INTRODUCTION

Dalia is very delicious in taste and is easy to make as well. It is nutritious for children and elders, for everyone. It can be digested easily, so people prepare Dalia and serve with Moong dal or milk. If lactation is less in a new mother then milk Dalia is given to her which increases lactation. So toady we will prepare nutritious Dalia.

Dalia is a traditional food in much of Northern Europe and Russia. Dalia was a typical means of preparing cereal crops for the table. It was also commonly used as prison food for inmates in the UK prison system and so "doing porridge" became a slang term for a sentence in prison. In India, Dalia is actually the blended coarse granules of wheat and various types of pulses. In developing countries breakfast meals for both adults and infants are based on local staple diet made from cereals, legumes, roots, cassava and potatoes tubers.

Cereals are limited in essential amino acids such as lysine even though rich in Threonine and Tryptophan, while most oil seeds and legumes are rich in lysine and deficient in sulphur containing amino acids, (Many and Shadaksharaswamy, 2008). Therefore, the combination of cereals and pulses in formulation of Dalia gives a nutritious food containing all the amino acids. Wheat is a good source of thiamine and nicotinic acid, but is relatively poor in riboflavin. Wheat is consumed in India mainly in the form of traditional products. Wheat porridge, popular in many parts of northern India, is made by cooking wheat grits, known as Dalia with water or milk and adding sugar to taste. It is also consumed as a savory dish after cooking with water, vegetables and spices. The wheat grits are prepared by coarse grinding of either polished or unpolished, cleaned wheat in a plate mill to a particle size of 300-850 μm (Manohar et al. 1998).

A meal consisting of a combination of cereal-pulse mixes is found to be more effective than the only cereal diet (Bijlani, 1993). If a combination of such foods is given in the form of a meal, it is better than giving an individual food, for long-term adherence. It is a fact that the product based on either
cereals or pulses alone are nutritionally inferior. Therefore, it was thought in this study to develop a nutritious Dalia (porridge) mix with cereals and pulses combination, which has quality that is more superior.

Multi Grain Mix Nutrition Dalia is an astonishing breakfast meal, that is packed with minerals, vitamins, an amazing amount of protein, Energy, Carbohydrates and dietary fibre. Multi Grain Dalia is a whole grain product. Its key benefit lies in its nutritional value that helps in lowering cholesterol, and hence aids weight-loss. It is very delicious in taste, with a mildly sweet nut like flavor and contains a myriad of beneficial nutrients. It is nearly 15% of Proteins which contains high amount of fiber, B-Complex Vitamins including Niacin, Thiamin and Riboflavin, essential Amino Acids, Methionine, Lecithine and some Vitamin E.

Oat bran is a dietary fiber and beta-glucan enriched oat fraction that can be used in products aiming towards improved nutritional status. Oat bran is usually separated from endosperm components by sieving or classification processes. Traditional oat bran products have beta-glucan content around 8 to 12 %, whereas oat bran concentrates can have remarkably higher beta-glucan content (see attached table). For AACC definition of oat bran.

In recent years, a wide range of processed foods in ready-to-eat form has been marketed with increased interests in health foods. Consumers also now believe in health benefits or nutrition as being desirable food qualities. Breakfast cereals have potential to contribute as nutritious food because of dietary fibre and other health significant bioactive compounds in whole grains. In addition to whole grain benefits, multigrain concept can provide breakfast foods with number of benefits associated with these grains. This multigrain blends helps to mix different whole grains to maximize their nutritional, functional and sensory properties. Apart from health significance, convenience is also a recent trend in international as well as Indian food market. Conveniences products are quick and easy to prepare, thus, saves cooking time and require few cooking skills (Mandge et al. 2011). Hence, the study was undertaken with the following
Green gram contains 62.62% carbohydrate, 23.86% protein, and 16% dietary fibers (per 100g) (Wikipedia). It is free from the heaviness and tendency to flatulence. Cooked dhal of green gram is a very digestive food for invalid and sick persons. Its regular use during childhood, pregnancy and lactation helps one to get the required nutrition.

**Objectives:**

1. To formulate and develop nutritious multigrain Dalia.
2. Process Standardization- blending ratio through sensory evaluation.
3. To evaluate the nutritional characteristics of the developed multigrain Dalia.
4. Storage study on the developed multigrain Dalia in different packaging material at ambient temperature.
REVIEW OF LITERATURE

In this chapter, an attempt has been made to assimilate the previous works within the framework of present study, which were helpful in interpretation of results. The literature referred to planning and executive of present investigation and for discussion of results. The review has been presented as follows.

2.1 Nutritive value of cereals and pulses

Nagpal and Bhatia (1971) reported that the green gram proteins are mainly deficient in sulphur containing amino acids and tryptophan while better balance in their amino acid composition.

Geervani and Theophillus (1980) reported that the boiled green gram had significant improvement in biological value, digestibility coefficient, protein efficiency ratio, and net protein utilization than unprocessed green gram.

Reddy et al. (1982) revealed that food legumes are a cheaper source of plant proteins with a potential to be used as a substitute for animal proteins at a global level. The protein quality is somewhat inferior to that of animal proteins due to deficiency of two limiting amino acids, namely methionine and tryptophan as well as due to presence of certain anti nutritional factors like trypsin inhibitors, phytates, polyphenols etc. which adversely affects their nutritive value. Proteins present in pulses have been reported to interact with lipids, tannins, phytates and flavour compounds making it unavailable for nutritional purpose.

Rossi and Germondani (1984) revealed that the pulses contain 20-30% protein and about 60% carbohydrates. They are also fairly good source of thiamin, nicotinic acid, calcium, iron, copper, zinc, potassium and manganese. Total lipids were present in the range of 1-5%. The proximate composition was found to vary from species to species and variety to variety.

Salunkhe and Kadam (1989) and Reddy et al. (1980) reported that cooked pulses are the richest source of thiamine, pyridoxine and niacin. Moreover, legume grains also provide calcium and iron to our diet.
Zhoua et al. (1999) studied the oat lipids. They concluded that the oats work as a source of dietary fiber, the lipid component has both nutritional and functional potential. The oat lipids mediate the pasting properties of oat starch and hence influence functionality. Lipids are also implicated in the flavor/off-flavor attributes of oats.

Bhatty et al. (2000) reported that the per capita food intake of local population is estimated as 2618 calories per day and protein intake as 67.62 gram, which are 2.7 and 12.7 percent above the recommended dietary allowance, respectively. However, certain groups of population like children particularly below 5 years and lactating and pregnant women have high incidence of malnutrition.

Kushwah (2002) reported that pulses have high protein content value which is about twice than that in cereals and several times higher than that occurring in root tuber hence they have a great potential to improve the protein intake of meals in which cereals in combination with pulses are eaten.

Habibullah et al. (2007) revealed that two local varieties, M1 and NM-92, of mung bean were analyzed for their proximate and mineral composition using standard methods. In the proximate composition, the moisture, ash, protein, fat, fiber and carbohydrate contents of M1 were found to be 9.4%, 3.9%, 23.7%, 1.9%, 6.8% and 54.9%, respectively while in NM-92 this composition was found to be 8.3%, 3.0%, 20.8%, 2.2%, 7.1% and 58.9%, respectively. The data revealed that M1 had relatively higher values of moisture, ash and protein while NM-92 was found to be a bit superior in fat, fiber and carbohydrates content. The food energy value of M1 (340 kcal/100g) and NM-92 (347 kcal/100g) was almost equal.

Butt et al. (2008) studied the uniqueness of oat among cereals. Oat was found to be distinct among the cereals due to its multifunctional characteristics and nutritional profile. It is a good source of dietary fiber especially β-glucan, minerals and other nutrients. Oat and oat by products have been proven helpful in the treatment of diabetes and cardiovascular disorders.
Fares et al. (2008) reported that the processing and cooking increased the insoluble dietary fibers with slight decrease in soluble dietary fibers, total amylose and resistant starch content, whereas antioxidant compounds decreased.

