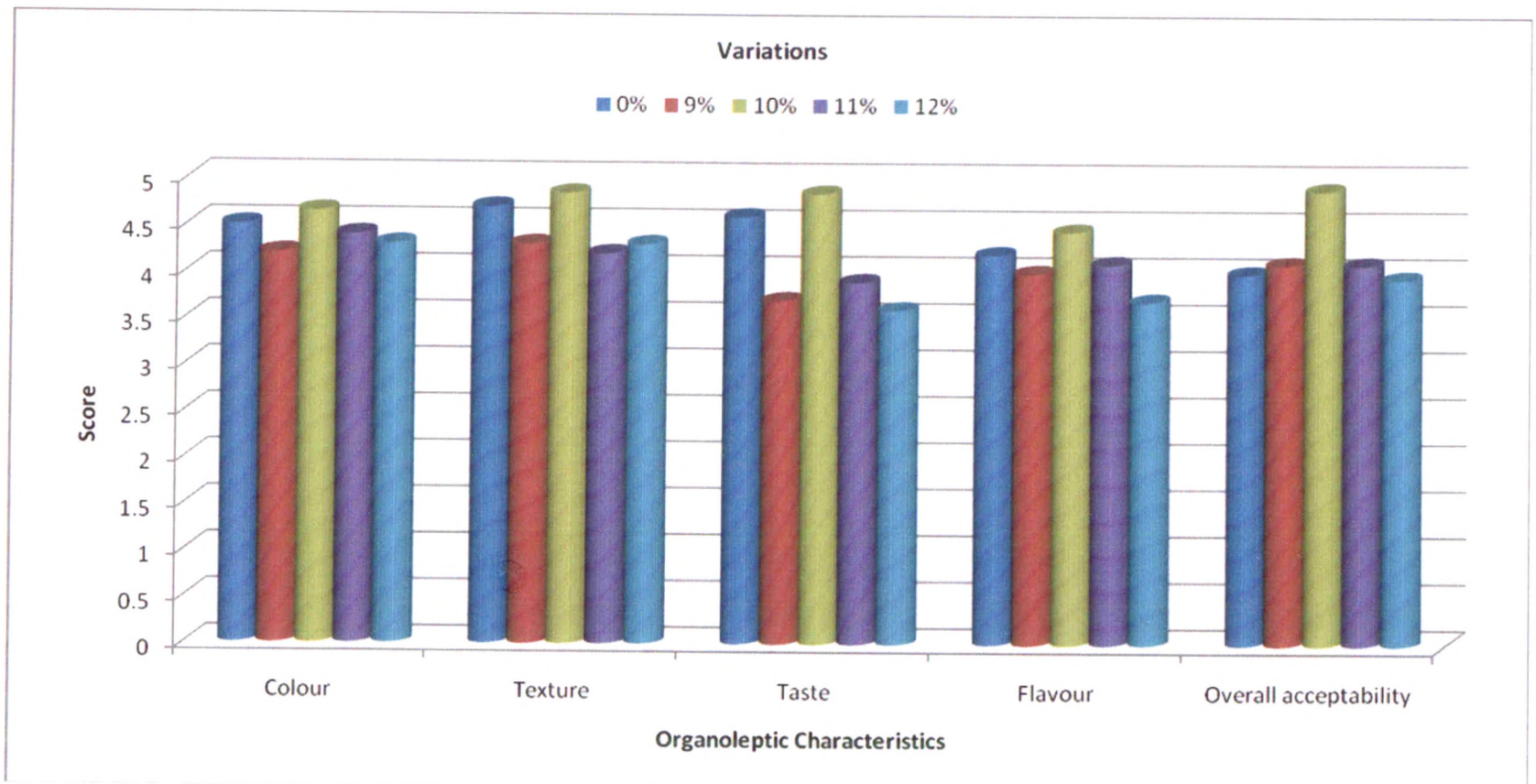


Fig.3. Sensory scores of *Chikki*

4.2.3 Organoleptic evaluation of bars

The mean scores for organoleptic characteristics of bars prepared without and with varying levels of incorporation of garden cress seed (Plate 5) are given in Table 7 and represented in Fig. 4.

The mean scores of colour of bars at 0, 7, 8, 9 and 10 per cent level of incorporation garden cress seed were 4.9, 4.9, 4.9, 4.5 and 4.7 respectively. Bars without garden cress seed scored 4.9 same as 7 and 8 per cent level of incorporation of garden cress seed. Statistical analyses showed that level of incorporation of garden cress seed at 8 per cent were significant. On the whole it was inferred that as the level of garden cress seed incorporation was increased the sensory scores were getting decreased.

The highest score (4.9) was recorded for texture of bars with 8 per cent level of garden cress seed incorporation and for without garden cress seed incorporation (control) whereas , the lowest score (3.95) was recorded by 9 and 10 per cent level of incorporation of garden cress seeds. The difference in the scores of texture was statistically significant. The highest score obtained by bars prepared with 8 per cent addition of garden cress seeds for taste (4.3) and lowest score (3.9) was recorded by 9 and 10 per cent of incorporation.

Wide variations were noticed in the mean scores of flavor prepared from varying levels of incorporation of garden cress seeds .The scores ranges from 4.2 to 4.5. Highest score was (4.5) at 8 per cent of incorporation of garden cress seeds and lowest score with incorporation of 9 per cent i.e. 4.2.

The mean scores for overall acceptability were with 8 per cent of incorporation of garden cress seeds at par to control. Hence, it is concluded that addition of garden cress seed up to 8 per cent level in bars was well accepted by panel members.

Table 7. Sensory scores of Bars

Variations	Level of garden cress seed incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavor	Overall Acceptability
I	0	4.9	4.9	4.2	4.3	4.6
II	7	4.9	4.8	4.2	4.5	4.6
III	8	4.9	4.9	4.3	4.5	4.7
IV	9	4.5	4.8	3.9	4.2	4.4
V	10	4.7	4.8	3.9	4.3	4.4
CD		0.41	0.39	0.36	0.50	0.50
SE ±		0.14	0.14	0.13	0.18	0.18
F-value		4.8**	3.7**	3.8**	3.06**	3.2**

** Significant at 1 per cent

4.2.4 Organoleptic evaluation of *Shakkar Pare*

The mean scores for organoleptic characteristic of *shakkar pare* prepared without and with varying levels of incorporation of garden cress seeds (Plate 6) are given in Table 8 and illustrated in Fig. 5.

Wide variations were noticed in the mean scores of colour prepared from varying levels of incorporation of garden cress seeds. The scores range from 3.5 to 4.7. Highest score (4.7) was without incorporation of garden cress seed and lowest score (3.5) with incorporation of 14 per cent of garden cress seeds.

The scores for texture of *shakkar pare* prepared with 0, 8, 10, 12 and 15 per cent of garden cress seed incorporation was 4.4, 4.4, 4.6, 4.0 and 3.8 respectively. Maximum score (4.6) for texture was obtained by *shakkar pare* prepared with 10 per cent garden cress seeds, while minimum score (3.6) for 14 per cent level of incorporation of garden cress seeds.

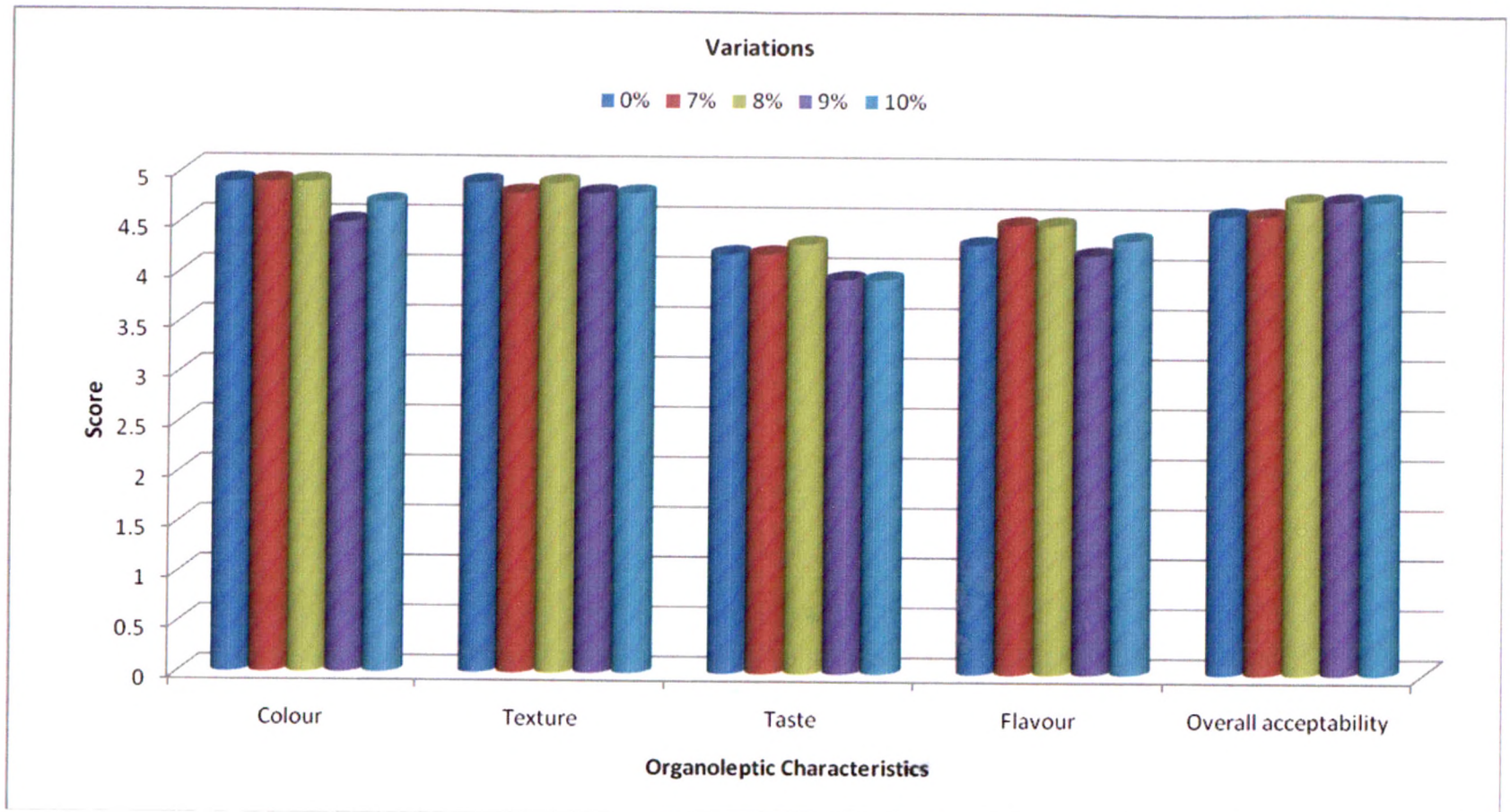


Fig.4. Sensory scores of Bars

The mean value for taste of *shakkar pare* prepared with 10 per cent levels of incorporation of garden cress seeds was more (4.5) among the other variations and lowest score (3.6) with 14 per cent incorporation. Hence, from the results it can be concluded that with addition of 10 per cent of garden cress seeds, to *shakkar pare* did not affect sensory parameters adversely. The mean scores for texture, taste, flavor and overall acceptability 4.6, 4.5, 4.7 and 4.7 respectively. The highest score was obtained by *shakkar pare* prepared with 10 per cent incorporation of garden cress seed whereas, lowest score for colour, texture, taste, flavor and over all acceptability was obtained by variation with 14 per cent incorporation.

