Formulation and Quality evaluation of composite flour for Missi roti

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CERTIFICATE – I

*This is to certify that the thesis entitled **"Formulation and Quality evaluation of composite flour for Missi roti"** submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (Ag). in Food Technology** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by **Ms. Bharti Shrinag** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.*

All the assistance and help received during the course of investigation has been duly acknowledged by her.

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CERTIFICATE - II

This is to certify that the thesis entitled ***"Formulation and Quality evaluation of composite flour for Missi roti"*** *submitted by Ms.* **Bharti Shrinag** *to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, in partial fulfilment towards the requirements for the degree of* ***MASTER OF SCIENCE (Ag). in Food Technology*** *in the Department of* ***Food Science and Technology*** *has been, after evaluation, approved by the External Examiner and by the Student's Advisory Committee after an oral examination on the same.*

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LIST OF ABBREVIATIONS

%	-	Percent
i.e.	-	that is
Mg	-	Milligram
Cm	-	Centimeter
G	-	Gram
NS	-	Non significant
CD	-	Critical difference
LDPE	-	Low density polyethylene
et al.	-	co-workers
w/v	-	weight/volume
˚C	-	degree centigrade
hr.	-	Hour
Min	-	Minute
ml.	-	Milliliter
SEm±	-	Standard error of mean
Approx	-	Approximately
Fig.	-	Figure

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INTRODUCTION

Missi roti is a delicious Indian flatbread made with a mixture of gram flour and wheat flour and seasoned with spices. Chapati is either leavened or unleavened flat bread consumed throughout the Indian subcontinent and other parts of Middle East. Chapaties constitute an important source of dietary proteins, calories, some of the vitamins and minerals for a large section of Indian population. Composite flour technology refers to the process of mixing various cereal based flours to produce high quality food products in an economical way. Formulation of composite flour is vital for development of value-added products with optimal functionality (Rehman et. al. 2007). It has not only better nutritional quality but also the necessary attributes for consumer acceptance. Use of composite flour based on wheat and coarse cereals in processed products is becoming popular because of the economic and nutritional advantages. The composite flours containing wheat and legumes are being utilized in many parts of the world.

The importance of coarse cereals in direct human consumption is declining even though poses good nutritive value. Coarse cereals like Maize, Sorghum and Pearl millet not only having the better nutritional value but it also has phytochemicals, antioxidants and fiber thus beneficial for health. Although coarse cereals are nutritionally rich and easily available but their utilization is limited due to the presence of various anti-nutrients, low palatability, poor digestibility of proteins and carbohydrates.

Wheat (*Triticum aestivum*) is the major food produce among all the cereal crops. It is a staple food of large segment of world population. Wheat is extensively used for production of flat breads such as the steam-leavened chapatti, a major source of nutrients and staple diet, about 85% of wheat consumption in India is in the form of chapattis. Madhya Pradesh produced 19.46 million tonnes of grains in 2011-12, an impressive jump of 19 per cent from its previous best of 16 million tonnes in 2010-11.

Maize flour is now used regularly in many households. It contains the highest amount of energy (ME 3350 Kcal/kg) among cereal grains and is highly palatable. Maize is largely grown in north India. Madhya Pradesh occupies first place amongst maize producing states of the country (area 13.51 %, production 14.57%). Most of the production comes from Madhya Bharat Pathar with Indore, Ratlam, Ujjain and Jhabua district as major producers.

Sorghum (*Sorghum bicolor (L)* Moench) popularly called as jowar, is the “King of millets” and is the fifth in importance among the world’s cereals after wheat, rice, maize and barley. It is a staple food grain in many Indian states. India has the largest share (32.3%) of the worlds area under sorghum and ranks seconds in production after the US. India is the third largest producer of sorghum in the world with 7.15 million tons. (GOI, 2007). Jowar is a gluten-free, high-protein, cholesterol-free source of a variety of essential nutrients, including dietary fiber, iron, phosphorus and thiamine. It is a good source of iron, which helps formation of hemoglobin in blood thus preventing anemia.

Pearl millet production is concentrated in the developing countries which account for over 95% of the production and acreage. India continues to be the single largest producer of pearl millet in the world. Pearl millet grain is the staple diet for farm household in the world’s poorest countries and among the poorest people (Basavaraj, 2010). But the demand for sorghum and bajra as a staple food is declining day by day as there are no alternative uses and value added products (Gundboudi, 2006). Sorghum and Pearl millet complement well with lysine-rich vegetable (Leguminous) and animal proteins and form nutritionally balanced composite foods of high biological value.

Legumes like soybean have been known as ‘‘a poor man’s meat’’. They supply protein, complex carbohydrates, fiber and essential vitamins and minerals to the diet, which are low in fat and sodium and contain no cholesterol. It is an also excellent source of protein and contains well-balanced amino acid profile. The nutritional value of cereal flours that are poor in lysine but rich in the sulphur containing amino acids is improved by the addition of legume flours. In addition to nutritional importance, they are also being recognized as having therapeutic and medicinal properties.

Chickpea occupies first position among pulses representing 35% of total area of pulses and contributing 45% of total production in India. In M.P. chickpea is grown in an area of 2.56 million hectare with an annual production of 2.37 million tons.

Soybean (*Glycine max*) is a unique crop, containing about 40% protein and 20% fat but soybean are not readily acceptable to most of the Indians as food, because of their characteristic beany flavor. The possibility of utilizing soybean to make crunchy snacks could open up large domestic markets if an acceptable product is available. In Madhya Pradesh the Area under Soybean Cultivation during Kharif 2014 was 55.462 lac Hectares and the production was 60.249 Lac MT.

Spices are prime source for flavor, aroma and taste in cuisines and play an active role of as medicines due to their high antioxidant properties. As medicine or food, the importance of spices cannot be overemphasized. The medicinal values of spices are very well established in treating various ailments like cancer, fever, malaria, stomach offset, nausea and many more. A spice may be available in several forms: fresh, whole dried, or pre-ground dried which requires further processing to be utilized in the form of value added product.

In present study composite flour mixes including coarse cereals, legumes, dried leafy vegetable and spices will be formulated so as to make the product available for people in general.

The present study is planned with the following objectives:

1. To standardize the ingredients in composite flour of missi roti.
2. To evaluate the physical, nutritional and functional qualities of missi roti mix.
3. Storage study of missi roti mix using different packaging materials at ambient temperature for 3 months.

REVIEW OF LITERATURE

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

Proximate Composition of Raw materials

Wheat (*Triticum astivum*) is an important cheapest source of energy and protein in the diets of population in developing countries (Hira et al. 1991). Moisture content of whole-wheat flour ranged from 6 to 9.85 % (Saxsena et al. 1995; Gandhi et al. 2001). Several workers reported that the protein percentage of whole wheat flour ranged from 8 to 10.0 % (Sidhu et al., 1990; Singh et al., 2000), while Fatima et al. (2001) found protein ranged between 10.5 to 14.5 %. The studies have shown that the content of gluten plays a vital role in the preparation of processed product. It has also been reported that the different varieties of wheat grain contain dry gluten 8.22 to 11.85 % and wet gluten 26.94 to 42.48 % (Singh et al. 1990). Wheat is deficient in lysine, but rich in methionine amino acid (Sharma and Subramanian 1991). Several workers reported that fat content in different wheat varieties were ranged from 0.2 to 2 % (Fatima et al., 2001; Singh et al., 2000; Gandhi et al., 2001).

The literature revealed that the wheat flour contains phosphorus 310 to 490 mg, iron 2.6 to11.3 mg, manganese 3.3 to 6.5 mg, copper 0.3 to 3.5 mg and zinc 1.0 to 4.7 mg per 100gram of wheat flour (Hira et al., 1991; Rawat et al., 1994). It has been stated that calcium content of wheat flour ranged from 29 to 54 mg per 100gm of wheat flour (Hira et al., 1991), while 120 mg of calcium per 100 gm of wheat flour reported by Rawat et al., 1994. The chemical composition of whole wheat flour for moisture, ash, crude protein, crude fat, crude fiber, nitrogen free extract, wet gluten and dry gluten range from 9.38 to 10.43%, 1.32 to 1.85%, 10.13 to 14.74%, 1.96 to 2.52%, 2.31 to 2.99%, 78.71 to 85.37%, 23.53 to 38.71% and 7.51 to 13.52%, respectively among different Pakistani wheat varieties (Ahmad, 2001).

Cereal grains like wheat, corn, rice, barley, sorghum, etc. provide 68% of the total world food supplies. Wheat is mainly used as a dietary staple, averaging two-thirds of total consumption (Anjum et al., 2005). Owing to shortage of wheat, several developing countries have devised programs to assess the feasibility of alternate sources for substituting or blending with wheat flour (Abdel-Kader, 2000). Keregeo and Mtebe (1994), suggested that the products were prepared using sorghum flour composited with wheat flour in the following proportions: 100% brown sorghum flour (standard products); and 80:20%; 60:40%; 40:60% and 20:80% for wheat/sorghum (white and brown) composite flours. Results indicated that in the case of composite flour bread, preference for the product improved as the amount of sorghum flour decreased. In the case of buns or 'maandazi' the 100% sorghum flour products of both white and brown were equally preferred. Buns prepared from 100% sorghum flour of white and brown varieties showed promising potential in the improvement of the acceptability of sorghum products. Taking advantage of such products, especially in villages, could enhance sorghum utilization in rural communities.