Vardis and Trichopoulou (2009) studied that the pulses represent one of the most important food categories that have been extensively used as staple foods to cover basic protein and energy needs throughout the history of humanity. In addition to their low lipid and high dietary fibre content, emerging evidence stresses the importance of pulses as carriers of several constituents of potential biological importance, including enzyme inhibitors, lectins, phytates, oxalates, polyphenols, saponins and phytosterols.

Kaushik et al. (2010) revealed that the food legumes are widely consumed all over the world and these are good source of dietary proteins, carbohydrates and minerals. Common domestic processing techniques like soaking, germination and cooking enhance the digestibility and nutritive value of legumes.

Kumar et al. (2011) studied the nutritional contents and medicinal properties of wheat. They were concluded that wheat is good source of protein, minerals, B-group vitamins and dietary fiber i.e. an excellent health-building food. It contains carbohydrate 78.10%, protein 14.70%, fat 2.10%, minerals 2.10%, and considerable properties of vitamins (thiamin and vitamin-b) and minerals (zink, iron). The wheat germ, which was removed in the process of refining, is also rich in essential vitamin E.

### 2.2 Development, formulation and analyzed values for cereals-pulses based products.

Khalil and Chughtai (1984) reported that the supplementation increased the protein content of the wheat and maize blends by 20-61%. Significant increase in other proximate constituents as well as K, Ca, P, Fe, Zn and Cu levels and lysine were observed. A supplementation level of 20% was considered adequate to achieve the desired nutritive benefits.
Ashturkar et al. (1992) reported that four types of weaning foods viz, RGB – rajkeera: green gram: bengal gram dhal, BRB – bajra: rice flakes: bengal gram dhal, JSB – jowar: soybean: bengal gram dhal, JPB – jowar: puffed bengal gram: green gram mixes were formulated and evaluated for sensory characteristics. The weaning foods supplied 349-362 Kcal, 12.6-17.2 g of protein per 100g. among the four weaning foods RGB had the highest calcium and iron contents and the maximum per cent digestibilities of protein and carbohydrate.

Sinha and Ali (1993) reported that supplementation of wheat flour with DSF improved the shelf life of baked goods in addition to increase in protein content.

Rawat et al. (1994) reported that the chapaties prepared from whole-wheat flour and wheat flour defatted soy flour (90:10) blend were evaluated for their quality characteristics. Soy fortified chapaties contained 18.8 to 19.0% higher protein and available lysine than the whole-wheat chapaties. The former also contained higher amount of calcium, phosphorus, iron, than the latter. Soy fortified chapaties were softer than whole-wheat chapatis, but retained 13% of trypsin inhibitor activity originally present in soy flour.

Gimbi and Almazan (1997) reported that in Tanzania germinated cereal flour added to weaning foods consisting of ungerminated cereal and sometime legume reduced bulk and viscosity and increased nutrients density.

Despande and Vaidehi (1998) studied the comparative evaluation of enriched effect of full fat and defatted soy flour in 20% level on wheat and bengal gram dhal flours was conducted by studying the acceptability, nutritive value and protein quality of their best accepted products, tandoori naan and kharboondi. Soy substituted products were acceptable and more nutritious with better protein quality as compared to their regular counterparts.

Baskran et al. (1999) developed eight types of supplementary foods based on popped cereals (wheat, ragi, bajra and sorghum) blended with legumes (soya and bengal gram) and fortified with essential vitamins and minerals. Four of the supplements were prepared with cereals, soy flour and bengal gram dhal and the other four were prepared with the combinations of cereals and soy flour. Organoleptic evaluation and feeding trials revealed that the foods were well accepted by rural mothers and children.
Gujral and Sodhi (2002) concluded that wheat grits concentration had the most pronounced effect on the consistency followed by temperature and sugar concentration. Consistency coefficient increased with increasing grits and sugar concentration but decreased with increasing temperature.

Storsrud et al. (2003) studied in several oats tolerated by coeliac patients. The aim of the present study was to investigate the nutritional and symptomatic effects of including oats in the gluten-free diet, as well as the patients’ subjective experiences. Twenty adult celiac patients included large amounts of oats in their diet. Food intake, gastrointestinal symptoms, blood samples and body weight were examined and compared with examination at baseline.

Manohar et al. (2011) studied the sensory characteristics of wheat porridge with soy protein isolate and skimmed milk powder. It was found that porridge made from wheat grits (Dalia) with the addition of SPI and SMP significantly altered the rheological and sensory attribute in addition to increasing the protein content compared to that made with wheat grits alone. Porridge made from raw Dalia along with SPI and SMP had excellent sensory attributes.

Sharma and Chawla (2011a) conducted a research on development and nutrient evaluation of oat supplemented products for old aged people with constipation. The developed products were found to be organoleptically acceptable. Supplementation of products with oats increased the crude protein, crude fibre, and fat content in comparison to the normal preparations. There was also an increase in the fibre fractions of the supplemented combinations.

Sharma and Chawla (2011b) reported that The first step to treat constipation is by increasing the intake of dietary fibre. Oats can be supplemented in a normal carbohydrate meal without the loss of taste, palatability. Supplementary product samples of sweet Dalia, salty Dalia and khichdi were prepared using broken wheat and rice as control while for test samples broken wheat for both sweet and salty Dalia and rice were supplemented with oats at 20 percent, 25 percent and 30 percent levels. The control and the most acceptable level of oat supplementation in the products were analysed for proximate composition (moisture, crude protein, crude fat, crude fibre, total ash) carbohydrates and energy were calculated.
Jha et al. (2013) reported that a wheat-based, particulate containing dairy dessert is popularly consumed as a breakfast food and is also considered as a health food. The suggested formulation had 17.82 % milk solids and 2.87 % wheat solids. This formulation was found to be most appropriate for manufacture of instant Dalia pre-mix with predicted sensory scores (Max. 100) of 85.35, 41.98 and 67.27 for mouthfeel, consistency and flavor, respectively; the viscosity of the product was 941.0 cp.

Nicole et al. (2010) observed that sorghum, maize, soy and wheat could be used to produce nutritious composit flours. These flours contain 2.27 and 4.10 g/g water binding capacity, 0.69 and 0.68 g/ml bulk density.

2.3 Sensory analysis

Molteberg et al. (1996) investigated the storage stability of oat flours. They were reported that storage of raw flours for five weeks resulted in 66% free fatty acids (FFA) but stable level of flavors and volatile compounds. After 18 weeks, the level of volatiles and FFA was higher, while the sample at 42 weeks had an intense paint flavor, high level of several volatiles, and reduced level of FA and FFA.

Aboubacar et al. (1999) reported that the important sensory attributes affecting consumer acceptance of sorghum porridge in West Africa as related to quality tests. The results indicated that the most important sensory attributes that determined consumer acceptance were texture, followed by taste and aroma while appearance and colour were the least important attributes. A wide range of porridge colour was acceptable to consumers.

Sadana and Chabra (2004) conducted a research on the development and sensory evaluation of low cost weaning food formulations. They concluded that germinated and supplemented grain flour weaning food formulation were more acceptable as compared to control products prepared from ungerminated wheat flour.

Nyombaire et al. (2011) analyzed the physico-chemical and sensory quality of extruded light red kidney bean (Phaseolus vulgaris L.) porridge. They found that the sensory parameters were significantly differ as compared to the control (Rwandan tradition porridge). Increasing moisture content from 25 g/100g to 36 g/100g significantly increased average bulk density.
Bagley and Christianson (1982) studied the swelling capacity of starch and its relationship to suspension, viscosity, effect of cooking time, temperature and concentration. It was found that the viscosity increased very rapidly with concentration above 16% at the lowest temperature of 60°C. As the cooking temperature was raised to 65, 70, and 75°C, these rapid viscosity increases occurred at progressively lower concentrations.