Among 60% of prepared snacks, the highest acceptable snacks were of 10% level of incorporation of garden cress seed (Parameshwari and Nazni, 2012).

Table 8. Sensory scores of *shakkar pare*

Variations	Level of garden cress seed incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavor	Overall Acceptability
I	0	**4.7**	4.4	4.3	4.5	4.5
II	8	4.1	4.4	4.3	4.5	4.4
III	**10**	4.2	**4.6**	**4.5**	**4.7**	**4.7**
IV	12	3.8	4.05	4.1	4.2	4.4
V	14	3.5	3.8	3.6	3.8	3.7
CD		0.55	0.59	0.57	0.57	0.49
SE ±		0.20	0.21	0.20	0.20	0.17
F-value		4.49^{**}	1.76^{NS}	2.99^{**}	2.51^{*}	4.72^{**}

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

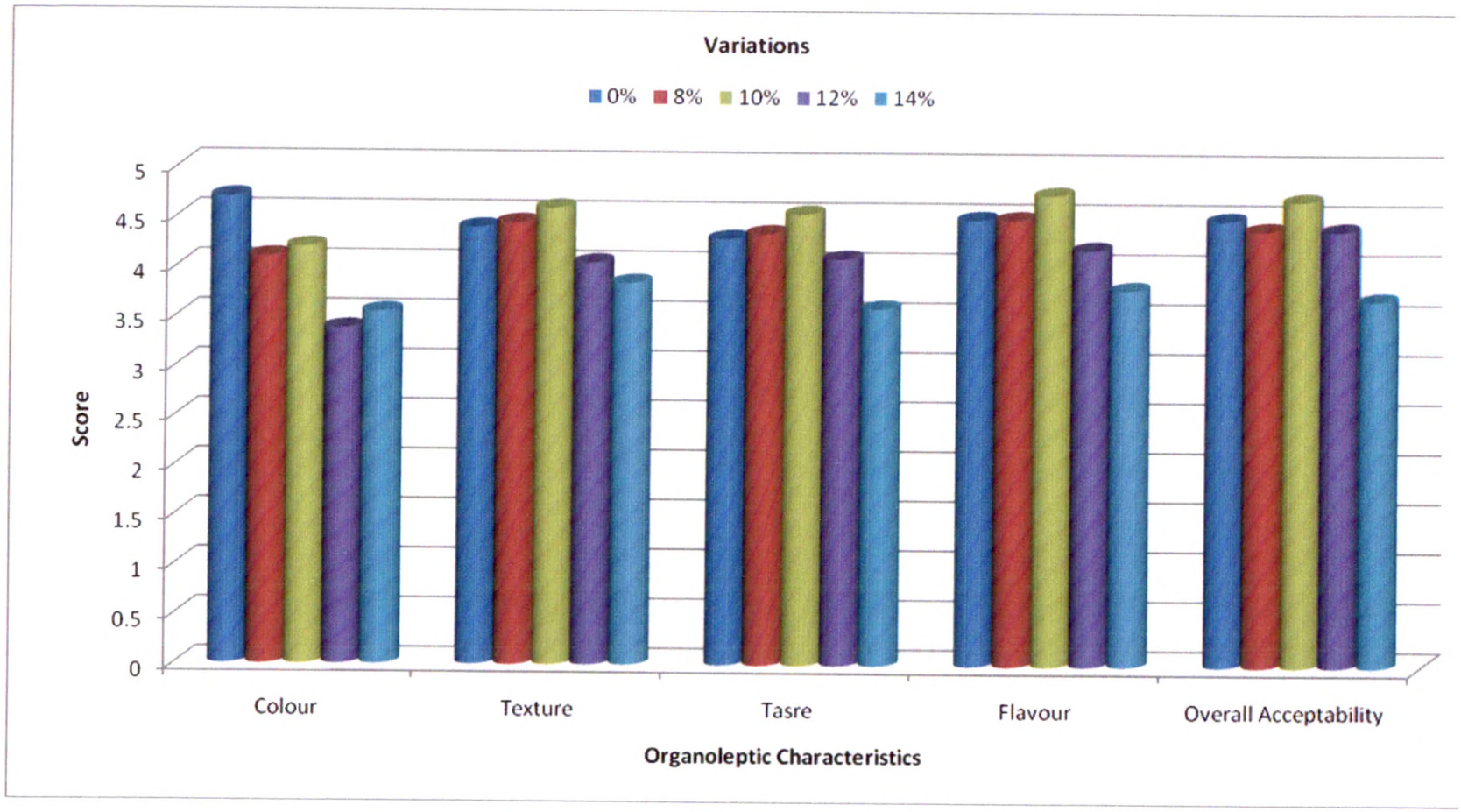


Fig.5. Sensory scores of *Shakkar Pare*

4.2.5 Organoleptic evaluation of *Dashami*

The mean values of organoleptic scores for the acceptability of *dashami* prepared with and without incorporation of garden cress seed (Plate 7) are given in Table 9 and illustrated in Fig.6.

The mean scores of colour of *dashami* prepared with 0, 7, 8, 9 and 10 per cent level of incorporation of garden cress seed varied from 3.8 to 4.7. The *dashami* prepared with 8 per cent level of incorporating recorded maximum scores (4.7) while lowest score (3.8) was recorded for 10 per cent level of incorporation. The scores obtained for *dashami* with 7, 8, 9 and 10 per cent level garden cress seed incorporation differed significantly. On the whole it can be said that the colour of *dashami* with 8 per cent level of incorporation of garden cress seeds was accepted.

The scores obtained for texture of *dashami* prepared with 0, 7, 8, 9 and 10 per cent level of incorporation of garden cress seed were 4.3, 4.5, 4.6, 3.9 and 3.5 respectively. The maximum score (4.6) was obtained by 8 per cent level of garden cress seed incorporation and the minimum score (3.5) was obtained by 10 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of *dashami* differed significantly .From the finding it can be said that 8 per cent level of incorporation of garden cress seeds was found to be the most accepted.

The mean score secured for taste was ranging from 3.7 to 4.6. The highest score (4.6) for taste was secured by 8 per cent level of garden cress seeds incorporation while the minimum score (3.7) was allotted for 10 per cent incorporation. The result showed that the taste of *dashami* at 0, 7, 8, 9 and 10 per cent level of incorporation of garden cress seed was significantly different.

Scores registered for the flavor of *dashami* with 0, 7, 8, 9 and 10 per cent level of incorporation of garden cress seed was between 3.7 to 4.7.The highest scores of 4.7 for flavor was recorded by *dashami* prepared with 8 per cent level of incorporation of garden cress seeds. Statistical analysis showed that difference was significant. On whole, it was inferred that 8 per cent level

of incorporation of garden cress seeds in *dashami* was considered as most suitable level.

The mean scores for overall acceptability of *dashami* with 0, 7, 8, 9 and 10 per cent level of incorporation of garden cress seed were found to be 4.7, 4.4, 4.8, 4.0 and 3.7 respectively. Statistical analysis indicated that scores obtained by *dashami* at various levels of incorporation of garden cress seed differed significantly. The highest score (4.8) for the overall acceptability was secured by 8 per cent level of incorporation of garden cress seed in *dashami* while the minimum score (3.7) was at 10 per cent level of incorporation of garden cress seeds.

Table 9. Sensory scores of *Dashami*

Variations	Level of garden cress seed incorporation(%)	Mean value of sensory scores				
		Colour	Texture	Taste	Flavor	Overall Acceptability
I	0	4.3	4.3	4.2	4.7	4.7
II	7	4.6	4.5	4.1	4.2	4.4
III	**8**	**4.7**	**4.6**	**4.6**	**4.7**	**4.8**
IV	9	41	3.9	4.1	4.0	4.0
V	10	3.8	3.5	3.7	3.7	3.7
CD		0.42	0.36	0.38	0.37	0.37
SE ±		0.15	0.13	0.14	0.13	0.13
F-value		5.7**	12.5**	5.2**	10.92**	12.81**

** Significant at 1 per cent

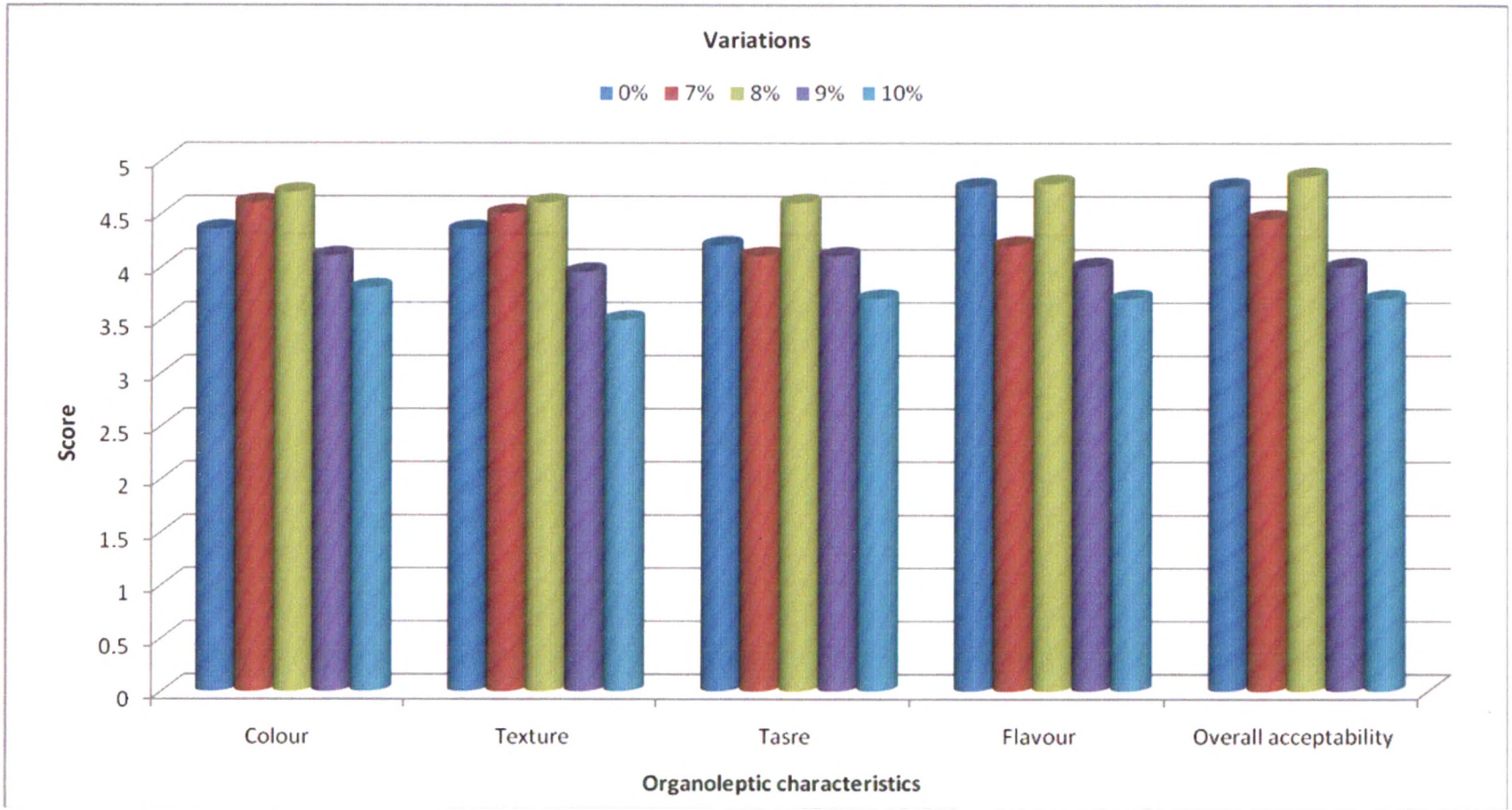


Fig.6. Sensory scores of *Dashami*

4.3 Nutrient analysis of developed products

4.3.1 Nutrient analysis of RTM Powder

The data on nutritional composition of RTM powder before and after incorporation of garden cress seed is presented in Table 10 and graphically presented in Fig. 7. served as control and accepted. After analyzing the samples in laboratory the obtained composition of RTM powder with garden cress seed showed numerical increase in nutrient content over RTM powder prepared without addition of garden cress seed.