Pearl millet contains relatively higher proportion of unavailable carbohydrates and the release of sugar is slow, making it suitable for diabetic persons. Six recipes of commonly consumed foods (pearl millet, sorghum, finger millet, mung bean) were tested in western India for their glycemic index (GI). Recipe based on pearl millet was found to have lowest GI (55) as compared to other recipes. This suggests that presence of high phytin phosphorus content of pearl millet influences the glycemic response (Mani et al. 1993).Pearl millet - based baby food prepared from 70 % flour , 13 % malt and 17 % milk powder increased digestibility and lowered the viscosity of the foods and provided adequate protein and energy level for one - year - old children (Badi et al. 1990) . Extrusion of baby food prepared from 70 % pearl millet and 30% cowpea supplied 17 % of the daily needs of protein, 72 % lysine and 110% of threonine in two- year - old children (Almeida - Dominguez et al.1990) .

In Nigeria, pearl millet is dry milled in to flour and mixed with wheat flour for production of bread. Chapatti prepared from pearl millet flour enriched with soybean (Glycine max) flour produced high protein efficiency ratio with minimal thickness and increased puffing and uniformity of color and texture. Chapatti prepared with bleached pearl millet has better acceptability. Overall acceptability score of chapatti prepared with acid - treated pearl millet flour and heat - treated pearl millet flour increased significantly as compared to that prepared from raw flour (Poonam 2002).

In spite of greater availability, low cost and comparatively good nutritional value, use of pearl millet and sorghum in food industry is very little. Pearl millet has remained a food for economically weaker sections (Desikachar 1975) because of some constraints that limit its acceptability. The major constraints are gray color and poor shelf life of the flour. Sorghum has fibrous seed coat, colored pigment and characteristic astringent flavor. Sorghum contains high levels of insoluble fiber with low levels of (3- glucans. Most of the crude fiber is present in the pericarp and endosperm cell walls .The fiber is composed mainly of cellulose, hemicellulose and small quantities of lignin. Some of the high tannin sorghums have higher levels of dietary fiber because of complexes between sorghum tannins and proteins (Bachknudsen and Munck 1985).

High fiber contents are very important for reducing gastro - intestinal problem of diabetics. Sorghum is rich in fiber as well as mineral content and incorporation of sorghum in various products increases the fiber content and decreases sugar level. Consumption of whole sorghum recipes resulted in lower glucose level, lesser peak rise in glucose and lesser area under curve in diabetics, compared to dehulled sorghum and wheat recipes (Lukshmi and Vimala 1996). Endosperm of sorghum grain is rich source of starch, protein, vitamin B-complex. Bran of sorghum is excellent source of fiber, containing lesser amounts of ash and proteins. Phytochemicals as tannins, anthocyanin’s, phenolic compounds, phytosteroles etc. are important health maintaining contents of sorghum flouras reported by Hahn et al., (1984).

Soybean is a very rich source of essential nutrients and one of the most versatile foodstuffs. It possesses good quality protein which is comparable to 4 other protein foods and is suitable for all ages, infants to the elderly. The soy protein is highly digestible (92–100%) and contains all the essential amino acids except methionine which is relatively low but good source of lysine. Soybean protein products also contain a high concentration of isoflavones, up to 1 g/kg (Setchell et al., 1987). The health benefits of soy proteins have been documented, related to the reduction of cholesterol levels and menopause symptoms and the reduction of the risk for several chronic diseases, i.e., cancer, heart disease, and osteoporosis.

The addition of soy protein in diet or replacing animal protein in the diet with Soy lowers blood cholesterol (Carroll, 1991). Moreover, soy protein is acceptable in almost all diets due to no cholesterol and absence of lactose. The improved processing methods of soy ingredients caused greater functionality and blander flavor. The isoflavones, a class of phytochemicals found in soybeans have been reported to be responsible for cholesterol-lowering, (Potter, 1998). Soybean (*Glycine max*) with 40% protein and 20% oil assumes the most predominant position in solving the food problems created by the ever-increasing population in India and other world countries as suggested by Gandhi et al. (2001). Anderson (1995) found that every 1% reduction in cholesterol values is associated with an approximate 2–3% reduction in the risk of coronary heart disease. Daily intake of 20–50 grams of isolated soy protein could result in a 20–30% reduction in coronary disease risk (Bakhit et al., 1994). Lee et al., (1991) reported an important link between soy consumption and reduced risk of certain types of cancer.

In many areas where diets are deficient in both protein and calories full fat soy flour can become an ideal supplement because it’s high nutritive value (Sharma and Subramaniam 1991). Flour was obtained by roasting, dehusking and milling the soybean (Joshi and Vaidehi 1998, Sharma and Subramaniam 1991).Full fat soy flour is one of the most promising forms in which soybean protein (40%) and oil (20%) can be used for human diet. Under Indian climatic condition storage stability of full fat soy flour becomes a problem. Improvement of shelf life of full fat soy flour is therefore possible through use of better packaging materials and application of technically superior method like modified atmospheric packaging, (Bargale et al., 1991).

Bengal gram or chickpea (*Cicer aeritenium*) is an important legume, consumed in different forms at different stages of maturity. The major part of cultivated bengal gram is eaten as the mature dry seed either in the form of whole seed or in the form of dhal or besan which is extensively used in India for preparing several savory & sweet dishes. The various constituents in the bengal gram viz., moisture ranged from 5.34 to 12.7, protein 16.7 to 24.6, fat 4.9 to 6.85, total ash 2.04 to 3.3, crude fiber 1.7 to 10.79 and carbohydrates from 56.8 to 70.9% (Shobana et al., 1976, Singh et al., 1977; Jambunathan and Singh 1979, Rossi et al, 1984).

Fatty acid content and tocopherol of whole maize flour are well known for flavor and are important in regulating increased blood pressure, cholesterol levels and cardiovascular diseases as atherosclerosis (Sen et.al. 2006). Maize germ is a rich source of lysine and exceeds the double amount of lysine in wheat flour (Tsen et.al. 1974). Hence, its substitution will reduce protein malnutrition. Only 35% of maize production is used in the form of chapattis/roti in the country while higher production percentages go for animal feeding.

Physical and functional properties

The flour, dough and tandoori roti samples, collected from different sources, were assessed for various quality characteristics. In general, survey indicated the use of mill aata in preparing tandoori roti and the use of salt in the formulation. The dough was of softer consistency due to higher amount of water (75-80%) added. The shape of the tandoori rotis was found to be circular, with a diameter of about 18 cm and thickness of 4.5mm. However, texture of tandoori rotis varied widely, as indicated by shear value ranging from 16.9 to 52,5 N and sensory textural score from 3.3 to 6.5. tandoori rotis prepared from whole wheat flour had softer texture and batter flavour. The moisture content in tandoori roti ranged from 31.7 to 40.2%, which is higher than that of chapatti (25-30%).(Saxena and Rao,1995).

The mechanical and rheological properties of the dough exert promising effect on the overall quality of baked products (Blokshma and Bushuk, 1988). The arrangement and interaction of constituents (especially proteins) and the structure of materials are the responsible factors affecting the rheological properties (Bushuk, 1985). The final product quality depends upon the dough rheology taking place during the processing of the constituents (Lindahl, 1990). The nature of ingredients, their proportions, mixing time and beating conditions are responsible for the quality of batter which finally determines the baked product quality (Baixauli *et al.,* 2007). The dough rheological properties are influenced by the structure of the aggregates and their tendency to interact with each other. Quality and quantity of the proteins affect the water absorption capacity of the dough (Finney, 1984).

The rheological properties of the composite flours are significantly affected as the level of replacement of cottonseed flour in the wheat flour was enhanced (Bajwa, 1997). Similarly 10% replacement of the defatted peanut flour in the wheat flour altered the water absorption capacity and extensibility of the dough mix (Rao and Vakil, 1980), while no significant effect on the peak height and mixing time was observed with the 10% addition of cotton seed flours in the two different types of wheat flours (Rasool, 2004). More water absorption with sticky dough is observed, as the fiber content of chapattis was increased and the mixing time of the dough was decreased (Ahluwalia and Kuar, 2001). Addition of cottonseed, peanut, safflower and soy flour in wheat reduced the mixing tolerance while increase in the water absorption is observed (Mathews, 1972).

The water absorption of composite flour containing 10% chickpea flour decreased significantly from 68.40% at (0 day) to 66.5 % (60days) as a function of storage time (Shahzadi, 2004). Flaxseed mucilage is composed of mainly polymeric carbohydrates while galacturonic acid, rhammose, galactose, fructose, glucose are also present in small quantities. It can help to improve the water absorption characteristics of the dough (Fedeniuk and Biliaderis, 1989).

The most important parameters of chapatti quality are flavour and texture and are evaluated as soft texture, greater pliability, light creamish brown colour with small brown spots, slight chewiness, fully puffed, and baked wheatish aroma (Shaikh et al., 2007; Haridas et al., 1986). The chapatti should be easily torn and flexible so that it can be folded by the forefinger and thumb (Dhaliwal et al., 1996). This product is made by mixing the flour and water to develop the dough, after relaxing; balls are sheeted (Gujral and Pathak, 2002). The size and shape of the chapattis vary from region to region, culture to culture and family to family but normally these are circular or round disc in shape and size of 150-200 mm in diameter and 1-4 mm thickness. After rolling, chapattis are baked on a pan by contact heating and puffed directly on gas fired burner and consists mostly of crust with little crumb (Sridhar and Rao, 1993; Gupta, 1990).

Composite flour

Cereal grains and legumes play significant role in supplying the nutrients, as well as providing over 70% of the daily energy requirements (Edwards *et al.,* 1971). The composite flour technology refers to the process of mixing wheat flour with cereals and legumes to make use of local raw material to produce high quality food products in an economical way. Chapattis (unleavened flat breads) can be nutritionally improved by the composite flour technologies (Rasool, 2004).