Sanni et al. (1999) conducted a research on physico-chemical characteristics of weaning food formulated from different blends of cereal and soybean. The results showed that all the fermented blends reconstituted well in boiling water and an increased water holding capacity. There was also an increase in the values of the index of gelatinization of the blends at the end of the fermentation.

Mandge et al. (2011) studied the effect of cooking treatment on physicochemical and functional properties of instant multigrain porridge. The water absorption of grains increased significantly with increase in soaking time/temperature. Complete gelatinization of starch with no stickiness in cooked grains was obtained at 65 °C/3.5 h (soaking) followed by steaming (15 psi/15 min). It was concluded that multigrain blends can be instantized into an acceptable and nutritional, traditional breakfast food (porridge). The multigrain porridge given soaking treatment at 65 °C/3.5 h and steaming treatment for 20 min was having better physical and sensory properties.

Balasubramanian et al. (2011) studied the effect of selected dehulled legume incorporation on functional and nutritional properties of protein enriched sorghum and wheat extrudates. Sorghum extrudates incorporated with legumes showed lower water absorption index, water solubility index and pasting properties. Water absorption index and water solubility index were found to be maximum at 15% incorporation. Nutritional profile was found to be significantly higher for 15% as compared to 10% and 15% incorporation levels.

Ghavidel and Davoodi (2011) studied the processing and assessment of quality characteristics of composite baby foods. The results of analysis showed following range of constituents per 100g of formulations on dry weight
basis, protein, 18.1-18.9 g; fat, 0.78-1.36 g; iron, 5.09-6.53 mg; calcium, 265-310 mg. The lowest water absorption capacity was in case of wheat green gram based and the highest was in rice lentil based sample.

Nnam (2001) studied the Chemical, sensory and rheological properties of porridges from processed sorghum (*Sorghum bicolor*), bambara groundnut (*Vigna subterranea L.*) and sweet potato (*Ipomoea batatas*) flours. It was found that, relative to the sorghum traditional complementary food, the composite flours had higher levels of lipids, protein, ash, crude fiber and minerals (p < 0.05). The porridges from the composite flours were generally liked slightly by the panelists and were about seven times less viscous than the porridge from the traditional sorghum complementary food.

Kanu et al. (2009) conducted a research on the production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults. They were found that the formulated products contain 10-13% protein, 75-80% carbohydrate and 132.2-477.8% Kcal energy. Blended porridge was found to be rich source of potassium and calcium. They recommended that these could be used to meet specific nutritional requirements of different classes of people.

### 2.4 Storage

Heinio et al. (2002) studied the development of rancidity during long-term storage of native and processed oat. During the storage period, significant changes in the sensory profiles of the native and processed oat groats were observed. In native oat, the most intensive changes due to deterioration had already occurred after one month of storage, whereas in processed oat, these changes were perceived considerably later.

Mridula et al. (2010) was revealed that the fortified bengal gram sattu was prepared following standardized sattu making procedure and fortified as per FDA using wheat flour with thiamin, riboflavin, niacin, Ca and Fe and stored at 25°C, 65% RH and 35°C, 65% RH and at ambient condition (16-39°C, 18-98% RH) in low density polyethylene and laminated aluminum foil pouches. Alcoholic acidity increased by 0.04% in different sattu samples during 180 days storage. Free fatty acids content (as oleic acid) also
increased from 0.06% (in fresh) to 0.14%; however it did not affect sensory acceptability of sattu stored under different conditions. Protein digestibility, Ca and Fe contents in fortified sample were 80%, 170.1 mg/100g and 12.5 mg/100 g, as against 80.6%, 69.5% and 10.2 mg/100 g, in control sample respectively. Storage temperatures and packaging materials did not affect the overall quality of fortified sattu except moisture content and total microbial load during six months storage.

Head et al. (2011) studied that the storage stability of oat groats processed commercially and with superheated steam (SS) were remained shelf stable over the time periods tested without any substantial changes in colour, cold paste viscosity, and content of free fatty acids. Changes in the moisture content of stored groats reflected the seasonal changes in the humidity of the surroundings.

Khanam et al. (2011) reported that supplementary food formulations contained 20-21% protein 370-390 Kcal of energy and 2300 hg of β carotene per 100g. Sensory studies indicate that the products were acceptable with shelf life of 1 year under normal storage condition. However the formulated porridge was nutritionally better than only cereal base supplementary food formulation available commercially.

Khan et al. (2012) studied the optimization and stability of instant wheat porridge (Dalia) mix. It was found that instant porridge (Dalia) mix remained stable for 9 and 12 months respectively in polypropylene (PP) and metallised polyester (MP) pouches under ambient temperature (15-34°C) condition. Deterioration in instant porridge mix during storage was mainly caused by autoxidation of lipids, browning due to Millard reaction and development of off-flavour.
MATERIALS AND METHODS

The present investigations on “Formulation and development of multigrain Dalia” were carried out in the department of Food Science and Technology, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the year 2013-2014. The chapter therefore describes the materials and various methodologies used in the investigation.

3.1 Experimental materials

Wheat and Green gram were procured from local market, while oat was procured from the Department of Plant Breeding and Genetics, J.N.K.V.V., Jabalpur.

3.2 Preparation of Multi grain Dalia

3.2.1 Processing of selected grains

Wheat and green gram were cleaned to remove the dirt, dust and foreign matter by winnowing. The cleaned grains were then ground in vertical metallic disc grinder consisting of one stationary and one rotating discs, and sieved using sieves of different sizes to obtain coarse grits of similar size.

The oat grains were milled to remove the shells, cleaned and polished to obtained clean grains. The grains were then subjected for further grinding to obtain grits. The particle size of the grits was varied by adjusting the clearance between the plates. Fine flour was removed by sieving and particle size distribution of grits was determined by passing it through standard sieves of different mesh size (22, 25, 30, and 44).

The following table shows the different combinations for the preparation of multigrain Dalia.
Table 1: Different combinations for preparation of multigrain Dalia.

<table>
<thead>
<tr>
<th>Combinations</th>
<th>Wheat</th>
<th>Green gram</th>
<th>Oat</th>
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3.2.2 Development and standardization of multigrain Dalia

Preliminary studies were conducted to standardize the formulation for the development of the different cereal-pulses based Dalia. Multi grain Dalia was prepared from different grits of wheat, green gram and oat, using above different combination. After mixing properly they were subjected to sensory as well as nutritional evaluations.
3.2.3 Preparation of multi grain Dalia

Grains

Cleaning

Milling

Sieving

Standard size of grits

Weighing

Blending

Packaging

Polyethylene bags

Laminated pouches

Sealing

Storage

(Stored at ambient temperature 30°+/-2 °C, RH 80%)

Flow chart for preparation of multigrain Dalia
3.3 Physical and functional properties

3.3.1 Bulk Density

Wang and Kinsella (1976) A 3.0 g sample of the finely powdered (60 mesh) sample was placed in a 25ml graduated cylinder and packed gently by tapping the cylinder on a rubber sheet until a constant volume was obtained. The procedure was repeated at least three times with different samples and the average value was taken. The bulk density was expressed as g ml\(^{-1}\) of sample.

\[
\text{Bulk density (g ml}^{-1}\text{)} = \frac{\text{Weight of material (g)}}{\text{Volume of container (ml)}}
\]

3.3.2 Water absorption capacity (WAC)

WAC was determined by the method given by Sosulski et al. (1976). 1 gm of sample was put in a centrifuge tube to which 10 ml of water was added. The mixture was then allowed to stand for 10 minutes before centrifuge at 3500 rpm for 30 minutes. The water was the drained completely by inking the tube at 45° angle and then measured. Initial and final volumes are given in percentage.