The values for control and accepted RTM powder were moisture 1.65 g/100g and 2g/100g, protein 13.3 g/100g and 14.15 g/100g, fat 15.25 g/100g and 18.75 g/100g, fiber 2.7 g/100g and 3.7 g/100g, total mineral content 2 g/100g and 2.1 g/100g, carbohydrate 64.05 g/100g and 41.05 g/100g, iron 3.12 mg/100g and 16.85 mg/100g , calcium 44.3mg/100g and 98.15mg/100g. The values were significantly increased for moisture, fiber, iron, calcium content whereas significantly decreased in carbohydrate content.

On the whole, it can be said that addition of garden cress seed in RTM powder is beneficial to increase nutrient composition. Iron content increased from 3.12 to 16.85mg/100gm.

Table 10. Nutrient composition of RTM Powder

Nutrients	Control Mean ± SD	Accepted variation Mean ± SD	't' value
Moisture (g/100g)	1.65±0.07	2±1.44	0.48**
Protein (g/100g)	13.3±2.12	14.15±2.19	0.55NS
Fat (g/100g)	15.25±0.35	18.75±0.35	14.58**
Fiber (g/100g)	2.7±0.14	3.7±0.14	10.10**
Total mineral(g/100g)	2±0.05	2.1±0.2	1.00NS
Carbohydrate(g/100g)	64.05±1.20	41.05±1.37	25.55**
Iron (mg/100g)	3.12±0.24	16.85±0.49	50.85**
Calcium (mg/100g)	44.3±1.27	98.15±1.34	58.33**

NS: Non significant

** Significant at 1 per cent

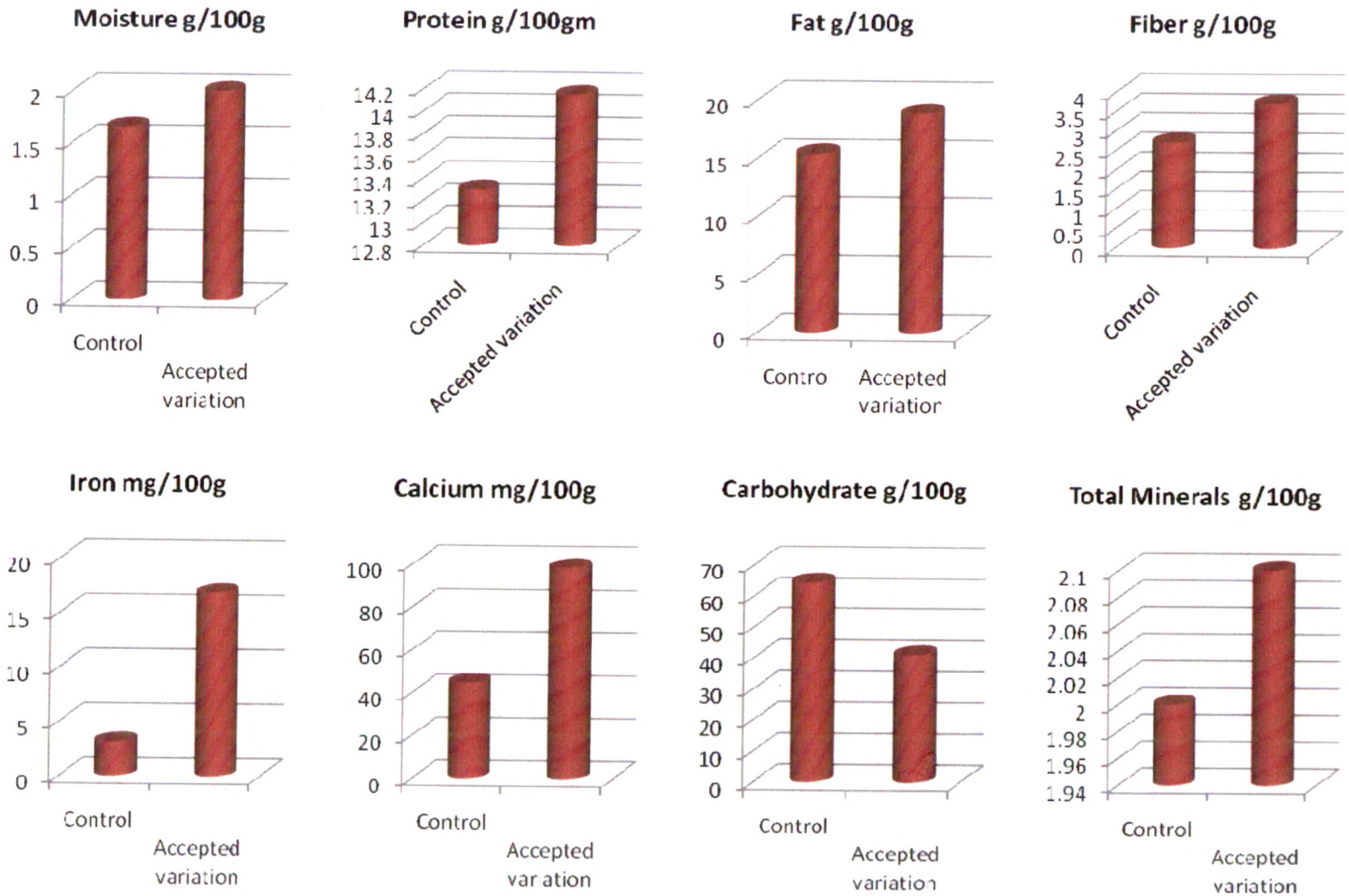


Fig. 7 Nutrient composition of RTM Powder

4.3.2 Nutrient analysis of *Chikki*

The data on nutritional composition of *chikki* prepared without and with incorporation of garden cress seeds, served as control and accepted is presented in Table 11 and graphically presented in Fig. 8.

The moisture, protein, fat, fiber, total mineral , carbohydrate, iron, calcium content of control and accepted *chikki* were 2.95 g/100g and 3 g/100g, 3.9 g/100g and 5.2g/100g, 30.62g/100g and 26.25g/100g, 2.04g/100g and 2.86 g/100g, 2.91g/100g and 2.99 g/100g, 56.85g/100g and 59.05g/100g, 3mg/100g and 12.37mg/100g, 100mg/100gm and 223.75mg/100g respectively. From the results it was inferred that *chikki* with addition of garden cress seed had fat, fibre, carbohydrate, iron and calcium content increased which were statistically significant.

The results showed that the incorporation of garden cress seed in *chikki* was helpful in increasing the nutrient content.

Kotagi et al, 2013 also reported that addition of garden cress seeds significantly increased the iron content of the products.

Table 11. Nutrient composition of *Chikki*

Nutrients	Control Mean ± SD	Accepted variation Mean ± SD	't' value
Moisture (g/100g)	2.95±1.34	3±1.41	0.57^{NS}
Protein (g/100g)	3.9±0.56	5.2±0.56	3.42^{NS}
Fat (g/100g)	30.62±0.17	26.25±0.35	23^{**}
Fiber (g/100g)	2.04±0.084	2.86±0.16	9.11^{**}
Total mineral (g/100g)	2.91±0.4	2.99±0.3	0.33^{NS}
Carbohydrate (g/100g)	56.85±1.03	59.05±0.91	3.25^{*}
Iron (mg/100g)	3±0.14	12.37±0.88	21.29^{**}
Calcium (mg/100g)	100±0.28	223.75±2.05	120.14^{**}

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

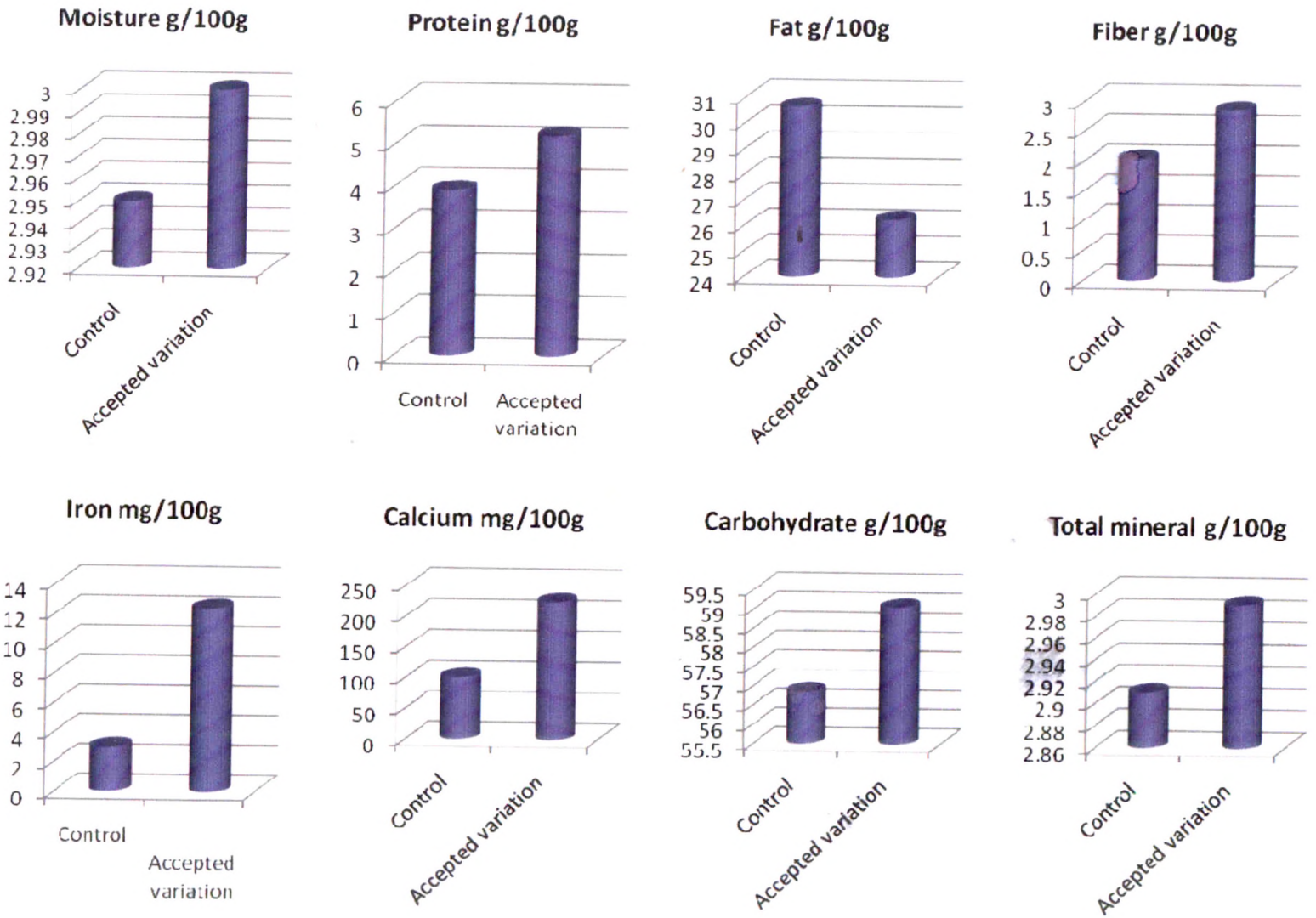


Fig. 8 Nutrient composition of *Chikki*

4.3.3 Nutrient analysis of Bars

Nutritional composition of bars developed without incorporation of garden cress seed (control) and with garden cress seed (most accepted experimental variations) is presented in Table.12 and graphically presented in Fig.9.