The total protein content and the total essential amino acids are important factors from nutritional view point; essential amino acids should be supplied in adequate amounts in the daily diet (Anjum et al., 2005). Cereal proteins are deficient in few essential amino acids like lysine and tryptophan but these deficiencies are mainly related to endosperm portion of the kernel (Myer et al., 1996). Wheat flour substitution with legume could contribute the increasing demands for protein and energy rich food preparations (Iqbal et al., 2006). However, bioavailability of proteins and energy from raw legumes is poor and require processing prior to consumption (Melcion and Vander Poel, 1993;). Although, they have high protein contents but generally contain low or moderate levels of potentially harmful antinutritional factors (Taiwo, 1998).

Composite flours prepared by blending wheat and legumes can improve the status of protein and limiting amino acids. In a research trial, layer cakes were successfully prepared from chickpea-wheat (white and whole) composite flour blend (Gomez et al., 2008). In another research trial, sorghum and wheat flour composite blends up to 10% and 20% sorghum resulted in acceptable breads and biscuits (Elkhalifa and El-Tinay, 2002). Composite flours of small red, black, pinto and navy bean flours with wheat flour were successfully used by Anton et al. (2008) for tortilla preparation up to 25% of substitution levels.

Salem et al. (1999) studied the effect of partial replacement of corn tortilla 23 with soybean, chickpea and lupine flours. They reported improvement in color and taste of tortilla with chickpea augmentation. They also found that fortification of tortilla flour with 5% lupine, 15% soybean and 20% chickpea flours improved the sensory and physical properties of the baked tortilla. Blends of soybean flour and cassava flour can be used to prepare biscuits. The law of complementarity's can be employed to improve the nutritional status of the bakery products by partial replacement of wheat with lysine rich flours e.g. defatted maize germ meal. Rehman et al.(2007), suggested that formulation of composite flour is vital for development of value-added products with optimal functionality.

Nutritional evaluation of unprocessed composite flour, wheat flour chapatis and composite flour chapatis revealed a significant increase in moisture and protein content and non-significant difference in ash and crude fibre contents of composite flour chapatis when compared with unprocessed composite flour and wheat flour chapatis. Various processing methods, namely dough making and roasting involved in chapati making, significantly ($p<0.05$) reduced the phytic (11 per cent) and polyphenol (64 percent) content of the developed chapati compared with unprocessed composite flour. As a result the protein and starch digestibility of the developed chapati was improved over the unprocessed composite flour (Neelam Khetarpaul, Rajni Goyal, 2009).

The composite flours can be prepared and used to improve the nutritional and technological properties of the chapattis. Gandhi et al. (1983) demonstrated that chapattis made from wheat flour containing 10-15% soy flour were of satisfactory flavour, texture, appearance and overall acceptability by trained sensory panel, although flavour and texture were significantly different from the all-wheat-flour chapattis. Similarly Lindell and Walker (1984) also found that soy supplemented wheat flour chapattis would fulfill a nutritional need as they are higher in fat and protein with a well-balanced profile of amino acids.

Kadam et al.(2012), conducted research work on development and evaluation of composite flour for missi roti / chapati were carried out to develop the nutritious flours from various food commodities (wheat flour, chickpea, and soybean and methi leaves powder) to make good quality of chapaties. Four types of bends were acceptable. They were made from wheat flour, chickpea, full fat soy flour and methi powder in different ratio viz; 'A' wheat flour: chickpea flour (80:20). 'B' wheat flour: fullfat soy flour (90:10) 'C' wheat flour: chickpea flour: soy flour (80:10:10) and 'D' wheat flour: chickpea flour: soy flour: methi leaves powder (75: 10: 10: 05). The proximate composition of blends used for preparation of various products contained higher amount of protein and other nutrients. They contained proteins(11.8 to 15.37%), fat (1.53 to 3.45%), fiber (1.24 to 2.05%), ash (2.08 to 2.70%) and carbohydrates (65.99 to 74.2%).These results showed that soy flour / chickpea flour alone or in combination, both increased the amount of protein significantly. Calcium, phosphorus and iron were found to increase on supplementation of chickpea, soy flour and methi powder. Iron was high in methi supplemented blend. All these blended flours were found to have good sensory quality characteristics of products as control. All these blended flours could be well stored in polyethylene bags or tin boxes for the period of 3 months without any deterioration of quality. The supplementation of 5% methi powder increased the nutritional quality of flour particularly in minerals (calcium and iron) and fibers.

Muhmmad et al. (2012),The phytic acid and trypsin content were higher in un-autoclaved soy flour supplemented composite flour. The defatting of soy flour also increases the level of these anti-nutrients in chapattis. The phytate and trypsin content of composite flour decreased as a result of baking. The protein, fiber and ash contents of composite flour increased while moisture content and nitrogen free extracts (NFE) decreased by the addition of soy flour. Mineral contents of chapattis except Mn increased by the incorporation of soy flour. The chapattis were found acceptable by the panel of judges at 10 percent replacement level of whole wheat flour by soy flour.

Rawat et al.(1994) Chapaties prepared from whole wheat flour and defatted soy flour (90:10) blend were evaluated for their quality characteristics. Soy fortified chapaties contained 28.8 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 soften than whole- wheat chapaties, but retaind 13% of trypsin inhibitor activity originally present in soy flour.

Pushpamma and Geervani (1981) reported the nutrient composition of sorghum. The average nutrient composition of sorghum roti (per 100 g) i.e. Calories (29 k.cal.) Protein (8g), Fat (1g), Carbohydrate 61(g), ash (2g), fiber (2g), Calcium (67mg), Iron (5mg) Thiamine (0.1 mg) , riboflavin (0.1mg), Niacin (0.80mg). Pushpamma and Geervani (1981) have reported the vitamin B losses during the process of roti preparation.

Murty et al. (1979), reported that Consumers prefer white pale yellow colored dense and round grains, free from colored spots for roti preparation.

Tsen et al. (1971), reported that a mixture of wheat flour fortified with 12% deffated soy flour increased the lysine content by two times that of wheat alone and the protein content of bread made from such a blended flour increased by approximately 35%.

Dhingra and Jood (2004) incorporated soybean (full-fat and defatted) and barley flours at substitution levels of 5, 10, 15 and 20% into wheat flour to study the effect of flour blending on functional, baking and organoleptic characteristics of bread. They observed that the increase in the percentage of soybean and barley flour separately as well as in combinations leads to decline the mixing time of dough and the sedimentation value, gluten contents as well as the water absorption capacity of the flour blends increased. The breads prepared from these blends also showed variation in loaf weight, loaf volume and sensory characteristics. The higher levels from 10% of soy flour (full-fat and defatted) or 15% of barley flour let to the increase in the acceptability of the product declined due to compact texture of the crumb and the strong flavor.

The experimental puffed products prepared by extruding mixers of corn flour, soybean and safflower pastes with proportions: (i) 89:8:3, (ii) 83:11:6 and (iii) 80:17:3, having 6.6%, 45.9% and 32.9% protein content respectively, showed no significant effects on flavour, crunchiness and acceptance for products i and iii but product ii having greater amount of safflower paste showed bitter taste and lower acceptability scores (Martinez-Flores *et al.*, 2005). The fermentation of whole wheat flour for 45 min reduced significantly the content of phytic acid.

Bread preparation from such treated flours dough had high nutritional impact. Cultivars and their interaction significantly improved the sensory qualities such as color, taste, texture and overall acceptability (Qazi *et al.,* 2003). Blends of soybean flour (SF) and cassava flour (CF) were prepared on a replacement basis (CF/SF, 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80 and 0:100) and biscuits weights produced from the blends decreased with increased SF substitution. The color, texture, flavor, taste and overall acceptability of the flour blend biscuits were not found to be significantly different. The biscuits got higher scores for all the sensory attributes evaluated at 50% level of SF incorporation (Akubor and Ukwuru, 2003).

Khan et al. (2005) and Anjum et al. (2006) observed significant improvement in the mineral contents (Fe, Zn, Ca, Mg and Cu) of chapattis supplemented with soy flour /hulls and found that soy flour and hulls can be replaced up to 24 and 4.5 % levels, respectively to produce organoleptically acceptable chapattis. Chapattis made from defatted soy bean flour supplemented wheat flour were found acceptable but those made from rape seed and sunflower flours were unacceptable (Jain et al., 2000). The protein content was increased from 11.9% to 19.8% at 20% blending level of defatted soy flour. The textural parameters like cohesiveness, springiness, hardness and chewiness were also affected by the incorporation of defatted soy flour (Gandhi et al., 2000).

In another study conducted by Gujral and Pathak (2002), it is observed that whole wheat flour replaced with flours from millets, rice, corn, barley and black gram showed chapattis with higher extensibility even after 24 hrs of storage. Some of the additives like sodium caseinate also considerably enhanced the texture of chapattis. Sekhon et al. (1980) concluded that triticale flour can be blended with wheat at a level of 50% to prepare acceptable chapattis. Arya et al. (1978) concluded that wheat flours with more fat contents produced chapattis with a softer and smooth texture and better folding ability. Barley can be blended up to 40% with wheat flour to yield acceptable quality of chapattis (Sood et al., 1992).

The chapattis prepared from the composite flour containing 15g roasted flaxseed powders, 0.05g oil and 80g of whole wheat flour provided 29.9g carbohydrates, 6.3g protein, 5.9g fat and 198 K calories (Soniya et al., 2004). The texture of chapattis became progressively harder with storage at both room and refrigerated temperatures. A decrease in sensory quality and acceptability of the chapattis was observed with storage. The rate of staling was lower at refrigerated temperature than that of room temperature storage of chapattis (Sheikh et al., 2007). The texture of chapattis can be affected by the hardness of wheat. The flour with higher moisture retention and gelatinization of starch in hard wheat results in the chapattis with soft and pliable texture (Srivastava et al., 2000).