3.3.3 Cooking time

Cooking time was determined by the method given by Mundra (2009). The cooking time was noted in case of dalia preparation. For this, a known quantity of Dalia was dropped in known quantity of boiling water and time to time the doneness of Dalia was noted by pressing the cooked Dalia strand between the glass slides and the time taken for disappearance of chalky spot was considered as cooking time.

3.3.4 Moisture Content

Moisture was analyzed using the MBS4 moisture analyzer at 100°C for 10 minutes.
3.4 Proximate analysis

3.4.1 Carbohydrates

Total carbohydrate in the samples was estimated by hydrolysis method as described in AOAC (1995). 2.5gm sample was taken in the flask and suspended in 200 ml of distilled water. 20ml of 3N HCl was added refluxed in an air condenser for 3hrs. On cooling, it was neutralized with alkali to pH 7.0, filtered and volume was made to 250 ml with distilled water.

The total carbohydrate in the filtrate was determined by titrating it with Fehling’s solution (A & B) using 1 ml of methyl blue indicator. Factor was worked out by titrating 1% dextrose with Fehling’s solution. In each titration Fehling’s solution in the conical flask was heated with a constant flame and titration was done with filtrate in the burette until the end point (Brick- Red color) was obtained. The total carbohydrate content was calculated as follows:

\[
\text{Factor} = \frac{\text{1g dextrose} \times \text{dextrose titration value}}{100}
\]

\[
\text{Dextrose} \% = \frac{\text{Factor} \times 250}{\text{Titrated value} \times \text{weight of sample}} \times 100
\]

Total carbohydrate (%) = Dextrose % X 0.9

3.4.2 Crude Protein

The protein content in sample was determined by using Kel-Plus digestion, distillation and titration method as given by AOAC (1995) 0.2g of sample was weighed accurately and transferred in DTL (digestion tubes large) taking care to see that the material did not stick to the neck of the tubes. The catalyst mixture of 0.3g and concentrated sulphuric acid (10ml) were added. Then the tubes were placed in an
inclined position in digestion chamber and heated till the liquid became clear (green blue color). The contents in the flasks were allowed to cool, diluted and then distilled using 40% sodium hydroxide and 4% boric acid. During distillation, ammonia was liberated from the samples and absorbed in the conical flask containing boric acid and 2-3 drops of mixed indicator changing the colour to light green. The distilled off ammonia was titrated against 0.1N sulphuric acid. The blank was also run in a similar way. Protein percentage was then calculated from the nitrogen percentage by multiplying with factor 6.25 as follows:

\[
\text{Nitrogen\%} = \frac{14.01 \times 0.1 \times (\text{TV - BV}) \times 100}{\text{Sample weight} \times 1000}
\]

Where,

- **TV** = Titrated value
- **BV** = Blank value
- 14.01 = Ammonia molecular weight
- 0.1 = Normality of Sulphuric acid for titration
- Crude protein (%) = Nitrogen\% \times 6.25

3.4.3 Ash

The ash content in the sample was estimated by burning the sample (5g) on gas burner until it was completely charred. The samples were then put in muffle furnace for combustion at 520°C for 5hrs and weighed after cooling. The heating in muffle furnace was repeated until constant weight was obtained (AOAC, 1995). Percentage ash was then calculated as follows:

\[
\text{Ash \%} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Weight of sample}} \times 100
\]

3.4.4 Crude fat

Crude fat was extracted using petroleum ether (AR grade 60-80°C) using the SOC-PLUS, Pelican make as given by AOAC (1995). 5g of sample was weighed accurately, placed in thimble and plugged
with cotton. The thimble was placed over a pre weighed soxlet beaker (A). The soxlet beakers were then fixed on the SOCS–PLUS equipment and 80ml petroleum ether added. The samples were then heated for one hour at 80°C, after which the temperature was raised to 160°C for another one hour. After extraction the thimbles were removed and excess solvent dried in Hot Air Oven at 200°C and final weight of beaker obtained. Fat was calculated as follows:

\[
\text{Crude Fat %} = \frac{\text{Final weight of beaker} - \text{Initial weight of beaker}}{\text{Weight of sample}} \times 100
\]

3.4.5 Crude fiber

The fibre content was determined by fibra plus – operational procedure for crude fiber.

- Weigh the sample accurately and note down the weights (W).
- Transfer the weighed sample into oven dried crucibles.
- Place the crucible in the metal adapter of fibra plus hot extraction unit and ensure proper sealing of crucible against the adapter rubber.

**Acid Wash**

- Pour 150 ml of 1.25 % H₂SO₄ into the extractors from the top for each sample.
- Don’t leave any place with out crucible.
- Switch on the instrument and set the initial temperature to 500 °C.
- After boiling starts, reduce the temperature to 400 °C.
- Allow the samples to boil for 45 minutes in acid.
- After 45 minutes boiling, drain the acid and wash the samples twice or thrice with distilled water.
- During draining, ensure that the knob is vacuum mode.
- If the draining is not effective due to clogging of sample in the crucible, then, keep the knob in pressure mode, press the pressure button twice or thrice and immediately turn the knob to vacuum mode.
Alkali Wash

- Pour 150 ml of 1.25 % NaOH into the extractors from the top for each sample.
- Don’t leave any place with out crucible.
- Switch on the instrument and set the initial temperature to 500 °C.
- After boiling starts, reduce the temperature to 400 °C.
- Allow the samples to boil for 45 minutes in alkali.
- After 45 minutes boiling, drain the alkali and wash the samples twice or thrice with distilled water.
- During draining, ensure that the knob is vacuum mode.
- If the draining is not effective due to clogging of sample in the crucible, then, keep the knob in pressure mode, press the pressure button twice or thrice and immediately turn the knob to vacuum mode.
- After alkali wash take out crucibles and dry them in hot air oven @ 100 °C until the crucibles are free from moisture.
- Cool down the hot crucible to room temperature using a desicator.
- Weigh the crucibles and record the reading (CWBA=W1)
- Place all the crucibles in the muffle furnace at 400 °C for ashing.
- Cool down the all hot crucibles after ashing to room temperature using a desicator.
- Now weigh the crucibles and record the readings (CWAA=W2)

CALCULATION

- Sample weight = W
- CWBA = W1
- CWAA = W2
- W3 = (W1-W2)

\[
\% \text{ of Crude Fiber} = \left( \frac{W3}{W} \right) \times 100
\]
3.4.6 Estimation of Minerals

Minerals content of dalia were obtained by calculation using table values (Gopalan et al. 1996). In this case, percentage mineral content was calculated based on the mineral content of different ingredients used in the formulation of the Dalia.

3.4.7 Energy Value:

The total energy values were calculated by using values 4, 4, and 9 for protein, carbohydrate and fat respectively as follows:

Total energy (kcal/100g) = [(% available carbohydrates X4) + (% protein X4) + (% fat X9)]

3.5 Sensory evaluation

All the combinations of Dalia were cooked respectively in boiling water at a ratio of grits to water 1:8 (w/v). The organoleptic properties of nutritious Dalia were evaluated by the panel of 10 judges based on the sensory attributes of colour and appearance, taste, flavour, mouth feel and overall acceptability. The evaluation was done on a nine point hedonic scale as described by Amerine et al. (1965).

SENSORY EVALUATION SCORE CARD

Give the rating of the food products provided on the sensory attributes based on the following ratings:

1. Like extremely 9
2. Like very much 8
3. Like moderately 7
4. Like slightly 6
5. Neither like nor dislike 5
6. Dislike slightly 4
7. Dislike moderately 3
8. Dislike very much 2
9. Dislike extremely 1
### Sensory Attributes

<table>
<thead>
<tr>
<th>Sensory Attributes</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
<th>T₆</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aroma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall acceptability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:

#### 3.6 Storage studies

The shelf-life studies of Multigrain Dalia were carried out in polyethylene and laminated pouches for a period of 3 months at ambient temperature. 250 g of best one combinations of multigrain Dalia and control samples were packed and kept at room temperature for 90 days. Both samples were drawn periodically after 0, 30, 60, 90, days and analyzed moisture and overall acceptability according to the standard procedures as described earlier in the chapter.