The values for control and accepted bars were moisture 2.9g/100g and 3g/100g, protein 9.8g/100g and 10.28 g/100g, fat 22.27 g/100g and 23.23 g/100g ,fiber 0.13 g/100g and 0.63 g/100g, total mineral content 1.7 g/100g and 2.2 g/100g, carbohydrate 62.21 g/100g and 59.35 g/100g , iron 1.32 mg/100g and 8.12 mg/100g, calcium 139.88 mg/100g and 171.58mg/100g. The values were significantly increased for fat, fiber, total minerals, iron and calcium content.

The nutrient profile of prepared snacks revealed that a direct relationship, with the increase in garden cress seed, there was an increase in iron and calcium content of the snacks (Gigi and Rashmi, 2014).

Table 12. Nutrient composition of Bars

Nutrients	Control	Accepted variation	
	Mean ± SD	Mean ± SD	't' value
Moisture (g/100g)	2.9±1.41	3±1.41	0.1^{NS}
Protein (g/100g)	9.83±0.32	10.28±0.31	2.14^{NS}
Fat (g/100g)	22.27±0.03	23.2±0.14	13.23^{**}
Fiber (g/100g)	0.13±0.014	0.63±0.014	50^{**}
Total mineral (g/100g)	1.7±0.3	2.2±0.1	3.33^{*}
Carbohydrate (g/100g)	62.21±1.38	59.35±1.88	2.5^{NS}
Iron (mg/100g)	1.32±0.10	8.12±0.01	97.14^{**}
Calcium (mg/100g)	139.88±0.45	171.58±1.49	41.16^{**}

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

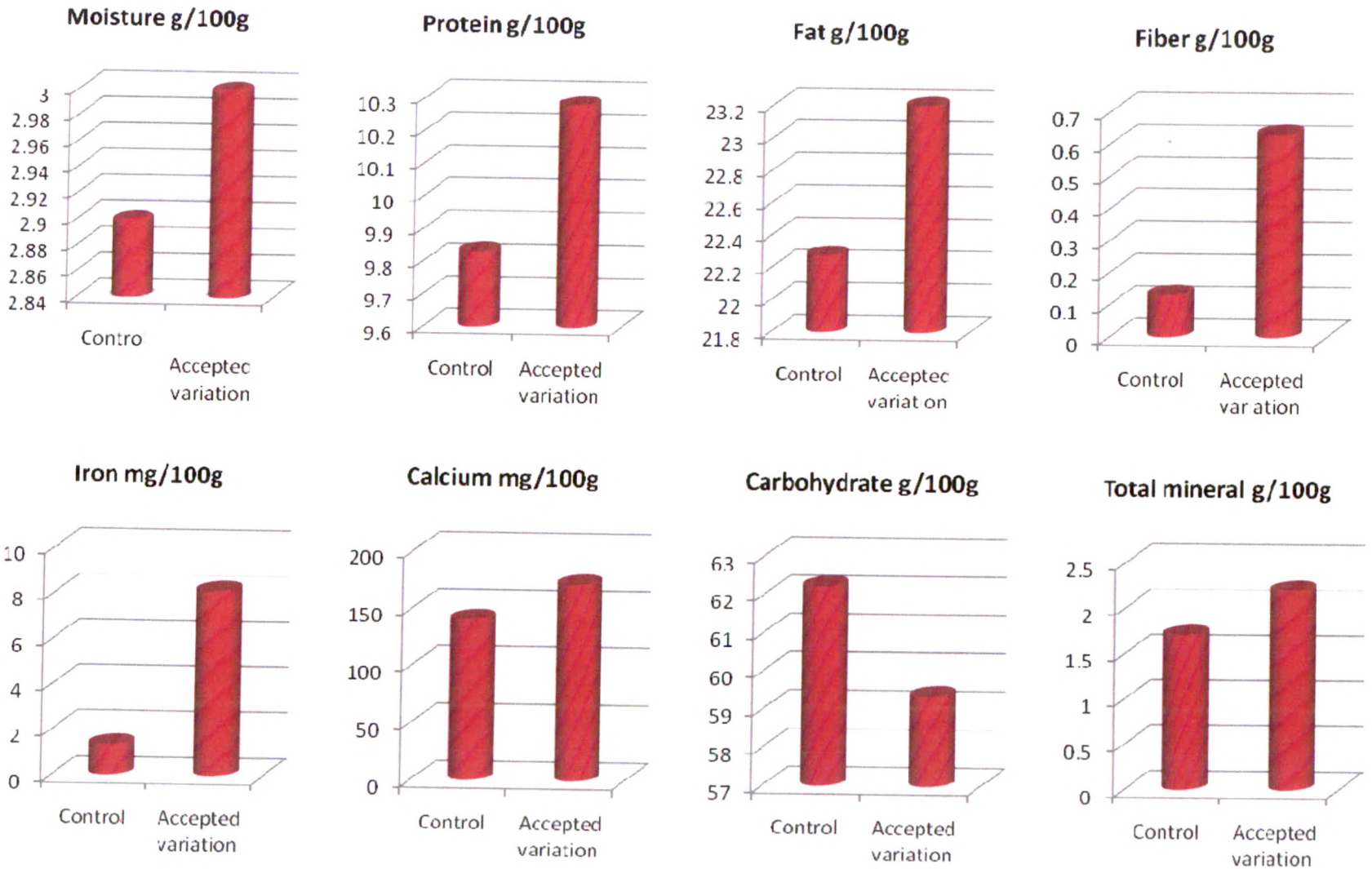


Fig. 9 Nutrient composition of Bars

4.3.4 Nutrient analysis of *Shakkar pare*

The nutritional composition of *Shakkar pare* developed without incorporation of garden cress seed (control) and with garden cress seed (most accepted experimental variations) is depicted in Table 13 and graphically presented in Fig.10.

The nutritional composition of control and accepted product showed that moisture content 3.5 g/100g and 4 g/100g, protein 8.5 g/100g and 9.35 g/100g, fat 8.15 g/100g and 8.92 g/100g, fiber 0.47 g/100g and 1.17 g/100g , total mineral 0.9 g/100g and 1.4 g/100g , carbohydrate 77 g/100g and 74.67 g/100g , iron 2.5mg/100g and 11.8 mg/100g, calcium 261 mg/100g and 61.05 mg/100g.

From the results it was inferred that fat, fiber, total mineral, iron, calcium increased significantly in *shakkar pare,* whereas carbohydrate content decreased.

Table 13. Nutrient composition of *Shakkar pare*

Nutrients	Control	Accepted variation	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	3.5±2.12	4±2.82	0.28^{NS}
Protein (g/100g)	8.5±0.28	9.35±0.35	1.21^{NS}
Fat (g/100g)	8.15±0.07	8.92±0.035	25.66^{**}
Fiber (g/100g)	0.47±0.077	1.17±0.07	14^{**}
Total mineral (g/100g)	0.9±0.1	1.4±0.2	4.54^{*}
Carbohydrate (g/100g)	77±1.9	74.67±1.9	1.71^{NS}
Iron (mg/100g)	2.5±0.07	11.8±0.35	54.70^{**}
Calcium (mg/100g)	26.1±0.98	61.05±1.20	4.53^{*}

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

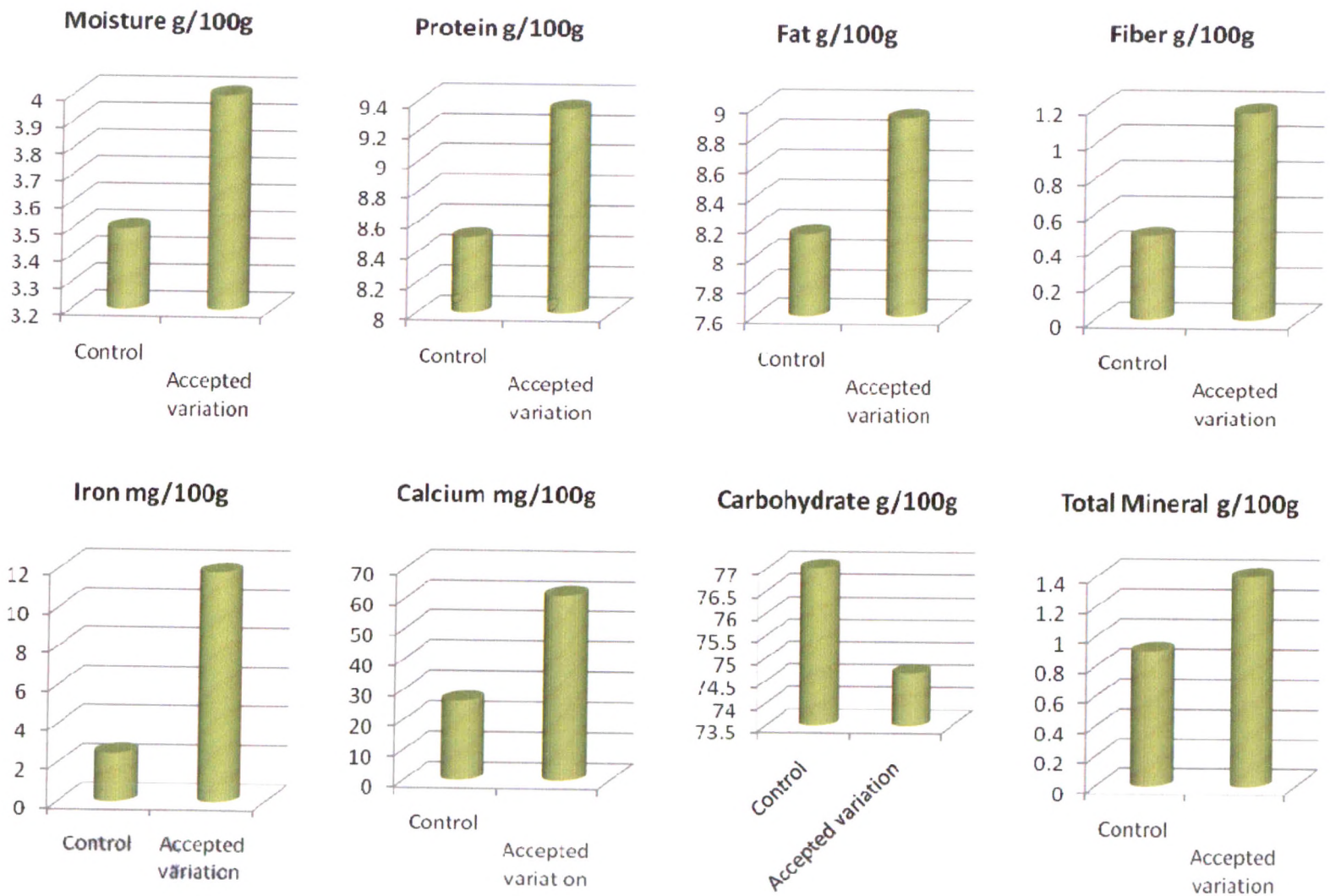


Fig. 10 Nutrient composition of *Shakkar pare*

4.3.5Nutrient analysis of *Dashami*

The nutritional composition of developed *dashami* without incorporation of garden cress seeds (control) and with garden cress seeds (most accepted experimental variations) is given in Table 14 and depicted in Fig.11.