Storage study

Baranwal et al. (2014), studied the effect of packaging on the microbial quality of malted composite flour. The product making and sensory quality were assessed to find out the most appropriate level of MCF (malted composite flour) blend incorporation. On the basis of sensory quality, 40% was best and thus selected for further study. This selected malted composite flour was packaged in HDPE bags at room temperature for three months in two different packaging conditions i.e. vacuum sealing and ordinary heat sealing. The microbial quality was assessed at monthly intervals during entire storage period. Microbiological study depicted that microbial counts of flour in both packaging was far below the permissive limit up to three months of storage.

Good packaging actually serves two purposes, which are essentially technical and presentational. Technical aspects in packaging aim to extend the shelf life of the food by better protection from all the hazards during storage. Presentational aspects are not concerned with shelf life but such packaging increases sales by creating a brand image that the buyer instantly recognizes (Peter and Axtell, 1993).

MATERIALS AND METHODS

This chapter deals with the various experimental materials and methodologies used for **"Formulation and Quality evaluation of composite flour for Missi roti."** The present investigation was carried out in the Department of Food Science and Technology, College of Agriculture, JNKVV, Jabalpur (M.P.) during the year 2014-15.

3.1. Materials and methods

3.1.1 Food commodities:

Wheat (*Triticum* aestivum), chickpea (*Cicer arietinum* L), soybean (*Glycine max*), bajra (*Pennisetum glaucum*), jowar (*Sorghum Bicolor* maize (*Zea mays*),*)* and spices were purchased from the local market of Jabalpur.

3.1.2 Preparation of full fat soy flour

Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The clean grains were tempered with water to 20-25 per cent moisture content and then autoclaved for 15 min in a pressure cooker. They were removed and dried directly in the sun for 3-4 days till the material was completely dried having 6 – 8 per cent moisture content. Soybean was then ground to make fine flour and sieved through 80 – 100 mesh sieve. The flour samples obtained were kept in airtight container before use.

3.1.3 Drying of spices

The fresh leaves of Methi and coriander were washed under tap water and cut into small pieces separately and dried in hot air oven at 60°C for 6-7 hrs. Fresh onion and green chilli were also washed and chopped into small pieces and dried in oven at 60-65°C.

3.2 Procedure for the preparation of Missi roti mix

All the flours (wheat/ maize/ jowar/ bajra/chickpea/ soybean flour) and dry spices (chilli, onion, coriander, fenugreek leaves) and salt were mixed properly packed in polypropylene bags and stored at ambient temperature for further use.

3.3 Treatment combinations

Table 1. Different formulations of Missi roti mixes.

Combinations	Wheat	Chickpea	Bajra	Jowar	Maize	Soybean
$B_1/J_1/M_1/Mix_1$	65	30	-	-	-	-
B_2	45	25	20	-	-	5
B_3	35	20	30	-	-	10
B_4	30	15	35	-	-	15
J_2	45	25	-	20	-	5
J_3	35	20	-	30	-	10
J_4	30	15	-	35	-	15
M_2	45	20	-	-	20	10
M_3	35	15	-	-	30	15
M_4	30	10	-	-	35	20
Mix_2	35	25	10	10	10	5
Mix_3	25	15	15	15	15	10
Mix_4	10	15	20	20	20	15

Spices– 5 g in each combination (fenugreek + chilli + coriander + onion 2.5:0.5:1:1)

3.4 Procedure of the Roti preparation from missi roti mix.

1. Instant mix was taken in a bowl than little oil and salt were added to it.
2. Stirred the mix with a fork then formed a well in center and added half bowl of lukewarm water and made to dough through kneading.
3. The dough was covered for 30 minutes.
4. Turn the dough on to lightly floured work surface and divide in to four equal sized pieces and shaped in to balls.
5. Then rolled each one out in to a thick round about 16 c.m.
6. Missi roti were baked in a pan at temperature 180-200°C.

Missi roti's of all combinations were prepared and subjected to sensory and nutritional evaluations.

3.5 Sensory evaluation of products:

The sensory quality characteristics of the products such as colour and appearance, taste, texture, flavor and overall acceptability were evaluated by panel of judges using nine point hedonic scale as described by Amerine et al. (1965).

The ratings were given as per the hedonic rating as mentioned below:-

Sl. No.	Remarks	Score
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	Code 1	Code 2	Code 3	Code 4	Code 5
Colour & Appearance					
Flavor					
Taste					
Texture					
Overall acceptability					

Note: Score above 7.0 shows acceptability within score of 1-9.

3.5 Physical properties

A. Weight of missi roti

3 roti of uniform size and thickness were taken and weighed. The average weight was expressed as g.

B. No of roti

Total no. of roti was taken from the roti prepared from 100g instant mix.

C. Diameter

The diameter of roti was measured by laying 5 roti edge to edge and measuring to the nearest mm (AACC, 1967). The roti were rotated to 90^{0} and their diameter was re-measured as a check determination. The average diameter of roti was reported in mm.

D. Area and Circumference of roti

Area of roti was calculated by using formula πr^2 in cm^2 and Circumference was calculated by using formula $2\pi r$ in cm.

E. Bulk density of missi roti mix

Bulk density of missi roti mix was measured according the method of Wang and Kinsella (1976).

F. Hunter colour analysis

Colour was measured using Hunter colour lab analyzer where L, a and b values were recorded for the different Missi roti and Missi roti mix combinations.

3.6 Proximate composition of Missi roti mix

The nutritional evaluations of missi roti mix with respect to various constituents were carried out by the following procedures.

3.6.1 Determination of moisture content

The moisture content of the sample was determined by the using moisture meter.

3.6.2 Determination of protein content

The protein content in sample was determined by using conventional Micro-Kjeldhal digestion and distillation procedure as given in AOAC (1992).

3.6.3 Determination of Fat content

The fat content of the sample was determined by the procedure as described in AOAC (1992) using soxh plus fat analysis system.

3.6.4 Determination of Ash content

The ash content present in the sample was determined according to the procedure given in AOAC (1992).

3.6.5 Determination of crude fiber

The crude fiber was determined by the method as described in AOAC (1992).

3.6.6 Determination of Total Carbohydrates

Total carbohydrate in the samples was estimated by hydrolysis method as described by Hassid and Abraham (1965).

3.6.7 Mineral contents

Minerals content of chickpea were obtained by calculation using table value (Gopalan *et al*., 1996)

3.6.8 Energy value

Energy content was calculated by factorial method AOAC (1995) using following formula:

$$\text{Energy (kcal)} = 4.0 \times \text{protein (g)} + 4.0 \times \text{carbohydrate (g)} + 9.0 \times \text{fat (g)}$$

3.7 IVSD and Water absorption capacity of mixes

3.7.1 In vitro starch digestibility (IVSD)

The in-vitro starch digestibility was determined by the method of Singh and Jambunathan (1982).

3.7.2 Water absorption capacity (WAC)

Water absorption capacity was measured by the methods of Sosulski *et al*. (1976).

3.8 Statistical analysis

The data obtained from various experiments were statistically analyzed. A complete randomized design was adopted for statistical analysis of data of experiments related to storage studies by following the procedure as described by Panse and Sukhatme (1963).

3.9 Storage studies

The shelf-life studies of various flours were carried out in polypropylene, low density polyethylene and aluminum foil bags for a period of 3 months at ambient conditions; found acceptable in sensory studies. 100 gm of each sample were packed and kept at room temperature for 90 days. All samples were drawn periodically after 0, 30, 60, 90, days and subjected to product development and there sensory evaluation.

RESULTS

The present investigation on 'Formulation and Quality evaluation of composite flour for Missi roti' were carried out with the objectives to formulate and develop a nutritious flour for missi roti from wheat , maize , bajra , jowar, chickpea, full fat soy flour and dried spices. The obtained results have presented in different tables and graphs.

4.1 Development and Optimization of Missi roti mixes.

4.1.1 Development and Optimization

Missi roti were prepared with varying levels of ingredients such as cereals (wheat /bajra / jowar / maize) pulses (chickpea /soybean) dried spices (fenugreek, onion, chilli, coriander), salt and lukewarm water using earlier mentioned basic recipe for missi roti. Accordingly missi roti were prepared with 10-70 percent wheat flour, 10-40 percent chickpea flour, 20 -50 percent bajra/jowar/maize flour, 5-20 percent soybean flour and 5 percent dried spices. Another missi roti mix was prepared using different cereals flour including 10-65 percent wheat, 10-25 percent chickpea, 20-35 percent each of Bajra, jowar, maize, 5-10 percent full fat soy flour and 5 percent dried spices. Control missi roti was prepared with 65 percent wheat, 30 percent chickpea, 5 percent dried spices i.e. fenugreek (2.5g), onion (1 g), coriander (1g) chilli (0.5g), salt (2g) and oil (10ml) were added. Finally roti were prepared using the optimum level of ingredients arrived at desired formulation from the earlier results of acceptability studies of missi roti formulations.

In the primary sensory evaluation test, roti were prepared from different formulations and evaluated by panelists. The score for the products with 10-45 percent wheat flour, 10-25 percent chickpea flour, 20-35 bajra /jowar /maize flour 5-15 percent soybean flour were highest in terms of all sensory attributes. Panelists suggested for removal of the turmeric powder from the missi roti mixes for good taste. They also suggested that cooking time more than 1-2 min adversely affected the colour and texture of the missi roti. On the basis of above findings, the levels of different ingredients and method of preparation was finalized and presented in chapter III.