#### 3.7 Statistical analysis

The results/data of the analysis for different parameters were analyzed statistically to assess the degree of variation within the treatments as compared to the control. The data were subject to analysis of variance (ANOVA) and least significance difference to determine the difference between means, analyzed by Genstat computer package using Completely Randomized Design (CRD) at 5% level of significant.
The skeleton of analysis of variance

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Source of variance</th>
<th>d.f.</th>
<th>SS</th>
<th>MSS</th>
<th>F calculated</th>
<th>F table value (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Treatments</td>
<td>(t-1)</td>
<td>TSS</td>
<td>TMS</td>
<td>TMS/EMS</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Error</td>
<td>(n-t)</td>
<td>ESS</td>
<td>EMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>(n-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where,

\[ t = \text{Number of treatments} \]
\[ n = \text{Number of observations} \]
\[ \text{d.f.} = \text{Degree of freedom} \]
\[ \text{T.S.S.} = \text{Treatment sum of square} \]
\[ \text{E.S.S.} = \text{Error sum of square} \]
\[ \text{T.M.S.} = \text{treatment mean sum of square} \]
\[ \text{E.M.S.} = \text{Error mean sum of square} \]

\[ \text{C.V.} = \sqrt{\frac{\text{EMS}}{\text{GM}}} \times 100 \]

\[ \text{SE}(d) = \sqrt{\frac{2\times\text{EMS}}{r}} \]

\[ \text{C.D.} = t_{(0.05)} \times \text{SE}(d) \]

Where,

\[ \text{C.V.} = \text{Coefficient of variation} \]
\[ \text{S.E.}(d) = \text{Standard error of difference} \]
\[ \text{G.M.} = \text{Grand mean} \]
\[ \text{C.D.} = \text{Critical difference} \]
\[ t_{(0.05)} = \text{t-value at 5% probability level} \]
RESULTS

The present investigations were carried out in the Department of Food science and Technology for the Formulation and development of multigrain Dalia and its quality evaluation. The results obtained during the course of investigation have been described in this chapter in the form of tables.

4.1 Qualitative and Physical properties of grains

Following contents available in the grains, which are using to developed the multigrain Dalia.

Table 1. Qualitative attributes of grains

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Types of Grain</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Carbohydrate (%)</th>
<th>Fiber (%)</th>
<th>EV(Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wheat</td>
<td>12.50</td>
<td>1.9</td>
<td>1.8</td>
<td>70.00</td>
<td>0.26</td>
<td>347.10</td>
</tr>
<tr>
<td>2.</td>
<td>Oat</td>
<td>12.10</td>
<td>5.1</td>
<td>3.4</td>
<td>61.40</td>
<td>10.7</td>
<td>339.90</td>
</tr>
<tr>
<td>3.</td>
<td>Green gram</td>
<td>23.86</td>
<td>1.9</td>
<td>3.9</td>
<td>65.62</td>
<td>16.0</td>
<td>375.02</td>
</tr>
</tbody>
</table>

Table 2. Physical properties of grain

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Treatments</th>
<th>Bulk density (g/ml)</th>
<th>Water absorption capacity (%)</th>
<th>Cooking time (minute)</th>
<th>MC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wheat</td>
<td>0.72</td>
<td>250.01</td>
<td>15.37</td>
<td>11.00</td>
</tr>
<tr>
<td>2.</td>
<td>Oat</td>
<td>0.54</td>
<td>350.00</td>
<td>14.52</td>
<td>10.48</td>
</tr>
<tr>
<td>3.</td>
<td>Green gram</td>
<td>0.85</td>
<td>278.87</td>
<td>11.42</td>
<td>9.4</td>
</tr>
</tbody>
</table>
4.2 Physical and functional attributes of multigrain Dalia

The results of the physical and functional characteristics of multigrain Dalia i.e. bulk density, water absorption capacity and cooking time as compared to control are given in table 3 and also comparisons are shown by the figure 3 and 3.1.

4.2.1 Physical and functional characteristics of multigrain Dalia

The results of physical and functional attributes of multigrain Dalia as compared to control Dalia are given in table 3 and figure 3.

Table 3. Physical and functional attributes of multigrain Dalia

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Bulk density (g/ml)</th>
<th>Water absorption capacity (%)</th>
<th>Cooking time (minute)</th>
<th>MC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0.72</td>
<td>250.75</td>
<td>15.43</td>
<td>11.00</td>
</tr>
<tr>
<td>T2</td>
<td>0.74</td>
<td>254.50</td>
<td>16.25</td>
<td>10.60</td>
</tr>
<tr>
<td>T3</td>
<td>0.67</td>
<td>270.14</td>
<td>14.48</td>
<td>10.59</td>
</tr>
<tr>
<td>T4</td>
<td>0.71</td>
<td>268.02</td>
<td>15.17</td>
<td>9.79</td>
</tr>
<tr>
<td>T5</td>
<td>0.72</td>
<td>268.42</td>
<td>16.21</td>
<td>10.75</td>
</tr>
<tr>
<td>T6</td>
<td>0.69</td>
<td>284.19</td>
<td>14.54</td>
<td>10.96</td>
</tr>
<tr>
<td>SEM ±</td>
<td>0.02</td>
<td>3.35</td>
<td>0.87</td>
<td>0.38</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.04</td>
<td>9.77</td>
<td>2.52</td>
<td>1.10</td>
</tr>
</tbody>
</table>

MC= Moisture content

**Bulk density**

The bulk density of multigrain Dalia ranged from 0.67 to 0.74 g/ml against control T1 at 0.72 g/ml. Treatment T2 scoring highest value at 0.74 followed by T1 (0.72), T5 (0.72), T4 (0.71), T6 (0.69) and T3 (0.67). It is clear from the results that bulk density was increased with supplementation of pulses grits. All the treatments were at par with Treatment (T2) of multigrain Dalia. There were no significant differences between the treatments.
Water absorption capacity

As evident from the table 3 multigrain Dalia was found to contain moisture 284.19,270.14,268.42,268.02,254.50 and 250.75 for T6,T3,T5,T4,T2 and T1 respectively. The highest value was recorded at 284.19% for T6 multigrain Dalia, which was significantly superior than others whereas minimum water absorption capacity was recorded in T1 (250.75). It is clear from the results that the Water absorption capacity was induced as blending with different ratio of pulses grits. Treatments T4 and T5 were at par with each other.

Cooking time

The cooking time analyzed for Dalia based on wheat showed a positive trend and it is greatly increased with the addition of pulses grits. T2 got the highest value at 16.21 min. against control wheat Dalia scoring value at 15.43. Treatments T2, T5, T4, T1, T6 and T3 scored 16.25,16.21,15.43,15.17,14.54 and 14.48 respectively. T2, T5 and T3,T6 were at par with each other. Supplementation of green gram were increased the cooking time of multigrain Dalia.

Moisture

As evident from the table 3 multigrain Dalia was found to contain moisture 11.00,10.96,10.75,10.60,10.59 and 9.79 for T1,T6,T5,T2,T3 and T4 respectively. The highest value was recorded at 11.00% for control wheat Dalia T1, whereas minimum moisture content was recorded in T4 (9.79). It is cleared from the results that the moisture content was reduced as amount of wheat grits blending with different ratio of pulses grits.