Fiber, fat, calcium content, total mineral, iron and calcium content of *dashami* prepared with garden cress seed showed significant increase in nutrient content over *dashami* prepared without addition of garden cress seed.

The nutritional composition of control and accepted product showed that moisture content 9.95 g/100g and 10 g/100g, protein 5.9 g/100g and 6.34 g/100g, fat 6.75 g/100g and 8.75 g/100g, fiber 0.34 g/100g and 1.05 g/100g , total mineral 0.9 g/100g and 1.4 g/100g , carbohydrate 75.05 g/100g and 72.05 g/100g, iron 2.57mg/100g and 10.15 mg/100g, calcium 49.26 mg/100g and 81.1 mg/100g.

Table 14. Nutrient composition of *Dashami*

Nutrients	Control	Accepted variation	't' value
	Mean ± SD	Mean ± SD	
Moisture (g/100g)	9.95±0.070	10±0	1.66^{NS}
Protein (g/100g)	5.9±0.42	6.34±0.31	0.53^{NS}
Fat (g/100g)	6.75±0.35	8.75±0.35	8.33^{**}
Fiber (g/100g)	0.34±0.084	1.05±0.09	11.83^{**}
Total mineral (g/100g)	0.9±0.1	1.4±0.2	4.54^{*}
Carbohydrate (g/100g)	75.05±1.35	72.05±0.63	4.05^{*}
Iron (mg/100g)	2.57±0.10	10.15±0.49	31.58^{*}
Calcium (mg/100g)	49.26±1.33	81.1±0.84	40.82^{*}

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

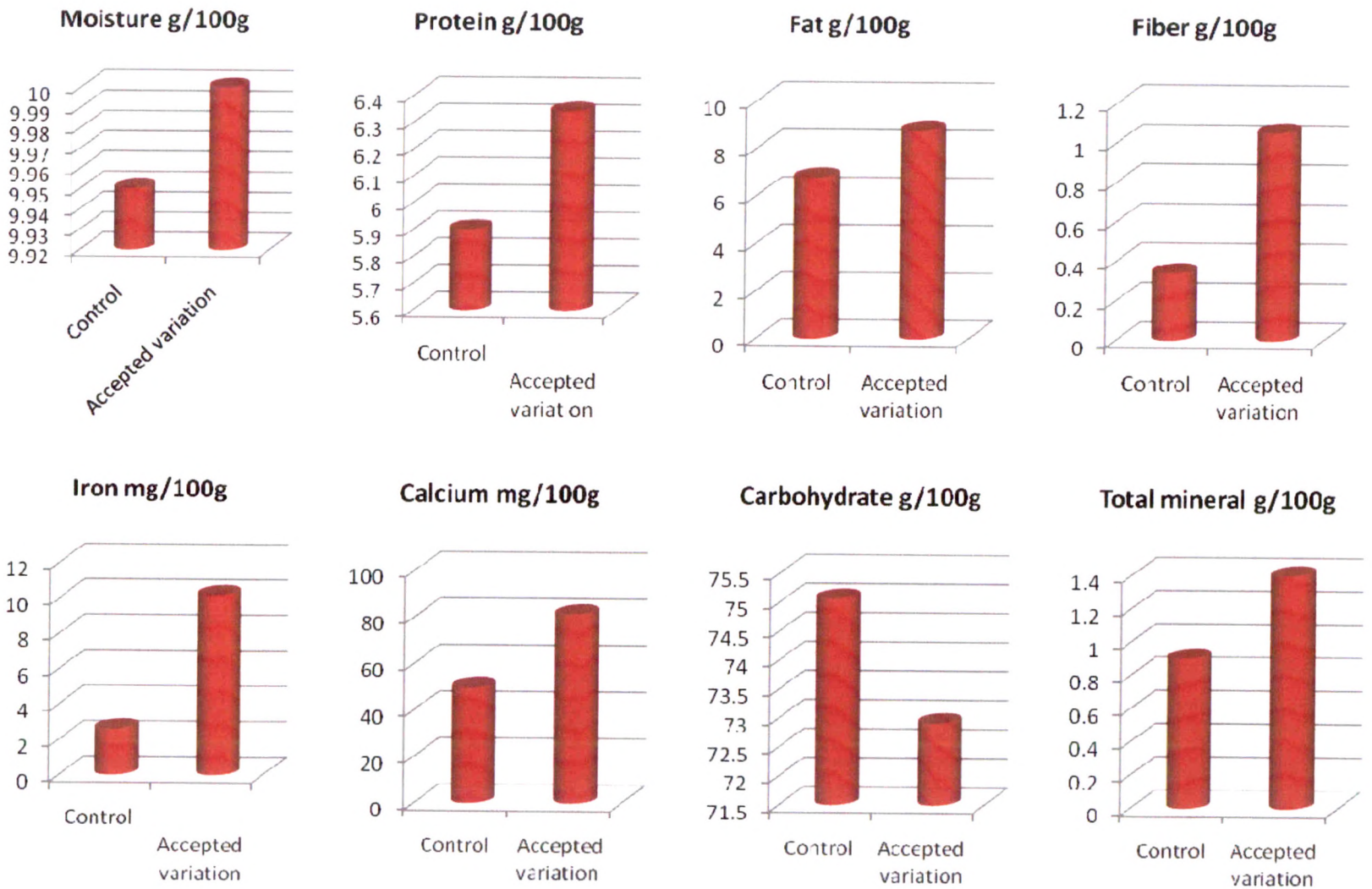


Fig. 11 Nutrient composition of *Dashami*

4.4 Keeping quality of developed products with most accepted level of incorporation of Garden cress seed

Five developed products namely RTM Powder, *chikki*, bars, *shakkar pare* and *dashami* prepared with accepted level of garden cress seed incorporation were evaluated for their keeping quality, for each product one sample was stored in zip lock bag and one in aluminum foil pouch for three weeks. Organoleptic evaluations for both the treatment were carried out by the semi trained panel members at initial, one, two and three week's period of storage. The effect of storage and storage condition on keeping quality of selected products was found out by comparing the scores recorded for overall acceptability of the selected products.

The mean score for overall acceptability of RTM powder prepared with incorporation of garden cress seeds stored in zip lock bag and aluminum foil pouch for varying periods are given in Table 15 illustrated in Fig. 12.

The mean score for overall acceptability of RTM powder stored in zip lock bag for initial, one, two and three weeks period of storage were 4.9, 4.8, 4.6 and 4.4 respectively. It was found that the score were significantly less for RTM powder kept in zip lock bag than that of stored in aluminum foil pouch. It was also observed that scores recorded by RTM powder for overall acceptability was found to be significantly decreased from second to third week for both the storage conditions.

On the whole, it was found that, as period of storage was increased the mean score for overall acceptability of both the samples was decreased.

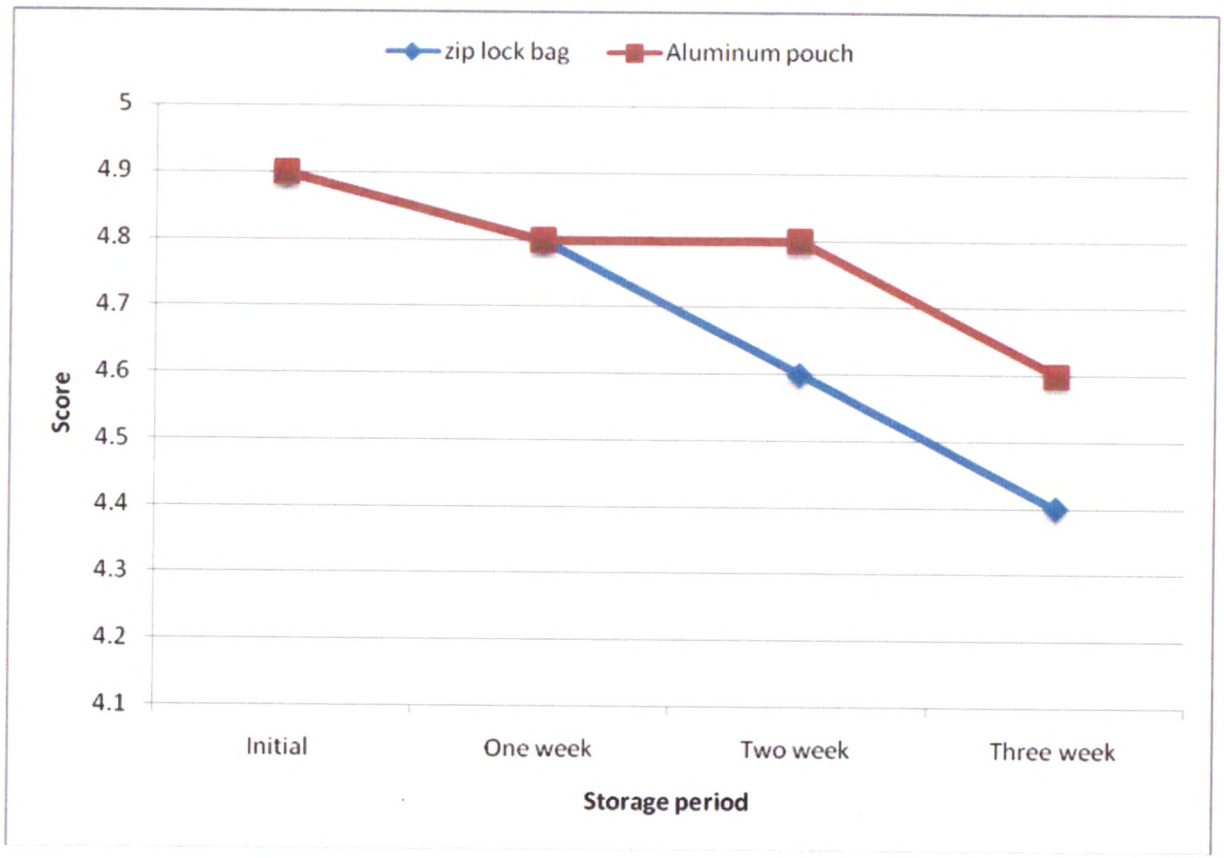


Fig. 12 Mean score for overall acceptability of RTM Powder stored in zip lock bagand aluminum foil for varying periods

Table 15. Mean score for overall acceptability of RTM Powder stored in zip lock bag and aluminum foil for varying periods

Sr. No.	Storage period	Mean score for overall acceptability for RTM Powder		't' value
		Zip lock bag Mean± SD	Aluminum foil Mean± SD	
I	Initial	4.9±0.22	4.9±0.22	NS
II	One week	4.8± 0.44	4.8± 0.44	NS
III	Two weeks	4.6± 0.54	4.8± 0.44	2.89*
IV	Three weeks	4.4± 0.54	4.6± 0.22	2.63*

NS: Non significant

* Significant at 5 per cent

The mean score for overall acceptability of *chikki* prepared with incorporation of garden cress seeds stored in zip lock bag and aluminum foil pouch for varying periods is given in Table 16 illustrated in Fig.13.