4.2 Sensory quality characteristics of missi roti

Different types of missi roti were developed from different formulations of cereals (wheat/ bajra/ jowar /maize) and pulses (chickpea/ soybean) and subjected to sensory test on 9 point hedonic scale.

4.2.1 Sensory attributes of missi roti fortified with Bajra and Soybean.

The results of sensory analysis of missi roti made from wheat, bajra, chickpea, soybean flour and spices in different ratios are given in table 2. Plate -1,fig-1.

Maximum score (8.50) for colour and appearance was found in B_1 formulation whereas minimum (7.0) score found in B_4 formulation. B_1 and B_2 formulations were statistically at par with each other. The data revealed that increase in the ratio of Bajra flour decreased the mean scores for colour and appearance of missi roti. The highest score (8.50) of flavor was obtained in B_1 formulation and B_4 combination scored lowest (7.50). The B_1 and B_2 formulations are statistically at par with each other.

Table 2. Sensory attributes of missi roti fortified with Bajra and Soybean.

Formulations	Colour and Appearance	Flavor	Taste	Texture	Over all acceptability
B1	8.50	8.50	8.20	8.12	8.33
B2	8.34	8.50	8.58	8.44	8.46
B3	7.56	7.82	7.54	7.86	7.86
B4	7.00	7.50	6.86	6.42	6.94
SEM ±	0.065	0.072	0.069	0.092	0.093
CD at 5 %	0.204	0.228	0.218	0.292	0.293

B_1- Wheat +chickpea (65:30)

B_2- Wheat +chickpea +bajra +soybean (45:25:20:5)

B_3- Wheat +chickpea +bajra +soybean (35:20:30:10)

B_4- Wheat +chickpea +bajra +soybean (30:15:35:15)

Note: 5% dried spices were added in all combinations.

The data depicts that, the mean score for taste ranged from 6.86(B_4) to 8.58(B_2). B_2 formulation was found to be significantly superior to other formulations. As can be seen from Table 2, in case of texture also the formulation B_2 got the maximum score (8.44) while the formulation B_4 got the lowest score (6.42). B_1 and B_3 were statistically at par with each other. The range of mean score value of overall acceptability is 6.94 to 8.46. Formulation B_2 was liked the most with a high mean score 8.46 followed by B_1, B_3 and B_4.

4.2.2 Sensory attributes of missi roti fortified with jowar and soybean.

The results of sensory analysis of missi roti made from wheat, jowar, chickpea, full fat soy flour and spices in different ratios are given in table no. 3,plate- 1,fig.-2.

The mean scores for colour and appearance of different combinations ranged from 6.96 to 8.50. The formulation J_4 got the lowest value while J_1 got highest value for colour and appearance. J_1 and J_2 were statistically at par with each other.

Table 3. Sensory attributes of missi roti fortified with jowar and soybean.

Formulations	Colour and Appearance	Flavor	Taste	Texture	Over all acceptability
J_1	8.50	8.50	8.20	8.12	8.33
J_2	8.40	8.54	8.42	8.36	8.43
J_3	7.52	8.08	7.84	7.76	7.8
J_4	6.92	8.00	7.48	7.30	7.42
SEM ±	0.066	0.069	0.088	0.167	0.063
CD at 5 %	0.208	0.220	0.278	0.528	0.201

J_1 - wheat +chickpea (65:30)

J_2 – Wheat +chickpea + jowar +soybean (45:25:20:5)

J_3 – Wheat +chickpea + jowar +soybean (35:20:30:10)

J_4- wheat +chickpea +jowar +soybean (30:15:35:15)

Note: 5% dried spices were added in all combinations.

The range of mean score value for flavor was 8.00 to 8.54. J_2 got maximum value and J_4 got minimum. All combinations were statistically at par with each other in case of flavor. In case of taste, the formulation J_2 got maximum score (8.42) followed by formulation J_1 (8.20), J_3 (7.84) and J_4 got 7.48. J_2 and J_3 became statistically at par with each other. As evident from Table 3 in case of texture also, the formulation J_2 got the maximum score (8.36) while the formulation J_4 got lowest score (7.30). All formulations are statistically at par with each other. In overall acceptability, the formulation J_2 was liked the most with a high mean score 8.43 followed by J_1, J_3 and J_4.J_2 and J_1 are statistically at par with each other.

4.2.3. Sensory attributes of missi roti fortified with maize and soybean.

The results of sensory analysis of missi roti made from wheat, maize, chickpea, soybean flour and spices in different ratios are given in table 4, plate-2, fig- 3.

Maximum score (8.50) for colour and appearance was found in M_1 formulation whereas minimum score (8.00) found in M_4 formulation. M_1, M_2 and M_3 formulations are statistically at par with each other. The M_2 combination was found to be scored lowest (7.86) for flavor while the highest score (8.50) was obtained in M_1 formulation. However, M_1 combination is followed by M_3 (8.04) and M_4 (7.86). M_3, M_4 were statistically at par with each other.

Table 4.Sensory attributes of missi roti fortified with Maize and soybean.

Formulations	Colour and appearance	Flavor	Taste	Texture	Over all acceptability
M_1	8.50	8.50	8.20	8.12	8.33
M_2	8.44	7.86	8.00	7.88	8.04
M_3	8.40	8.04	8.54	8.40	8.34
M_4	8.00	7.98	7.82	7.02	7.70
SEM ±	0.055	0.054	0.095	0.101	0.072
CD at 5 %	0.176	0.172	0.299	0.319	0.227

M_1- wheat +chickpea (65:30)

M_2- wheat +chickpea + maize + soybean (45:20:20:10)

M_3- wheat +chickpea +maize + soybean (35:15:30:15)

M_4- wheat +chickpea + maize +soybean (30:10:35:20)

Note: 5% dried spices were added in all combinations

The data depicts in Table 4 revealed that, the mean scores for taste ranged from 7.82 (M_4) to 8.54 (M_3), while M_1 and M_2 obtained 8.20 and 8.00. M_1, M_2 and M_4 were statistically at par with each other. In case of texture also the formulation M_3 got the maximum score (8.40) while the formulation M_4 got the lowest score (7.02). M_1, M_2 and M_3 were statistically at par with each other. An appraisal of Table 4 in overall acceptability, the formulation M_3 was liked the most with a high mean score 8.34 followed by M_1, M_2 and M_4. M_1 and M_3 were statistically at par with each other.

4.2.4. Sensory analysis of missi roti prepared from mixed flour

The results of sensory analysis of missi roti made from wheat, bajra, jowar, maize, chickpea, soybean flour and spices in different ratios are given in table no. 5, plate- 2, fig- 4.

The mean scores for colour and appearance of different combination ranged from 8.04 to 8.50. The formulation Mix_4 got the lowest value while Mix_1 got highest value for colour and appearance. Mix_1, Mix_2 and Mix_3 were statistically at par to each other.

Table 5 Sensory attributes of missi roti prepared from mixed flour

Formulations	Colour and appearance	Flavor	Taste	Texture	Over all acceptability
Mix_1	8.50	8.50	8.20	8.12	8.33
Mix_2	8.40	8.48	8.45	8.22	8.39
Mix_3	8.46	8.56	8.50	8.35	8.46
Mix_4	8.04	8.44	8.06	7.52	8.01
SEM ±	0.065	0.055	0.081	0.068	0.071
CD at 5 %	0.207	0.173	0.258	0.216	0.225

Mix_{1--} wheat +chickpea (65:30)
Mix_2- wheat +chickpea +bajra +jowar +maize +soybean (35:25:10:10:10:5)
Mix_3- wheat +chickpea +bajra +jowar +maize +soybean (25:15:15:15:15:5)
Mix_4- wheat +chickpea +bajra +jowar +maize +soybean (10:15:20:20:20:10)
Note: 5% dried spices were added in all combinations.

The Mix_4 combination was found to be scored lowest (8.44) for flavor while the highest score (8.56) was obtained in Mix_3 formulation. However the Mix_3 combination is followed by Mix_1 (8.5) and Mix_2 rated (8.48). All formulations were statistically at par with each other. In case of taste all combinations was statistically at par to each other and the formulation Mix_3 got the maximum score (8.50) followed by the formulation Mix_2 (8.45), while Mix_1 and Mix_4 obtained 8.20 and 7.80. As evident in case of texture also the formulation Mix_3 got the maximum score (8.35) while the formulation Mix_4 got the lowest score (7.52). The formulation Mix_3 was liked the most with a high mean score 8.46 for over all acceptability followed by Mix_1, Mix_2 and Mix_4.