4.2.2 Qualitative attributes of multigrain Dalia

The proximate analysis for nutritious Dalia based on wheat with soy, green gram, and horse gram grits in different ratios are given in table 4 and figure 4 and 4.1.
Table 4. Qualitative attributes of multigrain Dalia

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Carbohydrate (%)</th>
<th>Fiber (%)</th>
<th>EV (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>12.85</td>
<td>1.78</td>
<td>1.70</td>
<td>70.18</td>
<td>3.38</td>
<td>349.90</td>
</tr>
<tr>
<td>T2</td>
<td>13.57</td>
<td>2.36</td>
<td>2.22</td>
<td>68.19</td>
<td>2.44</td>
<td>350.59</td>
</tr>
<tr>
<td>T3</td>
<td>10.64</td>
<td>2.06</td>
<td>2.58</td>
<td>66.82</td>
<td>3.30</td>
<td>328.28</td>
</tr>
<tr>
<td>T4</td>
<td>11.73</td>
<td>1.52</td>
<td>2.19</td>
<td>68.08</td>
<td>4.38</td>
<td>343.08</td>
</tr>
<tr>
<td>T5</td>
<td>15.79</td>
<td>2.45</td>
<td>2.60</td>
<td>66.81</td>
<td>3.12</td>
<td>332.04</td>
</tr>
<tr>
<td>T6</td>
<td>13.17</td>
<td>4.06</td>
<td>2.44</td>
<td>65.65</td>
<td>3.58</td>
<td>354.63</td>
</tr>
<tr>
<td>SEM ±</td>
<td>0.77</td>
<td>0.26</td>
<td>0.20</td>
<td>1.46</td>
<td>0.33</td>
<td>10.85</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>2.25</td>
<td>0.76</td>
<td>0.59</td>
<td>4.25</td>
<td>0.95</td>
<td>31.61</td>
</tr>
</tbody>
</table>

**Protein**

It is cleared from the table 4 that the protein content in multigrain Dalia was found 12.85, 13.57, 10.64, 11.73, 15.79 and 13.17 % for T1 to T6 respectively. The highest percentage was obtained from T5, followed by T2, T6, T1, T4, T3, while T3 exhibited lowest protein content. It is clear that the addition of pulses grits the protein content increased significantly and 30% green gram supplementation was significantly superior to other formulated multigrain Dalia. Multigrain Dalia T2 and T6 were statistically at par with each other.

**Fat**

The fat content of multigrain Dalia increased significantly on blending with 30% oat grits but decreasing when blended with 15% green gram, while it is greatly increasing in blending ratio 50:20:30. The lowest value (1.52) obtained by T4 followed by T1(1.78), T2(2.36), T3(2.06), T5(2.45) and T6(4.06). 30% oat supplementation was significantly superior to other formulated multigrain Dalia. Multigrain Dalia T3 and T5 were statistically at par with each other.
Ash

The results also showed an increase in ash content with in Dalia supplemented with pulses though the difference was significant. The recorded values for ash were 1.70, 2.22, 2.58, 2.19, 2.60 and 2.44 within the combinations T₁ to T₆ respectively. T₂, T₄, and T₃, T₅ were statistically at par with each other. Maximum ash content was found in T₅ and T₃ whereas T₁ obtained minimum value at 1.70.

Carbohydrate

It can be seen from the results that carbohydrate values were lower in all cereal-pulses combinations as compared to control (T₁) Dalia. The highest carbohydrate value (70.18) was exhibited by control Dalia, which was reduced to 68.19, 66.82, 68.08, 66.81 and 65.65 within the treatments T₂ to T₆. Multigrain Dalia T₆ got the lowest value (65.65). T₃ and T₅ were statistically at par with each other. It can be seen from the results supplementation of pulses decreased the carbohydrate content in multigrain Dalia. Control wheat Dalia were significantly superior than other formulated Dalia.

Fiber

In terms of fibre, Dalia made from the combination of T₄,( wheat + green gram + oat) with the combination of (70:15:15 ) gave the highest value of 4.38% against Treatment T₁ had got lowest value at 2.44. The recorded values for fibre were 3.38, 2.44, 3.30, 4.38, 3.12 and 3.58 for T₁ to T₆ respectively. Wheat,Green gram and Oat supplemented (70:15:15) multigrain Dalia was significantly superior than other formulated Dalia. Incorporation of pulses gradually increased the fibers content in all multigrain Dalia.

Energy value

It is cleared from the results that the energy values did not follow a consistent pattern; it increased with 30% oat supplementation but decreased with 30% green gram. The highest energy value (354.63Kcal) was obtained from T₆ followed by T₂ (350.59), T₁ (349.90), T₄ (343.08), T₅ (332.04) and T₃ (328.28 Kcal) against control (349.90 Kcal). T₁ and T₂ multigrain Dalia were par at with each other. T₆ formulated multigrain Dalia was significantly superior than other formulated Dalia.
4.2.3 Organoleptic properties of multigrain Dalia

Different types of blend Dalia were developed from cereals and pulses grits and subjected to sensory taste on 9 point hedonic scale. From the sensory mean scores and the comments of the panelists, best combinations were selected T₅ (wheat+ green gram+ oat), T₄ (wheat+ green gram+ oat) and T₆ (wheat+ green gram+ oat) at the ratio of 60:30:10,70:15:15 and 50:20:10:30 respectively.

Table 5. Organoleptic properties of multigrain Dalia

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Appearance &amp; colour</th>
<th>Aroma</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall acceptability</th>
<th>Average Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>7.01</td>
<td>7.0</td>
<td>7.12</td>
<td>7.05</td>
<td>7.18</td>
<td>7.07</td>
</tr>
<tr>
<td>T₂</td>
<td>7.38</td>
<td>6.85</td>
<td>7.25</td>
<td>6.90</td>
<td>7.03</td>
<td>7.08</td>
</tr>
<tr>
<td>T₃</td>
<td>7.56</td>
<td>6.89</td>
<td>7.78</td>
<td>6.65</td>
<td>7.84</td>
<td>7.34</td>
</tr>
<tr>
<td>T₄</td>
<td>8.39</td>
<td>7.87</td>
<td>7.79</td>
<td>7.91</td>
<td>7.93</td>
<td>7.97</td>
</tr>
<tr>
<td>T₅</td>
<td>8.90</td>
<td>7.87</td>
<td>7.96</td>
<td>8.87</td>
<td>8.59</td>
<td>8.43</td>
</tr>
<tr>
<td>T₆</td>
<td>7.49</td>
<td>6.58</td>
<td>7.86</td>
<td>7.13</td>
<td>7.95</td>
<td>7.40</td>
</tr>
</tbody>
</table>

Appearance and colour

Maximum colour and appearance score (8.90) was found in T₅ (wheat + green gram + oat) at the ratio of (60:30:10) whereas minimum (6.65) was found in T₃ (wheat+oat) at the ratio 80:20. The data revealed that decreased the ratio of oat grits from decreased the mean scores for colour and appearance of multi grain Dalia. T₃ and T₅ multigrain Dalia were statistically at par with each other.

Aroma

The mean scores for flavour of the Dalia was statistically at par for T₂ and T₆ at 6.85 and 6.58 respectively. The T₆ combination was found to be scored lowest (6.58) while the highest score (8.87) was obtained in T₅ and T₄ respectively.
Taste

The data depicts in Table 5 revealed that, the mean scores for taste ranged from 7.12 to 7.96. The mean scores for taste of multigrain Dalia were above the acceptable limit with the lowest score (7.12) obtained from $T_1$ multigrain Dalia against the highest score (7.96) in $T_5$ multigrain Dalia. The control wheat Dalia had got means score value 7.07 it was at par with $T_4$ (7.97) and $T_5$ (8.43). Supplementation of green gram increased the mean scores for taste of multigrain Dalia.

Texture

An appraisal of table 5 showed that, the treatment $T_5$ got the highest value 8.87 against T3 at 6.65. the treatment $T_3$ got the lower value (6.65), and $T_5$ got highest value (8.87). and the treatment $T_3,T_2,T_1,T_6,T_4$, and $T_5$ rated 6.65,6.90,7.05,7.13,7.91 and 8.87 in assending order respectively.