The mean scores for overall acceptability of *chikki* stored in aluminum foil pouch for varying period were 4.9, 4.4, 4.0 and 3.8. Whereas it was 4.9, 4.2, 4.0 and 3.6 stored in zip lock bags.

Overall acceptability score of *chikki* stored for one to three weeks in zip lock bags and aluminum foil pouch differed significantly. It was also observed that more score was secured by *chikki* stored in aluminum foil pouch for one week.

In nutshell, it can be interfered from the findings that the effect of storage period was noticed on overall acceptability of *chikki* stored in zip lock bags and aluminum foil. Also overall acceptability score was decreased in both the samples as the period of storage was increased.

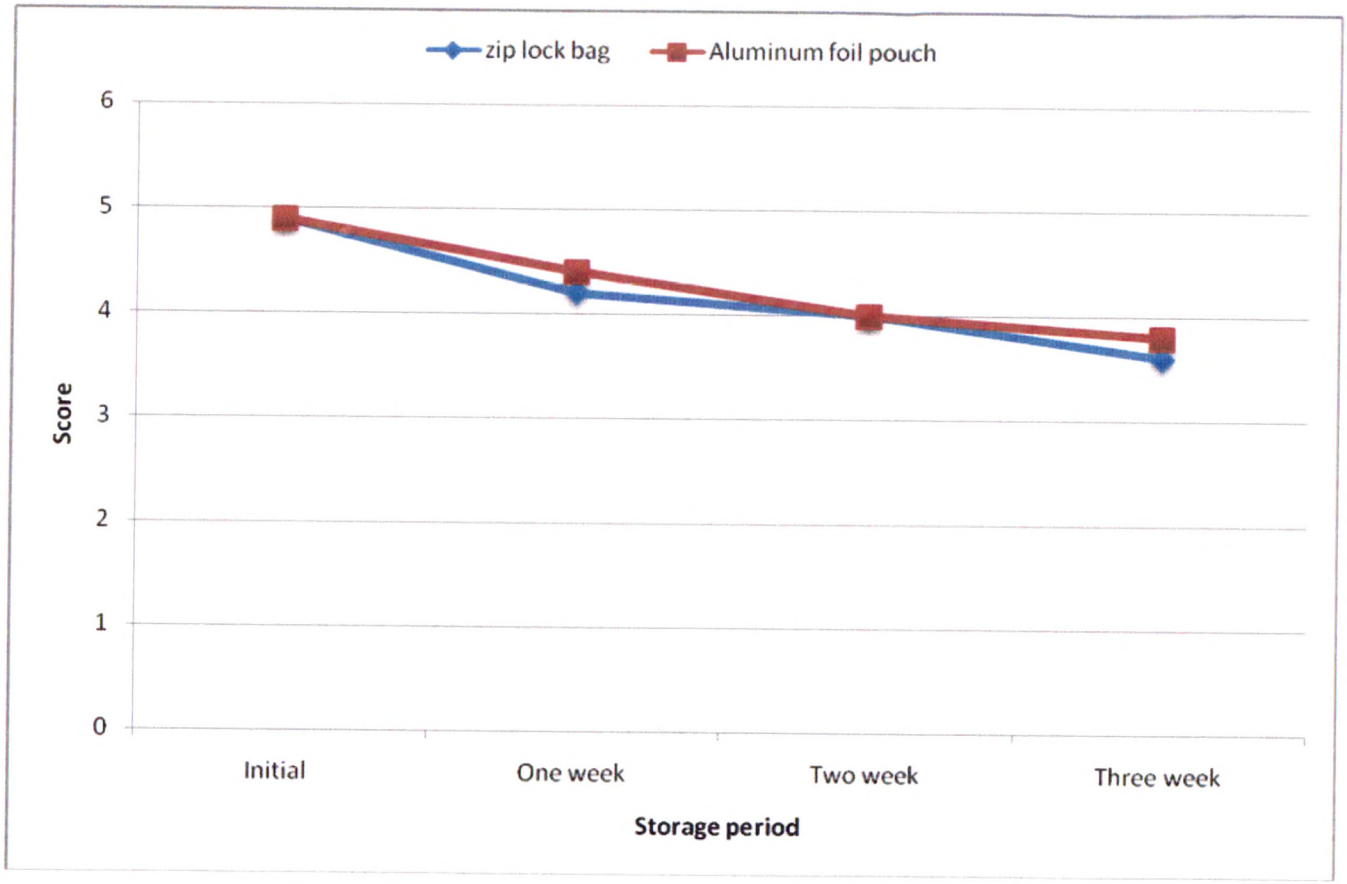


Fig. 13 Mean score for overall acceptability of *Chikki* stored in zip lock bag and aluminum foil for varying periods

Table 16. Mean score for overall acceptability of *chikki* stored in zip lock bag and aluminum foil for varying periods

Sr. No.	Storage period	Mean score for overall acceptability for *chikki*		't' value
		Zip lock bag Mean± SD	Aluminum foil Mean± SD	
I	Initial	4.9± 0.22	4.9± 0.22	NS
II	One week	4.2± 0.44	4.4± 0.54	2.89*
III	Two weeks	4.0± 0.70	4.0± 0.70	NS
IV	Three weeks	3.6± 0.54	3.8± 0.44	2.89*

NS: Non significant

* Significant at 5 per cent

The mean score for overall acceptability of bars stored at zip lock bag and aluminum foil pouch for varying period is given in Table 17 and illustrated in Fig. 14.

Wide variations were noticed in acceptability scores registered by bars stored in zip lock bag (4.7-3.8) and aluminum foil pouch (4.8-4.7) for period of three weeks. It was also noticed that significantly high score was secured by bars stored in aluminum foil after two and three weeks than bars stored in zip lock bag. Results indicated that as the period of storage was increased the acceptability of bars stored in both conditions was found to be decreased significantly.

Table 17. Mean score for overall acceptability of Bars stored in zip lock bag and aluminum foil for varying periods

Sr. No.	Storage period	Mean score for overall acceptability for Bars		't' value
		Zip lock bag Mean± SD	Aluminum foil Mean± SD	
I	Initial	4.7± 0.44	4.7± 0.44	NS
II	One week	4.8± 0.44	4.8± 0.44	NS
III	Two weeks	4.0± 0.70	4.2± 0.44	2.4*
IV	Three weeks	3.8± 0.44	4.2± 0.44	6.5**

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

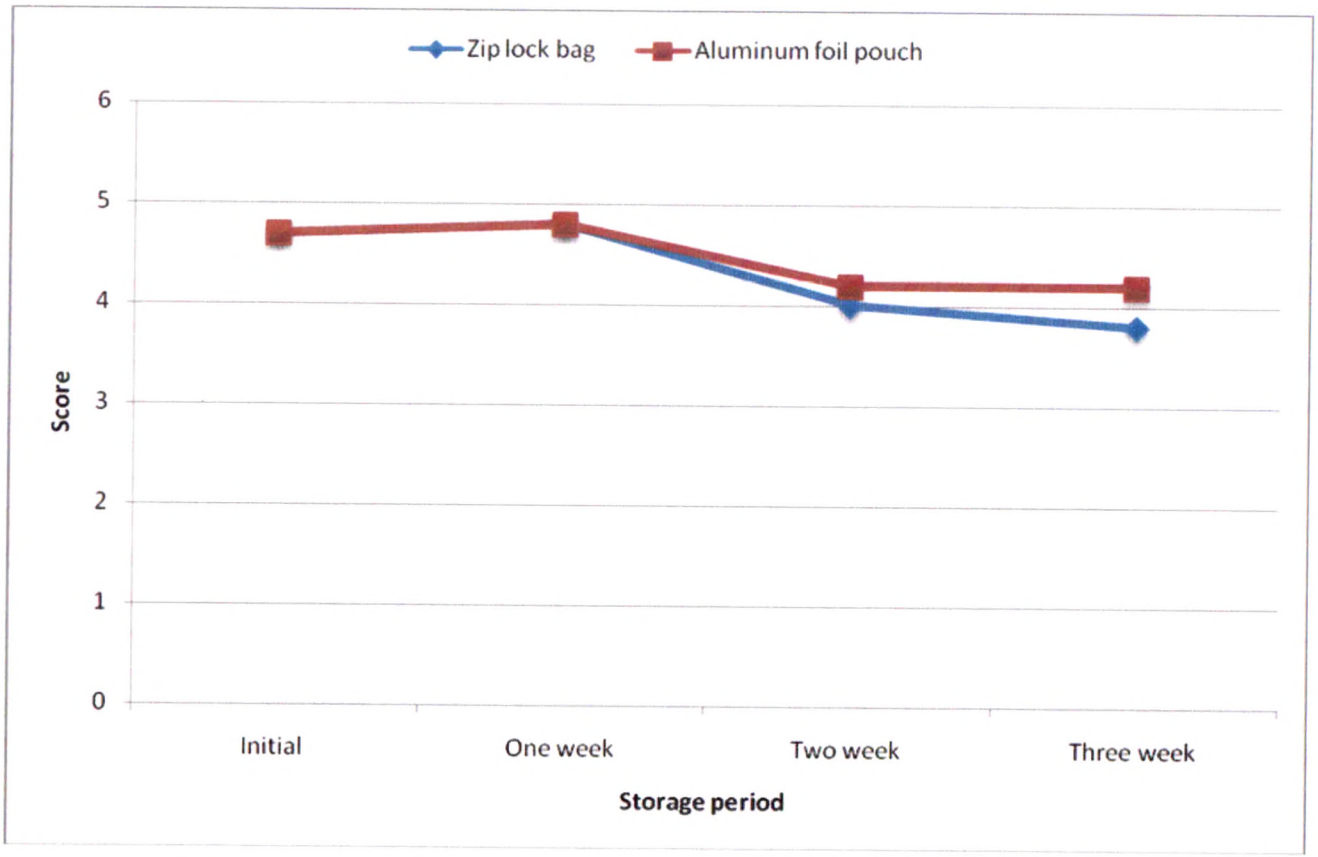


Fig. 14 Mean score for overall acceptability of Bars stored in zip lock bag aluminum foil for varying periods

The mean score for overall acceptability of *shakkar pare* stored in zip lock bag and aluminum foil pouch for varying period is given in Table 18 and illustrated in fig. 15.

Results indicated that maximum (4.7) score was recorded for *shakkar pare* at initial stage in both storage conditions. While minimum score was recorded *shakkar pare* stored for three weeks in zip lock bag (3.8) and in aluminum foil pouch (4.2).

It was observed that significantly high score was secured by *shakkar pare* kept in aluminum foil pouch for the period of two and three weeks. It was also found that as the period of storage increased overall acceptability was found to be decreased in both samples.

Table 18. Mean score for overall acceptability of *Shakkar pare* stored in zip lock bag and aluminum foil for varying periods

Sr. No.	Storage period	Mean score for overall acceptability for *Shakkar pare*		't' value
		Zip lock bag Mean± SD	Aluminum foil Mean± SD	
I	Initial	4.7± 0.44	4.7± 0.44	NS
II	One week	4.2± 0.44	4.4± 0.54	2.89*
III	Two weeks	4.0± 0.7.	4.6± 0.54	7.50**
IV	Three weeks	3.8± 0.44	4.2± 0.44	6.5**

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

The mean score for overall acceptability of *dashami* stored in zip lock bag and aluminum foil pouch for 1-8 days is presented in Table 19 and illustrated in Fig. 16.

The mean score for overall acceptability of *dashami* stored for varying period in zip lock bag were ranging from 4.8to 3.0and aluminum foil pouch were ranging from 4.8 to 3.2. Overall acceptability scores of *dashami* stored in both materials were same till third day of storage. The score was significantly decreased in zip lock bag after fourth day of storage.