4.3 Physical attributes of missi roti mix and its roti.

The results of the physical characteristics of different missi roti mix and its roti i.e. weight, diameter, no. of roti (100g mix), bulk density (instant mix) and colour analysis compared to control are given in the Table 6

Table 6 Physical attributes of missi roti mixes and its roti

Formulations	No. of roti (100g mix)	Average Weight of roti (g)	Diameter (cm)	Area (cm^2)	Circum ference	Bulk density (missi roti mix) g/ml
$B_1/J_1/M_1/Mix_1$	4	37.00	12.9	130.6	40.5	0.667
B_2	5	38.68	13	132.6	40.8	0.641
B_3	5	36.00	13.1	134.7	41.1	0.657
B_4	5	34.00	12.8	128.6	40.1	0.595
J_2	5	33.00	12.9	130.6	40.5	0.675
J_3	5	33.00	12.5	122.6	39.2	0.667
J_4	5	35.66	13.2	136.7	41.4	0.625
M_2	5	41.00	12.5	122.6	39.2	0.657
M_3	5	38.00	11.7	107.4	36.7	0.625
M_4	5	36.00	12.6	124.6	39.5	0.694
Mix_2	5	37.66	13.2	136.7	41.4	0.595
Mix_3	5	37.33	13	132.6	40.8	0.684
Mix_4	5	37.66	12.7	126.6	39.8	0.641

As data showed in table 6, average weight of roti ranges from 33- 41 g. M2 exhibited maximum weight and it was significantly superior compared to other formulations. J2 and J3 contain minimum weight than other formulations. No. of rotis prepared from 100g of mix was same for all formulations i.e. 5 compared to control (4). It is evident from the table that, diameter of roti ranges from 11.7 to 13.2c.m J_4 and Mix_2 exhibited maximum and M_3 showed minimum diameter than other formulations. As data showed in table 6, area of roti ranges from 107.4- 136.7 $c.m^2$. J_4 and Mix_2 exhibited maximum area and it was significantly superior compared to other formulations. M_3 exhibited minimum area than other formulations. It is clear from Table 6, circumference of missi roti ranges from 36.7 to 41.4 c.m. J_4 and Mix_2 exhibited highest circumference. It was significantly superior compared to other formulations. M_3 exhibited minimum circumference. The bulk density of mixed missi roti range from 0.595 – 0.694 g/ml. M_4 contains maximum bulk density value and B_4 and mix_2 contains minimum as compared to other formulations.

4.4 Hunter colour analysis of cereal and pulse based missi roti mixes and its rotis.

The results of colour analysis of missi roti mix and its roti made from different formulation are given in Table 7.

4.4.1 Hunter colour analysis of missi roti mixes.

It is clear from the results (table 7) that the addition of Bajra flour in missi roti mix reduced the L- values. In case of missi roti mix prepared from Bajra, the highest value of lightness (85.32) was obtained from B_1 followed by B_2 (82.54) and B_3 (81.00) while the lowest value 80.48 was obtained from B_4. The a-value was highest for missi roti mix B_1 (1.85) and lowest (0.66) obtained by B_4 formulation. Similarly the highest b- value of instant mix (20.30) was obtained by B_1 and lowest (17.33) in B_4 formulation.

As can be seen from the table that, in case of missi roti mix based on jowar, the highest value of lightness (85.32) was obtained from J_1 followed by J_2 (84.14) and J_3 (83.58) while the lowest value 83.49 was obtained from J_4. The a & b values were highest for missi roti mix J_1 (1.85, 20.30) and lowest (1.39, 18.74) obtained by J_4 formulation respectively.

Table 7 Hunter colour analysis of missi roti mixes.

Formulations	L	a	b
$B_1/J_1/M_1/Mix_1$	85.32	1.85	20.30
B_2	82.54	1.20	18.11
B_3	81.00	0.92	17.80
B_4	80.48	0.66	17.33
J_2	84.14	1.67	19.41
J_3	83.58	1.48	19.84
J_4	83.49	1.39	18.74
M_2	84.52	2.31	22.55
M_3	84.06	2.57	23.53
M_4	83.48	2.45	23.54
Mix_2	83.21	1.70	21.25
Mix_3	81.61	1.53	20.60
Mix_4	82.30	1.53	21.82

In case of maize incorporated missi roti mix, the highest value of lightness (85.32) was obtained from M_1 followed by M_2 (84.52) and M_3 (84.06) while the lowest value 83.48 was obtained from M_4. a and b value was highest for missi roti mix M_3 and M_4 (2.57, 23.54) and lowest (1.85, 20.30) obtained by M_1 formulation respectively.

An appraisal from the table 7 clearly indicated that in mixed flour missi roti mix, highest value of lightness (85.32) was obtained from Mix_1 followed by Mix_2 (83.21) and Mix_4 (82.30) while the lowest value 81.61 was obtained from Mix_3. The a-value was highest for missi roti mix_1 (1.85) and lowest 1.53 obtained by Mix_3 and Mix_4 formulations. Similarly the highest b- value of missi roti mix (21.82) was obtained by missi roti Mix_4 and lowest (20.30) in Mix_1 formulation.

4.4.2 Hunter colour analysis of missi roti.

In Bajra incorporated missi roti, the highest value of lightness (52.28) was obtained from B_1 followed by B_3 and B_2 while the lowest value (50.89) was obtained from B_4. The highest value of a & b (4.40, 24.77) was obtained from B_3 and lowest from B_2 (3.28, 20.54) respectively.

Table 8 Colour analysis of missi roti.

Formulation	L	a	b
$B_1/J_1/M_1/Mix_1$	52.28	3.88	23.87
B_2	50.94	3.28	20.54
B_3	51.28	4.40	24.77
B_4	50.89	4.15	24.20
J_2	54.60	4.04	24.27
J_3	49.67	3.63	24.50
J_4	51.85	5.77	25.02
M_2	51.90	4.42	26.86
M_3	46.63	4.58	22.63
M_4	50.19	6.97	27.86
Mix_2	49.53	5.44	27.15
Mix_3	46.13	4.83	22.79
Mix_4	52.04	4.03	24.78

The missi roti prepared from jowar showed highest value of lightness (54.60) in J_2 followed by J_1 (52.28) and J_4 (51.85) while the lowest value (49.67) was obtained from J_3. The highest a & b values of missi roti (5.77, 25.02) were obtained from J_4 and lowest from J_3 (3.63) and J_1 (23.87) respectively.

In maize incorporated missi roti, the highest value of lightness (52.28) was obtained from M_1 followed by M_2 (51.90) and M_4 (50.19) while the lowest value (46.63) was obtained from M_3. The highest a & b values of missi roti (6.97, 27.86) were obtained from M_4 and lowest from M_1 (3.88) and M_3 (22.63) formulation respectively.

In mixed flour incorporated missi roti the highest value of lightness (52.28) was obtained from Mix_1 followed by Mix_4 (52.04) and Mix_2 (49.53) while the lowest value (46.13) was obtained from Mix_3. The highest a and b values of mixed missi roti (5.44, 27.15) obtained from Mix_2 and lowest from Mix_1 (3.88) and Mix_3 (22.79) formulation respectively.

4.5 IVSD and Water absorption capacity of missi roti mix

The results of IVSD and WAC of instant missi roti mix are given in Table 9.

In- Vitro starch digestibility

It is evident from the table 9, that in-vitro starch digestibility of bajra based missi roti ranged from 3.06(B_2) to 3.69(B_3) percent, in the jowar based missi roti from 3.43(J_1) to 5.24(J_3) percent, in the maize based missi roti from 3.43(M_1) to 5.09(M_4) percent and in mixed flour missi roti from 2.63(Mix_2) to 3.43(Mix_1) percent in the formulations.

Table 9 IVSD and WAC of missi roti mix

Formulations	In-vitro starch digestibility (%)	Water absorption capacity (ml/100g)
B_1/J_1/M_1/Mix_1	3.43	132.2
B_2	3.06	136
B_3	3.69	136.4
B_4	3.15	138
J_2	4.54	134
J_3	5.24	137
J_4	4.01	140
M_2	3.44	133.3
M_3	5.05	136.2
M_4	5.09	142
Mix_2	2.63	133
Mix_3	2.88	146
Mix_4	2.95	142

Water absorption capacity

It is evident from the results that the water absorption capacity was decreased with the inclusion of different cereal/ pulse flours in missi roti mix formulations. The WAC of different missi roti mixes ranges from 132.2 to 138 ml/100g in missi roti mix of bajra, 132.2 to 140 ml/100g in jowar based missi roti mix, 132.2 to 142 ml/100g in maize based missi roti mix and 13.2. to 146 ml/100g in mixed flour missi roti mix.

4.6 Proximate Analysis

The blending of cereals and pulses to make different formulations of instant missi roti mix affected the proximate composition of instant mix. The results for the different biochemical parameters are given in Table 10 to 13.

4.6.1 Proximate analysis of missi roti mix fortified with Bajra and soybean.

Moisture content varied from 8.20 to 8.78 % as shown in the Table 10, B_2 exhibited maximum moisture content followed by B_3, B_4 and B_1 formulation with minimum moisture content. B_2 and B_3 were statistically at par to each other. It is clear from Table 10 that protein ranged from 13.76 to 17.51 percent in different formulations of missi roti mix. Formulation B_4 had significantly maximum protein content followed by B_3, B_2 and B_1 with the minimum protein content. The range of fat content was found to be 4.02 to 5.84 percent in various bajra based missi roti formulations as presented in Table 10. The maximum fat content exhibited by B_4 formulation followed by B_3, B_1 whereas minimum fat content present in B_2 formulation. B_3 and B_1 were statistically at par with each other. It is clear from table, that original missi roti (B_1) exhibited highest carbohydrate content (62.38) followed by B_2 (60.06), B_3 (57.60) and B_4 showed the lowest (55.86) content. All formulations were statistically at par from each other.

Table 10 Proximate analysis of missi roti mix fortified with Bajra and soybean.