Overall acceptability

All the Dalia were acceptable and combination $T_5$ (wheat 60%+green gram 30%+oat 10%) was superior than others with the highest value at 8.59. Control Dalia with the score (7.18) was got 5th rank and Treatment T2 scored lowest value at 7.03.

Mineral analysis

The different pulses grits had different effects on the mineral content of the multigrain Dalia as compared to control. The calculated results for the mineral content of the multigrain Dalia based on table values as compared to control Dalia are given in the table 6.

Table 6. Mineral content of multigrain Dalia

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Minerals mg/100g Dalia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calcium</td>
</tr>
<tr>
<td>$T_1$</td>
<td>41.0</td>
</tr>
<tr>
<td>$T_2$</td>
<td>76.0</td>
</tr>
<tr>
<td>$T_3$</td>
<td>42.8</td>
</tr>
<tr>
<td>$T_4$</td>
<td>68.6</td>
</tr>
<tr>
<td>$T_5$</td>
<td>94.0</td>
</tr>
<tr>
<td>$T_6$</td>
<td>78.7</td>
</tr>
</tbody>
</table>
Calcium

The values presented in Table 5 showed that calcium content ranged from 41.00 to 94.0 mg/100g in the different kinds of multigrain Dalia. The highest calcium content was recorded in T\textsubscript{5} (94.00 mg/100g) and lowest in T\textsubscript{4} (68.60 mg/100g). It is obvious from the results that calcium content was increased in all the multigrain Dalia as compared to control Dalia. The supplementation of 30% green gram gram increased the calcium content in multigrain Dalia.

Phosphorus

In appraisal of the table showed that, the phosphorous content in multigrain Dalia varied from 306mg/100g to 333.80mg/100gm. The highest phosphorus content was observed in T\textsubscript{5} (333.80mg/100g) and lowest in T\textsubscript{1} 306.00 mg/100g. The addition of pulses grits showed a remarkable increase in phosphorus content. T\textsubscript{2} and T\textsubscript{3} multigrain Dalia were statistically at par with each other.

Iron

A perusal of table 5 showed that the iron content varied from 5.30 to 6.92 mg/100g. The highest amount was recorded in T\textsubscript{5} (6.92 mg/100g) and lowest in T\textsubscript{3} (5.00 mg/100g). The supplementation of pulses grits in different ratio increased the iron content of the multigrain Dalia.

4.3 Shelf life of the multigrain Dalia

4.3.1 Effect of storability on the overall acceptability of multigrain Dalia

Mean scores value of overall acceptability of cooked multigrain Dalia presented in table 6 and fig 7 and 7.1. The maximum score (8.43) of overall acceptability of cooked multigrain Dalia was recorded in T\textsubscript{5} (wheat 60%+Green gram 30%+oat 10%) at initial stage of storage in both the packaging materials. Minimum score (6.93) was found in control wheat Dalia after 90 days of storage in polyethylene bags. From the table evident of results it has been showed that overall acceptability of supplemented multigrain Dalia were decreased with increase the storage period but packaging materials did not affect reasonably to overall acceptability of multigrain Dalia.
Table 7. Effect of storability on the acceptability of packed multigrain Dalia.

<table>
<thead>
<tr>
<th>Packaging material</th>
<th>Treatments</th>
<th>Period of storage (Days)</th>
<th>Average Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Polyethylene bags</td>
<td>T₁</td>
<td>7.07</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>T₅</td>
<td>8.43</td>
<td>8.41</td>
</tr>
<tr>
<td>Laminated pouches</td>
<td>T₁</td>
<td>7.07</td>
<td>7.07</td>
</tr>
<tr>
<td></td>
<td>T₅</td>
<td>8.43</td>
<td>8.42</td>
</tr>
</tbody>
</table>

4.4.1 Effect of storability on the moisture content of multigrain Dalia

The results were observed to be the same as all of the formulations were subjected to the polyethylene bags and laminated pouches during storage. The highest mean scores 11.74 and 11.56 were observed from control wheat Dalia in polyethylene bags and laminated pouches respectively while the lowest mean scores 10.67 and 10.63 were observed from T₅ multigrain Dalia in polyethylene bags and laminated pouches respectively. The results in table 7 and figure 8 and 8.1 showed that both packaging material did not affect reasonably to moisture content of stored multigrain Dalia during storage.

Table 8. Changes in moisture content of multigrain Dalia in following packaging (pouches) during storage.

<table>
<thead>
<tr>
<th>Packaging material</th>
<th>Treatment s</th>
<th>Period of storage (Days)</th>
<th>Average Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Polyethylene bags</td>
<td>T₁</td>
<td>11.00</td>
<td>11.09</td>
</tr>
<tr>
<td></td>
<td>T₅</td>
<td>10.57</td>
<td>10.63</td>
</tr>
<tr>
<td>Laminated pouches</td>
<td>T₁</td>
<td>11</td>
<td>11.04</td>
</tr>
<tr>
<td></td>
<td>T₅</td>
<td>10.57</td>
<td>10.59</td>
</tr>
</tbody>
</table>
DISCUSSION

This chapter deals with the justification of the experimental findings under taken in the proposed research programme. The results have been explained with the help of reported values of various parameters given by different workers. The results have already been given in detail in the preceding chapter.

5.1 Physical and functional attributes of multigrain Dalia

5.1.1 Bulk Density

The data presented in table revealed that maximum bulk density was recorded in T2 formulated multigrain Dalia whereas minimum bulk density was found in T6 supplemented multigrain Dalia. It was found that supplementation decreased the rate of bulk density of multigrain Dalia T2 (Wheat + Green gram,80:20) Dalia obtained the highest value for bulk density. Similar trend has been found by Akubor and Badifu (2004), in wheat flour.

5.1.2 Water binding capacity

Water binding capacity plays an important role during reconstitution into the blend before consumption. Water binding capacity depends on the availability of hydrophilic groups that bind water molecules and on the gel forming capacity of macromolecules. It is evident from the tables and figures that maximum WBC was found in T6 formulated multigrain Dalia, whereas minimum was found in T1 multigrain Dalia. Supplementation of pulses in the cereals, This might be due to higher amylose or amylopectin ratio presented in multigrain Dalia. These findings have been supported by FAO (1968 and) Kushwah (2002).

5.1.3 Cooking time

From the table we found that the maximum cooking time was in T2 whereas minimum-cooking time was observed in T3. T2 sample had higher cooking time may be due to hardness and high fibre content of formulated Dalia. A similar finding was reported by Mundra (2009) in cooking quality of noodles and dhalia.
5.2 Proximate attributes

5.2.1 Moisture

The maximum moisture content was found in control Dalia (T₁), whereas minimum was found in T₄ formulated multigrain Dalia moisture content decreased with formulation of various pulses grits. The moisture content may be low due to high fibre content. Similar findings have been supported by Sharma and Chawala (2011) in oat-supplemented products.

5.2.2 Protein

Protein content increased with incorporation of legumes grits. Table showed that maximum protein content was found in T₅ formulated multigrain Dalia, whereas minimum was found in T₃ multigrain Dalia. Different combination of multigrain Dalia supplemented with 30% Greeengram grits were significantly superior than other formulated multigrain Dalia. This could be due to the supplementation with the pulses grits. Similar findings have been observed by Vardis and Trichopoulou et al. (2009).

5.2.3 Fat

The fat content of control wheat Dalia increased gradually among pulses supplemented multigrain Dalia. However, a significant increase was observed in oat supplemented multigrain Dalia at the 30% level in T₆. This might be due to supplementation or fat rich grit of oat. These results are close agreement with Curley (2008) in oat porridge.