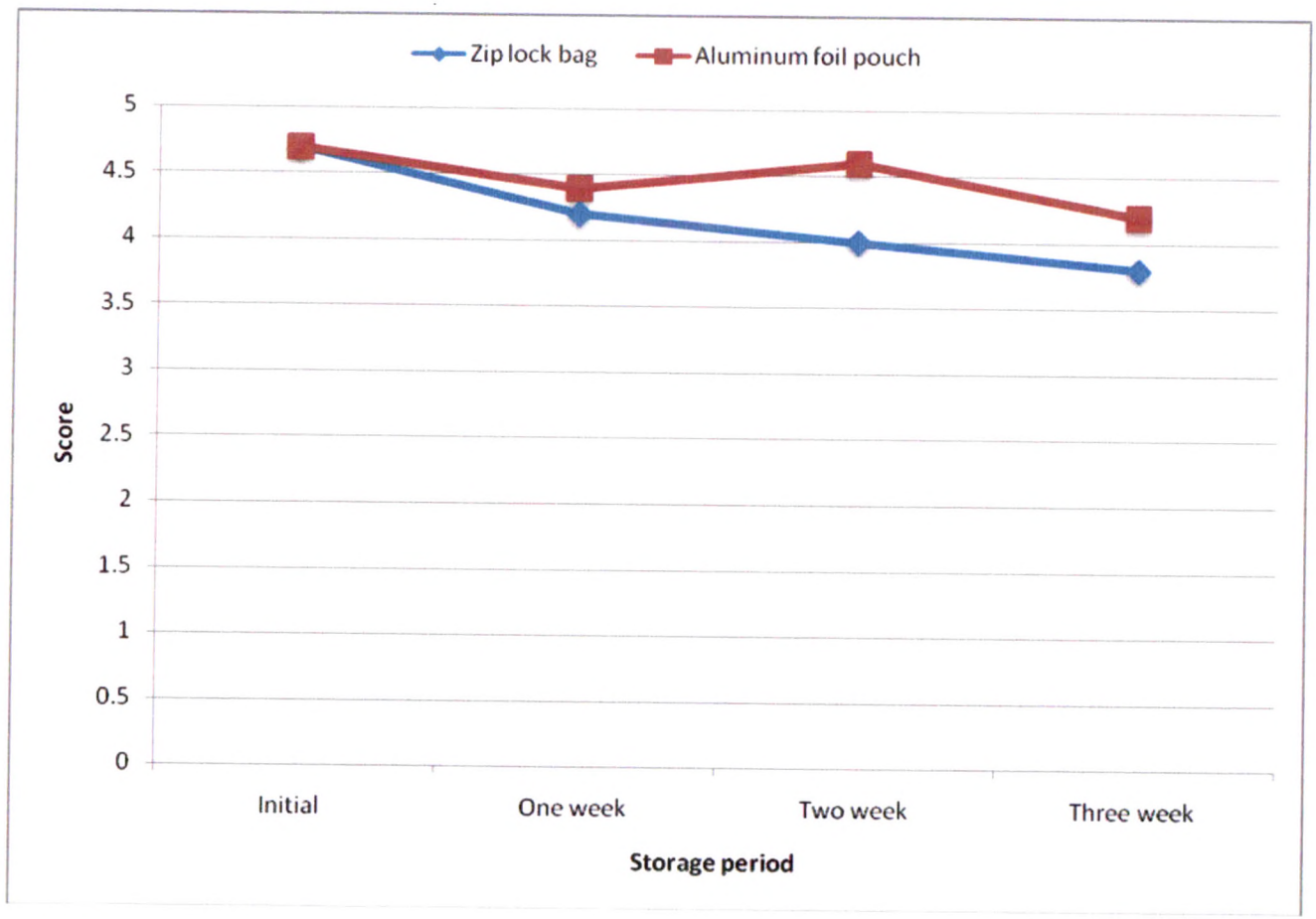


Fig. 15 Mean score for overall acceptability of *Shakkar pare* stored in zip lock bag and aluminum foil for varying periods

On the whole *dashami* stored in aluminum foil pouch had better acceptability than stored in zip lock bags.

In a study carried out by Kotagi *et al.*, 2013 revealed that increase in storage period of products the organoleptic scores significantly decreased in all attributed except for colour and appearance.

Table 19. Mean score for overall acceptability of *dashami* stored in zip lock bag and aluminum foil for varying periods

Sr. No.	Storage period	Mean score for overall acceptability for *dashami*		't' value
		Zip lock bag Mean± SD	Aluminum foil Mean± SD	
I	Initial	4.8± 0.44	4.8± 0.44	NS
II	First day	4.8± 0.44	4.8± 0.44	NS
III	Second day	4.8± 0.44	4.8± 0.44	NS
IV	Third day	4.4± 0.54	4.4± 0.54	NS
V	Fourth day	4.2± 0.44	4.4± 0.54	2.89*
VI	Fifth day	3.8± 0.44	4.0± 0.70	2.43*
VII	Sixth day	3.6± 0.54	3.9± 0.22	16.6**
VIII	Seventh day	3.0± 00	3.2± 0.44	5**

NS: Non significant

* Significant at 5 per cent

** Significant at 1 per cent

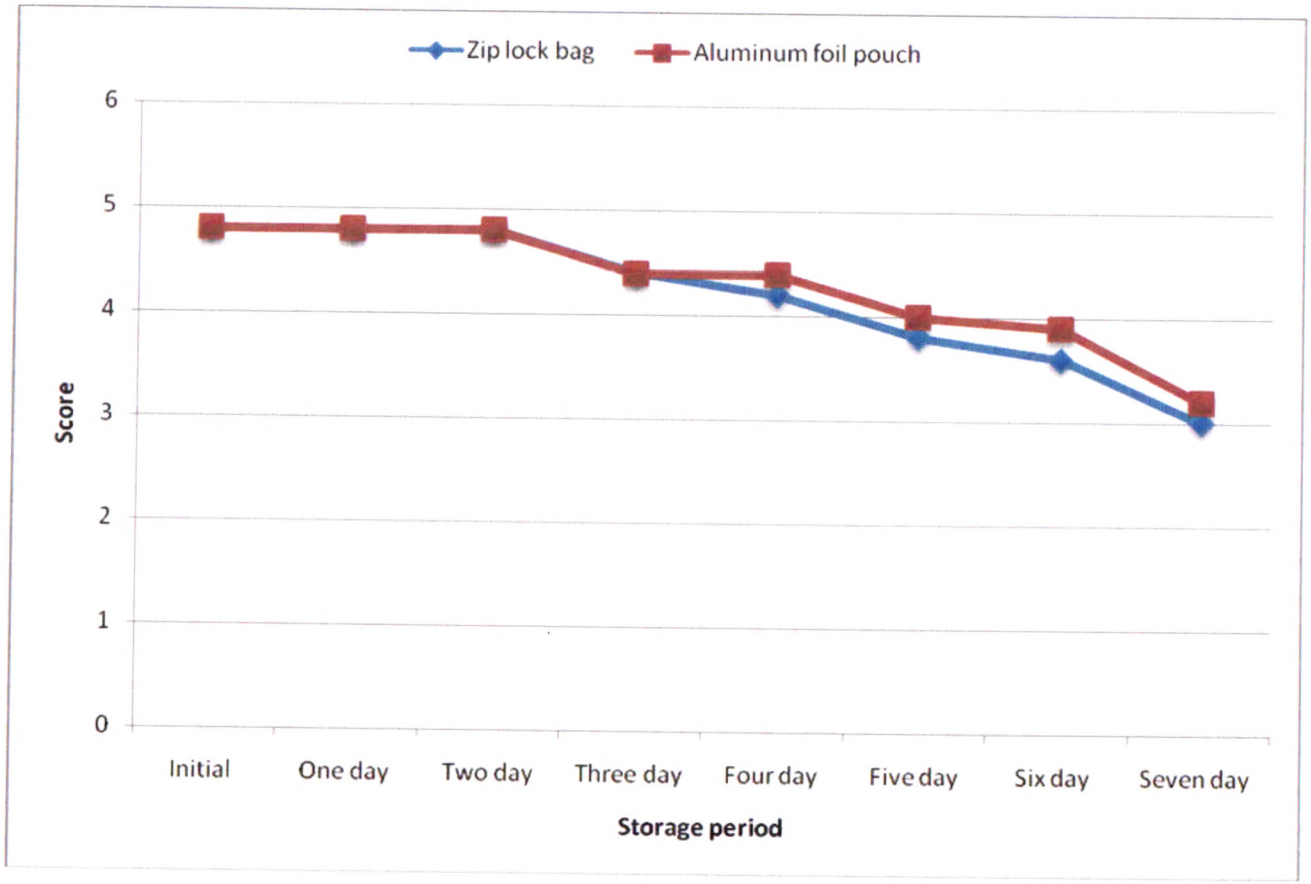


Fig. 16 Mean score for overall acceptability of *Dashami* stored in zip lock bag and aluminum foil for varying periods

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The present study was carried out to develop the value added food products with incorporation of garden cress seed for lactating women.

A survey of 100 lactating women was conducted to elicit the information regarding the general information, food habits, and form of consumption of garden cress seeds, method of storage, nutritional awareness, health benefits and storage period of garden cress seeds.

Based on information collected from survey it was imperative to develop recipes, which are suitable for lactating women. Hence, the products namely RTM (Ready to Mix) Powder, *chikki,* bars, *shakkar pare* and *dashami* were developed and stored in zip lock bag and aluminum foil pouch.

The levels of incorporation of garden cress seed in the selected products were 8, 10, 12 and 14 per cent. Four variations with selected levels of incorporation of garden cress seed (experimental samples) and basic product without garden cress seeds (control) were prepared. The prepared products were evaluated for their organoleptic quality by using five point ranking scale by the panel members. The most accepted level of incorporation of garden cress seed in the products were analyzed for their nutrient content namely protein, fat, fiber, total minerals, carbohydrate, iron and calcium. Keeping quality was also studied.

The findings indicated that a relatively very high percentage of lactating women (93%) were in the age group of 20 to less than or equal to 30 years of age and remaining were more than 30 to 40 years of age. The percentage of lactating women belonging to nuclear family was 74 per cent whereas 26 per cent were from joint family. Maximum lactating women (98%) were literate and only two per cent were illiterate.

Family income of 19 per cent respondents was less than Rs. 10,000 per month, 46 per cent were having Rs. 10,000 to 15,000 per month, 35 per cent were having monthly income Rs. 15,000 to more than 20,000 per month.

Majority of lactating women were vegetarian (56%) and 44 per cent were non-vegetarian. Among the selected respondents, 22 per cent were skipping meal. Reasons for skipping one or the other meal mentioned by lactating women were due to ignorance and busy household work.

It was found that 59 per cent were consuming garden cress seed, which was occasionally in the form of *kheer* or porridge. Only 5.08 per cent lactating women preferred garden cress seed in the form of *laddu.*

Majority (55.93%) of lactating women were storing garden cress seed for 6 months followed by 42.37 per cent for 3 months and only 1.69 per cent were storing for 9 months. Most of them (52.5%) gave preference to steel container for storing garden cress seeds, followed by plastic container.

Mean nutrient intake of lactating women was found to be below the Recommended Dietary Allowances (RDA). As per the RDA the requirement should be as energy 2920 kcal, Protein 74 g, fat 30 g, calcium 1200 mg and iron 21 mg. but their nutrient intake was as energy 1995 kcal, protein 60 gm, fat 25.33 gm, calcium 978 mg and iron 14.60 mg.