Formulations	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Crude Fiber (%)	Ash (%)	Energy value (k.cl)
B_1	8.20	13.76	5.01	62.38	1.60	2.5	349.65
B_2	8.78	14.88	4.02	60.06	1.66	2.52	335.94
B_3	8.76	16.19	5.06	57.60	1.72	2.60	340.7
B_4	8.57	17.51	5.84	55.86	1.80	2.70	346.04
SEM±	0.054	0.054	0.06	0.803	0.071	0.104	0.232
CD at 5%	0.173	0.170	0.19	2.532	0.226	0.328	0.763

Data presented in the Table 10 showed that the crude fiber ranged from 1.60 to 1.80 percent in various missi roti formulations. Formulation B_4 had maximum crude fiber content followed by B_3, B_2 and B_1 showed the lowest content. All formulations were statistically at par from each other. The ash content in different missi roti mix ranged from 2.50 to 2.70 percent. It is obvious from Table that B_4 had maximum ash content followed by B_3, B_2 and B_1 exhibited the minimum content. All the formulations were statistically at par with each other. Maximum energy value was exhibited by formulation B_1 (349.65) and minimum in B_2 (335.94k.cl). B_1 formulation was significantly superior to other formulations.

4.6.2 Proximate analysis of missi roti mix fortified with jowar and soybean.

The proximate composition of jowar based missi roti mixes were showed in table 11. Moisture content varied from 8.20 to 8.76 percent in all missi roti mix formulations. J_3 exhibited maximum moisture content followed by J_4, J_2 and J_1 formulation with minimum moisture content. It is clear from table that protein ranged from 13.76 to 16.69 percent in different formulations of missi roti mix. J_4 contains maximum protein content and it was statistically superior to other formulations.

Table 11 Proximate analysis of missi roti mix fortified with Jowar and soybean.

Formulations	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Crude Fiber (%)	Ash (%)	Energy value (k.cl)
J_1	8.20	13.76	5.01	62.38	1.60	2.50	349.65
J_2	8.35	14.44	3.28	59.45	2.84	2.40	325.08
J_3	8.76	15.57	4.14	57.64	3.76	2.30	330.1
J_4	8.38	16.69	4.81	57.86	4.18	2.50	341.49
SEM±	0.058	0.064	0.057	0.691	0.052	0.098	0.36
CD at 5%	0.185	0.204	0.181	2.179	0.166	0.309	0.926

The range of fat content was found to be 3.28 to 5.01percent in various missi roti mix formulations. J_1 was statistically superior to J_4 formulation. An appraisal of table 11 showed that original missi roti mix J_1 (control) exhibited highest carbohydrate content (62.38%) and minimum content in J_4 (57.64%). All combinations except J_1 were statistically at par to each other. The crude fiber content of missi roti mix ranged from 1.60 to 4.18 percent in various formulations. J_4 contains maximum fiber content. The ash content in different blends of missi roti mix ranged from 2.3 to 2.5 percent. It is obvious from table that formulation J_4 had statistically maximum ash content followed by J_1, J_2 and J_3 showed the minimum content. All formulations were become statistically at par with each other. Maximum energy value provided by formulation J_1 (349.65) and minimum by J_2 (325.08k.cl). J_1 was significantly superior to other formulations.

4.6.3 Proximate analysis of missi roti mix fortified with Maize and soybean

The proximate composition of maize based missi roti mix is presented in table 12. Moisture content varied from 7.60 to 8.78 percent in all missi roti mix formulations. M_2 exhibited maximum moisture content followed by M_2, M_3 and M_4 formulation with minimum moisture content.

Table 12 Proximate analysis of missi roti mix fortified with maize and soybean.

Formulations	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Crude Fiber (%)	Ash (%)	Energy value (k.cl)
M_1	8.20	13.76	5.01	62.38	1.60	2.50	349.65
M_2	8.78	15.57	4.54	57.86	2.08	2.53	334.58
M_3	7.97	16.26	5.34	55.44	2.26	2.40	334.86
M_4	7.60	17.44	6.08	53.46	2.46	2.60	338.32
SEM±	0.057	0.054	0.071	0.553	0.055	0.090	0.432
CD at 5%	0.181	0.173	0.226	1.743	0.176	0.283	1.23

It is clear from Table 12 that protein ranged from 13.76 to 17.44 percent in different formulations of missi roti mix. M_4 contains maximum protein content and it was statistically superior to rest of the formulations whereas M_1 exhibited minimum protein content. The range of fat content was found to be 4.54 to 6.08 percent in various missi roti mix formulations as presented in table. M_4 exhibited maximum fat content and M_2 contains minimum fat content. It is clear from table that original missi roti mix M_1 (control) exhibited maximum carbohydrate content (62.38%) hence it became statistically superior to rest of the formulations. M_4 showed the minimum carbohydrate content (53.46%). The crude fiber content of missi roti mix ranged from 1.60 to 2.46 percent in various formulations. M_4 exhibited maximum fiber content and M_4 and M_3 were statistically at par to each other. The ash content in different blends of missi roti mix ranged from 2.4 to 2.6 percent. M_4 was numerically superior to other formulations whereas M_3 contain minimum ash content. All formulations were statistically at par to each other. Maximum energy value were present in formulation M_1 (349.65k.cl) and minimum in M_2 (334.58k.cl) /100g. M_3 and M_2 were statistically at par to each other.

4.6.4 Proximate analysis of missi roti prepared from mixed flour

Moisture content varied from 8.17 to 8.95 percent as shown in the Table 13 in all missi roti mix formulations. Mix_2 exhibited maximum moisture content followed by Mix_4, Mix_1 and Mix_3 formulation with minimum moisture content.

Table 13 proximate analysis of missi roti prepared from mixed flour

Formulations	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Crude Fiber (%)	Ash (%)	Energy value
Mix_1	8.20	13.76	5.01	62.38	1.60	2.50	349.65
Mix_2	8.95	14.57	3.82	60.25	2.42	2.40	333.66
Mix_3	8.17	15.63	4.76	58.64	2.72	2.25	339.92
Mix_4	8.58	15.01	5.42	58.50	3.20	2.00	342.82
SEM±	0.059	0.076	0.045	0.585	0.082	0.795	0.532
CD at 5%	0.188	0.107	0.143	1.841	0.183	0.250	1.63

The protein ranged from 13.76 to 15.63 percent in different formulations of missi roti mix. Mix_3 exhibited maximum protein content followed by Mix_4, Mix_2 and Mix_1 formulation with minimum protein content. The range of fat content was found to be 3.82 to 5.42 percent in various missi roti mix formulations as presented in table. Mix_4 exhibited maximum fat content and Mix_2 contains minimum fat content. An appraisal of table, showed that original missi roti Mix_1 (control) exhibited highest carbohydrate content (62.38%) and minimum content in Mix_4 (65.45%). The crude fiber content of missy roti mix ranged from 1.60 to 3.20 percent in various formulations. Mix_4 was numerically superior to other formulations. The ash content in different blends of missi roti mix ranged from 2.00 to 2.5 percent. It is obvious from table, that formulation Mix_1 had statistically maximum ash content followed by Mix_2, Mix_3 and Mix_4 showed the minimum content. All formulations were statistically at par with each other**.** Maximum energy present in formulation Mix_1 (349.65) and minimum in Mix_2 (333.66k.cl). Mix_1 is significantly superior to other formulations.

4.7 Mineral content

The micro and macro nutrients are presented in Table 14 with respect to various formulations of instant mix made from different flour blends. An appraisal of table presented that the original missi roti mix and its modification varied significantly from each other in respect to all the macro and micro nutrients studied.

4.7.1 Mineral composition of missi roti mixes.

Iron

A perusal of Table 14 showed that the iron content varied from 5.12 (B_1) to 6.82 mg (B_4) in bajra based missi roti mix, 5.12(J_1) to 5.45 mg (J_4) in jowar based missi roti mix, 5.02 (M_2) to 5.12 mg (M_1) in maize based missi roti mix, 5.12 (Mix_1) to 5.40 mg (Mix_3) in mixed flour missi roti mix prepared from various flours.

Table 14 Mineral compositions of missi roti mixes

Formulations	Iron (mg/100g)	Calcium (mg/100g)	Phosphorus (mg/100g)
$B_1/J_1/M_1/Mix_1$	5.12	60.32	332.54
B_2	5.91	68.32	338.70
B_3	6.43	77.32	350.75
B_4	6.82	85.82	365.75
J_2	5.13	64.92	323.90
J_3	5.26	71.82	328.55
J_4	5.45	79.87	339.85
M_2	5.02	71.12	367.04
M_3	4.98	76.52	384.29
M_4	5.08	83.82	419.29
Mix_2	5.22	62.82	330.59
Mix_3	5.40	68,27	339.80
Mix_4	5.32	64.92	364.34

Calcium

The calcium content of bajra based missi roti mix ranged from 60.32(B_1) to 85.82 mg/100 g (B_4), Jowar based missi roti mix varied from 60.32(J_1) to79.87 mg/100 g (J_4), Maize based missi roti mix ranged from 60.32(M_1) to 83.82 mg/100 g (M_4) and in case of mixed flour missi roti mix ranged from 60.32 (Mix_1) to 68.27mg/100 g(Mix_3).

Phosphorus

An appraisal of the Table 14 showed that the phosphorus content in bajra based missi roti mix varied from 332.54(B_1) to 365.75(B_4) mg/100g, in jowar based missi roti mix 323.54 (J_2) to 339.85(J_4) mg/100g, in maize based missi roti mix 332.54 (M_1) to 419.29 (M_4) mg/100g, in mixed flour missi roti mix 330.59 (Mix_2) to 364.34 (Mix_4) mg/100g.

4.8 Changes in Overall acceptability of missi roti mix during storage.

Mean score of overall acceptability of missi roti prepared from different mixes are presented in Table 15, Plate no.5 and 6 It has been showed that overall acceptability of all missi roti was decreased with increase in storage period. Formulation B_2 (Bajra) packed in polypropylene (P_1B_2) exhibited the highest acceptability (7.78) up to the end of storage at 90 day followed by packed in low density polyethylene (P_2B_2) with 7.50 score as compared to control sample. Minimum score (7.45) was found in P_3 B_2 after 90 day of storage in Aluminum foil.