5.2.4 Ash

The ash content of control Dalia was minimum and it is not remained almost the same in various multigrain Dalia at all levels while control wheat dalai and T₅ multigrain Dalia were significantly different from other multigrain Dalia. This might be due to supplementation of green gram grits in multigrain Dalia. Similar findings have been supported by Sharma and Chawala (2011) in oat porridge.
5.2.5 Carbohydrate

The data showed that carbohydrate content was increased with formulation of high carbohydrate content grain grits in various multigrain Dalia. Maximum carbohydrate content was found in various control Dalia whereas minimum was found in T₆ multigrain Dalia. Results showed that carbohydrate content was significantly differ in all multigrain Dalia. Content was decreased with supplementation of pulses in all multigrain Dalia. This might be due to the high carbohydrate content of the formulations is attributed the high carbohydrate content. Similar findings have been supported by Mahgoub (1999) in weaning food formulation.

5.2.6 Fiber

The table showed that the fibre content was increased with increasing the ratio of supplementation of oat and grits in multigrain Dalia. Maximum fibre content was found in T₄ whereas minimum was found in T₂. These findings might be due to incorporation of oat and green gram, which are rich source of fibre. Similar findings have been supported Edema et al. (2005) in porridge supplemented with soy.

5.2.7 Energy Value

Energy value was observed to be high for all formulated multigrain Dalia. Maximum percentage was found in T₆ formulated multigrain Dalia, whereas minimum was found in T₃. Data showed that incorporation of green gram, oat and wheat grits enhance the energy value of formulated multigrain Dalia. This might be due to supplementation of protein, fat and carbohydrate rich grits. Similar findings have been supported by Mahgoub (1999) and Kulkarni et al. (1991) in weaning food formulation.

5.2.8 Minerals

It is obvious from the tables that incorporation of multigrain grits had different effect on the minerals content of supplement multigrain Dalia as compared to without supplemented multigrain Dalia.
Calcium

Calcium content of multigrain Dalia was observed in table. Highest calcium content was found in T5 whereas minimum was found in control multigrain Dalia. Data showed that the supplementation of green gram and oat grits increased the calcium content in all multigrain Dalia. This might be due to rich source of calcium in those grits. Similar findings have been reported by Kanu et al. (2009) in cereal-based porridge mixed.

Phosphorus

The data presented in table revealed that maximum phosphorus content was noted in T1 formulated multigrain Dalia whereas minimum was found in control multigrain Dalia. As evident from table that phosphorus content increased with the supplementation of oat grits in all multigrain Dalia. Similar findings have been found by Nicole et al. (2010) in ready to eat composite porridge flours.

Iron

Maximum iron content was found in T5 whereas minimum was found in oat (at 30%) supplemented multigrain Dalia. Supplementation of green gram grits had increased the iron content in multigrain Dalia. This might be due to the incorporation of rich source of iron content grits. Similar findings have been obtained by Camire (2002) in blended weaning foods. Thus addition of oat and Green gram grits could recommended for nutritional improvement of the multigrain Dalia especially from minerals point of view.

5.3 Storage study

The storage of the best multigrain Dalia was selected from three base Dalia. Dalia were packed in polyethylene bags and laminated bags kept at regular intervals for 0, 1, 2 and 3 months at ambient condition.

Moisture content

The tables showed that the moisture content slightly increased with increasing the storage period in all formulated multigrain Dalia in both type of packaging materials. Maximum moisture content was found in control T1
sample in polyethylene packaging material after 90 days of storage, whereas minimum was found in T$_5$ formulated multigrain Dalia in both type of packaging materials at initial stage of storage and moisture content increased with increases the storage time. It can be attributed to greater protection against water vapour, though polyethylene bags seem to be comparatively more permeable to water vapour. A similar finding was reported by Khan et al. (2012) in instant wheat porridge.

**Overall acceptability**

The overall acceptability of multigrain Dalia was significantly affected by different processing variables and declined with increase of storage period. The highest mean scores for overall acceptability of multigrain Dalia was found in T$_5$ formulated multigrain Dalia in both packaging material at initial stage of storage. The minimum mean score value was recorded in T$_1$ multigrain Dalia in polyethylene bags after 90 days of storage. The overall acceptability of formulated multigrain Dalia stored in laminated bags had better results as compared to polyethylene bags. The higher values in polyethylene bags might be due to high moisture absorption and permeability of atmospheric gases involved in reduction of colour and flavour. These findings in agreement with the results of Khanam et al. (2011) in supplementation of food formulation.
SUMMARY, CONCLUSION AND SUGGESTION FOR FURTHER WORK

6.1. Summary

Multigrain Dalia is a rich source of protein, fibers and highly energetic food product consumed and liked by everyone whether a child an old age person who require more protein and energy. Therefore the present study was made on development of multigrain Dalia at home scale level using cereals and pulses. The obtained results on various parameters like overall acceptability and nutritional attributes during various storage periods have been made and summarized in the following points.

- Multigrain Dalia T5 (Wheat+ Green gram+Oat) at the ratio of 60:30:10 was the best formulated multigrain Dalia, rich in nutrients and had excellent overall acceptability.

- Greengram blended multigrain Dalia had higher amount of protein as compared to other formulated multigrain Dalia.

- Fortification of 30% Green gram + 10% Oat grits in wheat based formulated multigrain Dalia could be recommended to increase and improve the biological value of protein and other nutrients such as calcium and phosphorus.

- In case of nutrients in T5 multigrain Dalia) at the ratio of 60:30:10 more nutritious as compared to other formulated Dalia.

- During storage laminated bag was found to be good as compared polyethylene bags for maintaining the good quality products under the period of 90 days.

- The formulation with 30% Greengram T1 had more nutritious value than other formulated multigrain Dalia.

- Shelf life of the T5 formulated multigrain Dalia (wheat+ greengram+oat, ratio 60:30:10) was found to be best in both the packaging materils for the period of the three months at ambient temperature.
6.2. Conclusion

On the basis of findings it was concluded that Greengram and oat blended multigrain Dalia could be consider the best from both nutritional and sensory point of view. The multigrain Dalia at the ratio of 60:30:10 with wheat+Greengram+oat was good in terms of protein and minerals. Supplementation of oat grits increased the amount of calcium, phosphorus, iron, fibers and calorific value in multigrain Dalia. It could be stored in laminated bags for 90 days at ambient temperature without any nutritional losses. Hence it was concluded that low cost high protein energy multigrain Dalia could be developed. Efforts should also be made to suggestion for transfer this technique to house hold women for cottage level. Multigrain Dalia help to alleviate the protein malnutrition problem in India.

6.3. Suggestions for further work

The consumption of Dalia incorporated with cereals and pulses grits should be encouraged as they are beneficial for improving the nutritional and health status of the general population.

- Techno-economic feasibility of multigrain Dalia should be evaluated.
- Assessed for micronutrient availability, dietary fiber content, invitro starch digestibility, invitro protein as well as carbohydrate digestibility should be studied.
- Biological evaluation of formulated multigrain Dalia by animal experiment should be done.
- To identify the various microorganisms during storage and packaging studies should be carried out for longer periods.
- Further use various types of packaging material to the inhance self life of multigrain Dalia.
- Improved cultivars must be select to increase the nutritional value of multigrain Dalia.
REFERENCES


Khan, MA, Semwal AD, Sharma, GK and Bawa AS. 2012. Studies on the optimization and stability of instant wheat porridge (Dalia) mix Food Science and Technology online first.


Bhatty N, Gilani AH and Nagra SA. 2000. Nutritional value of mung bean (Vigna radiata) as effected by cooking and supplementation Department of Rural Home Economics, University of Agriculture, Faisalabad, Pakistan, and Institute of Chemistry, University of the Punjab Lahore Pakistan.


http://www.mp.gov.in/mfoilfed/agriculture-organicproject.htm