After considering, the health benefits of garden cress seed for lactating women, need was felt to develop the products with incorporation of garden cress seed for them. Five products were developed. Four variations of each product with different level of incorporation of garden cress seeds were prepared as experimental sample and without incorporation of garden cress seeds was kept as control.

RTM powder with various levels of incorporation and without incorporation of garden cress seeds (Control), when subjected to organoleptic

evaluation indicated that 14 per cent incorporation of garden cress seeds was well accepted by panel members, overall acceptability score was 4.9.

Sensory evaluation of *chikki* with and without addition of garden cress seeds indicated that *chikki* with 10 per cent incorporation of garden cress seeds obtained higher scores.

Organoleptic evaluation of bars before and after addition of garden cress seeds indicated that bars with 8 per cent addition of garden cress seeds obtained maximum values.

Shakkar pare were prepared by incorporating garden cress seeds at various levels. After sensory evaluation, it was noticed that 10 per cent of garden cress seed incorporation was the most accepted variation by judges for *shakkar pare*.

Garden cress seeds were incorporated in *dashami* from 7 to 10 per cent level. The results revealed that garden cress seeds incorporation up to 8 per cent in *dashami* was best accepted by panel members.

The nutrient analysis of developed recipes showed that addition of garden cress seeds could increase the nutrient content of the developed products.

Incorporation of garden cress seeds in RTM powder, increased in moisture, fat, fiber, iron and calcium content significantly. Protein, total mineral, content were non-significant. Carbohydrate was decreased significantly.

Chikki with addition of garden cress seed showed that significant increase in values of nutrients Viz. fat, fiber, iron, calcium. Non-significant difference was seen in moisture, protein and total mineral. Carbohydrate reduced significantly.

In the bars increase in fat, fiber, total mineral, iron and calcium content significantly whereas moisture and protein increased numerically but

not reached at the level of significance and carbohydrate content was also decreased numerically with incorporation of garden cress seeds.

Shakkar pare with addition of garden cress seed increased fat, fiber, total mineral, iron and calcium content which were statistically significant over *shakkar pare* without garden cress seeds whereas carbohydrate content decreased significantly.

Addition of garden cress seeds could elevate the nutrient content of *dashami.* Fat, fiber, total mineral, irons and calcium content was increased significantly. Moisture and protein content was non significant whereas carbohydrate content was decreased significantly.

Keeping quality of developed products was assessed by recording the scores for overall acceptability. Results indicated that scores obtained by the products stored in aluminum foil pouch was significantly higher than zip lock bags. It was also observed that as the period of storage was increased the scores for overall acceptability were decreased in both storage conditions.

Overall acceptability scores of RTM powder stored for one to three weeks in zip lock bag and aluminum foil differed significantly after second and third week of storage.

Results indicated that overall acceptability scores of *chikki* stored in aluminum foil pouch was higher than *chikki* stored in zip lock bag. It was also noticed that as the period of storage increased the overall acceptability score was decreased in both storage conditions.

The mean score of overall acceptability of bars stored in zip lock bag and aluminum foil pouch for varying periods were ranging from 4.7 to 3.8 and 4.7 to 4.2 respectively. Hence bars stored in aluminum foil pouch were found to have better keeping quality than that of kept in zip lock bags.

Maximum score (4.7) was recorded at initial stage for *shakkar pare* stored in zip lock bag and aluminum foil. While minimum score was

recorded at third week period of storage by *shakkar pare* stored in zip lock bag (3.8). On the whole high score was secured by *shakkar pare* kept in aluminum foil pouch than stored in zip lock bag.

Keeping quality of *dashami* was assessed by storing it for eight days and evaluated daily for overall acceptability. Non significant difference was noticed in *dashami* stored for initial, first, second and third day of storage in both storage conditions. Overall acceptability score of *dashami* stored in zip lock bag was decreased from fourth day; on the other hand overall acceptability score of *dashami* stored in aluminum foil pouch was decreases after fifth day onwards. On the whole high score was secured by *dashami* stored in aluminum foil pouch than that of stored in zip lock bag. Hence, *dashami* stored in aluminum foil pouch have better keeping quality than those of stored in zip lock bag.

Overall, it can be said that keeping quality of the selected products depends on the type and duration of storage. Keeping quality of the selected products was found to be decreased as the period of storage was increased.

In conclusion the findings inferred that 8 to 14 per cent level of incorporation of garden cress seeds in the selected products was most accepted level of incorporation which helped to enhance the content of fat, fiber, iron and calcium. Selected products stored in aluminum foil pouch had better keeping quality than that of stored in zip lock bag. Hence, it is suggested that all the developed food products with incorporation of garden cress seeds can be used as supplementary foods to prevent iron and calcium deficiency among lactating women. Besides this, the garden cress seeds also have specific health benefits during lactation as it helps for milk secretion.

Garden cress seeds contain 100 mg iron per 100gm. The bioavailability of iron can be increased by processing of garden cress seeds as roasting, germination and popping etc. so the various products with

incorporation of processed garden cress seeds can be made to enhance the iron content thereby helping to combat anaemia for any age group.

The high calcium content (377 mg) and high phosphorous content (723 mg) in garden cress seeds helps to reduce osteoporosis and bone problems.

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Appendix

APPENDIX-I

GENERAL INFORMATION

Interview Schedule for Evaluation of Consumption Pattern of Garden Cress Seed of Lactating women

1. Name :
2. Age :
3. Weight:
4. Height:
5. BMI:
6. Month of lactation
7. Type of Family: Joint/ Nuclear/ Extended
8. Number of Family members: Small (1-4)
   Middle (4-8)
   Large (Above 8)
9. Literacy level: Literate/ Illiterate
   Primary-
   Secondary-
   High School-
   College-
10. Monthly family income:
    Rs. < 10,000
    Rs. 10,000-< 15,000
    Rs. 15,000->20,000
11. Occupation:

APPENDIX-II

Interview Schedule to Elicit Information on Food Habits of Lactating women

12. Food habits: Vegetarian/ Non Vegetarian

13. Meal Pattern: One/ Two/ Three

14. What food items do you take in:

Sr. no.	Meal pattern	Name of the item	Quantity
a.	Breakfast		
b.	Lunch		
c.	Snacks		
d.	Dinner		

15. Do you skip any meal a day?

Yes/No

If yes, which are they and for what reason?

16. Food mostly liked/ preferred for consumption and food avoided for consumption?

_____

_____

17. Do you know about Garden Cress Seeds?

Yes/No

18. Do you consume Garden Cress Seeds?

Yes/No

19. What is frequency of consumption?

Daily

Frequently

Occasionally

20. In which form do you consume Garden Cress Seeds?

21. Which method you prefer for storing Garden Cress Seed?

Steel container
Plastic container
Aluminum box
Polythene bag

22. How long can you store Garden cress seeds?

3 months
6 months
1 year

23. Do you think that Garden cress seed is nutritionally important?

Yes / no

24. Do you incorporate garden cress seeds in any recipes?

Yes / no
If yes, which are these preparations?

25. Do you know any health benefits of Garden cress seeds?

APPENDIX III

Ranking Scale

Recipe

Name of product- Date-

Name of panel member:

variations	Color	Texture	Taste	Flavor	Over all acceptability
Basic					
I					
II					
III					
IV					

5- Excellent

4- Very good

3- Good

2- Fair

1- Poor

Signature

APPENDIX -IV

Preparation of Basic Recipes

RTM Powder

Ingredients	Amount (gm)
Italian millet	56
Cardamom	1
Sugar	20
Ghee	2
Coconut	6
Date	5
Bengal gram roasted	10

Procedure:

1. Roast Italian millet, coconut, dates and bengal gram roasted.
2. Mix sugar and cardamom and grind to fine powder.
3. Sieve and store in air tight container.

Chikki

Ingredients	**Amount (gm)**
Coconut	50
Jaggery	40
Fat	10

Procedure:

1. Grind coconut finely.

2. Heat fat and melt jaggery properly.

3. Add grinded coconut and mix well.

4. Roll it and prepare *chikkies*.

Bars

Ingredients	Amount (gm)
Refined wheat flour	120
Fat	55
Sugar	55
Baking powder	¼ tsp
Vanilla essence	Few drops
Milk	30

Procedure:

1. Shift flour and baking powder.
2. Cream fat and sugar till light and fluffy.
3. Add essence in milk.
4. Mix flour well to make pliable dough.
5. Roll out and cut even number of bars.
6. Bake at 375°F for about 15 min.

Shakkar Pare

Ingredients	Amount (gm)
Wheat flour	50
Bengal gram flour	10
Sugar	30
Fat	10

Procedure:

1. Mix wheat flour, bengal gram flour and sugar.

2. Melt fat and add to flour and make dough.

3. Keep it aside for 30 min.

4. Roll out dough and cut into small shapes and fry till golden brown colour.

Dashami

Ingredients	**Amount (gm)**
Wheat flour	40
Bengal gram flour	5
Jaggery	50
Fat	5
Milk	As required

Procedure:

1. Mix wheat flour, bengal gram flour and jaggery with enough milk.

2. Add a pinch of salt into flour.

3. Roll out into small size chapatti and roast it with applying fat.

APPENDIX - V

1. Determination of moisture content

Moisture content of the product 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 5.0 g each in weighing bottle (previously heated to $90^{O}C$ to $100^{O}C$ and cooled in a desicator). The bottles were loosely covered with lids which contain sample transferred to oven for 3 hours at $105^{O}C$. After 3 hours bottles were removed from oven, allowed to cool in desicator and weighed accurately. Then again bottles were returned to oven for 1 hour and weighed. This procedure was repeated until the constant weight was observed. Moisture content of sample was calculated by the formula

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

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

2.1.1 Catalyst mixture

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

2.1.2. 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.

2.1.3. Methyl red indicator

2.1.4. 2 per cent boric acid solution

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

2.1.5. 0.1 N sulphuric acid

A measured quantity of 27.8 ml of concentrated sulphuric acid was dissolved in distilled water and the volume was made upto 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 gm of catalyst mixture, 20 ml of concentrate sulphric 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 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 flask of 250 ml capacity were cleaned and dried in an oven to a constant weight. Then three samples in an amount of 5.0 g were accurately weighed on a filter paper 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 soxhelt 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 content

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

Procedure

Exactly 2.0 gm sample were taken in 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 fibre content

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

5.1. Preparation of reagent

5.1.1. 0.255 N sulphuric acid solution

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

5.1.2. 0.313 N sodium hydroxide solution

A weighed amount of 1.25 gm of sodium hydroxide was dissolved in glass distilled water and the volume was made upto 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 solutions 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 boiling 0.313 N sodium hydroxide was add and boiled for 30 min keeping the volume constant by using distilled water. The mixture was again filtered through a muslin cloth and residue was washed with hot water till it was made free from alkali. The residue was washed with hot water to make it free from alkali and some alcohol. Then residue was transferred to crucible which was dried in an oven overnight at $80^{O}C$ 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

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

6. Determination of CHO content (NIN, 1983)

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

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

6. Determination of calcium content

Calcium content of selected samples was estimated by EDTA method.

6.1. Preparation of Reagents

6.1.1. 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.

6.1.2. Ammonium purpurate indicator

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

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

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

Procedure for Calcium

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

The calcium content of sample was calculated by formula

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

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

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

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 reading was obtained directly in ppm.

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

Where,

R – the reading on atomic absorption Spectrophotometer

ppm = mg/1000gm

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