Table 15 Overall acceptability of missi roti mix during storage.

Formulations	0 days	30 days	60 days	90 days
P_1 C	8.33	8.10	7.80	7.60
P_2 C	8.33	7.90	7.60	7.40
P_3C	8.33	7.75	7.52	7.30
P_1 B_2	8.46	8.44	8.20	7.78
P_2 B_2	8.46	8.20	8.00	7.50
P_3B_2	8.46	7.90	7.75	7.45
P_1 J_2	8.43	8.40	8.20	8.00
P_2 J_2	8.43	8.28	8.08	7.75
P_3J_2	8.43	8.10	7.80	7.50
P_1 M_3	8.34	8.20	7.95	7.75
P_2 M_3	8.34	8.00	7.75	7.50
P_3M_3	8.34	7.85	7.55	7.35
P_1 Mix_3	8.46	8.30	8.20	8.00
P_2 Mix_3	8.46	8.10	7.90	7.75
P_3Mix_3	8.46	7.80	7.60	7.45

P_1- Polypropylene, P_2- low density Polyethylene, P_3- Aluminum foil, C – $B_1/J_1/M_1/Mix_1$

Best formulation in sensory analysis- B_2,J_2 ,M_3, Mix_3

Formulation J_2 (Jowar) packed in polypropylene (P_1 J_2) showed the highest acceptability (8.00) up to the end of storage at 90 days followed by packed in low density polyethylene (P_2J_2) with 7.75 score as compared to control sample. Minimum score (7.50) was found in P_3 J_2 after 90 day of storage in Aluminum foil. Formulation M_3 (Maize) packed in polypropylene (P_1 M_3) showed highest acceptability (7.75) up to the end of storage at 90 days followed by packed in low density polyethylene (P_2M_3) with 7.50 score as compared to control sample. Minimum score (7.35) was found in P_3M_3 after 90 day of storage in Aluminum foil. Formulation Mix_3 packed in polypropylene (P_1 Mix_3) showed highest acceptability (8.00) up to the end of storage at 90 days followed by packed in low density polyethylene (P_2Mix_3) with 7.75 score as compared to control sample. Minimum score (7.45) was found in P_3Mix_3 after 90 day of storage in Aluminum foil.

DISCUSSION

The 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 given in detail in the preceding chapter.

5.1 Development of cereal and pulse based missi roti mix

Under the present study modified missi roti prepared by replacing wheat flour (65%) by bajra/jowar/maize flour (10-45%) and chickpea (30%) by soybean flour (5-20%) in different combinations. 5 % dried spices i.e. fenugreek(2.5g) , onion (1 g), coriander (1g), chilli (0.5g) were added in all combinations. Roti was prepared by mixing all ingredients with warm water to prepare stiff dough. Mason and Hoseney (1980) used boiling water to mix the dough in order to gelatinize the starch. Similar formulations were developed by kadam et.al. (2012) using wheat, chick pea, soybean and methi leaf powder. Some work has been done to develop procedures for preparing chapaties with flours other than wheat, such as pearl millet (Olewnik et al. 1984). Other procedures have been developed for preparing chapaties by replacing part of wheat flour with a non-glutinous flour and adding a soy supplement (Ebeler and Walker 1983).

5.2 Optimization

Different kinds of blends were developed to make chapattis and subjected to sensory evaluation. The optimization of various ingredients used in the missi roti preparation given in chapter III. 10 ml of oil /100gm of instant mix required for improving the texture of missi roti dough. Roti was prepared from bajra B2 and jowar J2 (Wheat 45:chickpea 25 :bajra/jowar 20 :soybean 5), maize M3 (wheat flour 35: chickpea flour 15: maize flour 30 :soybean flour 15) and mixed flour Mix_3 (wheat 25, chickpea 15, bajra 15 +jowar 15 +maize 15,soybean 5) were found to exihibit good in all sensory attributes as compared to other samples. The results revealed that the sensory scores of various attributes viz; colour & appearance in range 8.34 to 8.46 flavor 8.04 to

8.56, taste 8.42 to 8.58, texture 7.52 to 8.44 and overall acceptability in between 8.33 to 8.46 in the missi rotis. This may be due to addition of different cereals and soybean flour in appropriate combination. Kadam et.al. (2012) reported that on increasing the level of chickpea flour at the level of 25 and 30%, there were a decrease in the textural quality and overall acceptability of the missi roti. This indicates that higher amount of chickpea flour beyond 20% affected the textural quality characteristics. On the basis of their observations the blend consisting of 80:20 (wheat flour: chickpea flour) was considered the best for preparation of good quality chapattis. Gomez et al.(2008) studied the quality of cake prepared by using blend of wheat flour and cowpea and observed that the replacement of wheat flour by chickpea flour induced an increase in the initial firmness but cohesiveness and resilience diminished, increasing the tendency to hardening. Replacement of 50-80% of the wheat flour with other cereal grains could be achieved, and an acceptable chapati could still be produced (Ebeler and Walker, 1983). This product is made by mixing the flour and water to develop the dough, after relaxing; balls are sheeted (Gujral and Pathak, 2002).

5.3 Acceptability of missi roti prepared from different flours

As per the result showed in table 2-5, missi roti prepared from different flour of cereals and pulses were not found much difference in sensory qualities. Bajra/jowar and soybean fortified missi roti, formulation B2/J2 (45 wheat flour: 25 chickpea: 20 bajra/jowar: 5 soybean: 5 dried spices) were most acceptable than other formulations. This may due to good flavor, taste and texture of roti. In case of maize and soybean fortified missi roti combination M3 (35 wheat flour :15 chickpea : 30 maize: 15 soybean:5 dried spices) was accepted as best than other formulations. Missi roti prepared form mixed flour of cereals and pulses Mix3 (25 wheat flour: 15 chickpea :15g each bajra +jowar+maize: 15 soybean:5 dried spices) was found acceptable with overall acceptability score 8.46. As per the results increased level of soybean decreased the sensory score due to poor taste. This was supported by Singh et.al. (1996) as chapattis prepared from blended wheat flour with more than 20% defatted soy flour had undesirable taste. kadam et.al. (2012) also incorporated chickpea, soy and fenugreek leaves powder at different levels to wheat flour chapaties and found good in sensory acceptability. Gandhi et al. (1983) demonstrated that chapattis made from wheat flour containing 10-15% soy flour were of satisfactory flavour, texture, appearance and overall acceptability by trained sensory panel, although flavour and texture were significantly different from the all-wheat-flour chapattis. Similarly Lindell and Walker (1984) also found that soy supplemented wheat flour chapattis would fulfill a nutritional need as they are higher in fat and protein with a well-balanced profile of amino acids.

5.4 Physical and functional attributes of cereals and pulses based missi roti mix and its roti

An appraisal from table 6, number of roties (5), weight of roti, diameter, area, circumference and Bulk density (composite flour) of all combinations were nearly found to be same. The mechanical and rheological properties of the dough exert promising effect on the overall quality of baked products as reported by Blokshma and Bushuk, 1988. In this regard, Lindahl, 1990 suggested that the final product quality depends upon the dough rheology taking place during the processing of the constituents. The nature of ingredients, their proportions, mixing time and beating conditions are responsible for the quality of batter which finally determines the baked product quality (Baixauli *et al.,* 2007). Dhaliwal et al., 1996 suggested that the chapatti should be easily torn and flexible so that it can be folded by the forefinger and thumb. The size and shape of the chapattis vary from region to region, culture to culture and family to family but normally these are circular or round disc in shape and size of 150-200 mm in diameter and 1-4 mm thickness.

Studies of water absorption capacity of proteineous material are useful in assessing potential food application products. Water absorption capacity expressed in ml of water by 100 gm of flour was determined from instant mix made from different cereal and pulses are reported in Table 9. The water absorption capacity was found to be maximum in formulations B_4, J_4, M_4, Mix_3 (bajra, jowar, maize, mixed flour instant mix). As these results supported by Varnashree et.al. (2008) increased the protein content has been associated with the water binding properties in flour. Water absorption capacity increased from a value of 2.05g/g for the100% wheat flour to 2.52g/g for the 80:20 wheat /maize flour. The dough rheological properties are influenced by the structure of the aggregates and their tendency to interact with each other. Quality and quantity of the proteins affect the water absorption capacity of the dough (Finney, 1984). More water absorption with sticky dough is observed by Ahluwalia and Kuar, 2001, as the fiber content of chapattis was increased and the mixing time of the dough was decreased.

5.5 Hunter colour analysis

Colour is an important quality attributes that influence consumer acceptance of many food products. Consumer do not accept products in which colour varies from the expected normal appearance (Sen *et al*., 2004). Products prepared with wheat, bajra, maize, jowar, chickpea, soybean showed significant differences in colour values which may be due to incorporation of different concentration of the flours in mixes. The variation in the colour is also due to type of ingredients used.

5.6 Proximate composition of instant missi roti mixes.

As can be seen from the Table 10-13, gradual increase in protein, fat, crude fiber and ash content and decrease in carbohydrate with modification was observed in instant missi roti mixes. The increase may be due to addition of cereals and soybean flour in modified recipe which are rich in these nutrients. The increase in the nutritive value of flour by supplementation of other vegetables has also been reported by Sawhney and Kawatra (1986) and Geeta and Sadana (1995) . Calcium, phosphorus and ion were found to increase on supplementation of soy flour. The increase in the nutritive value of flour by supplementation of 10% full fat soy flour has also been reported by Singh et. al. (2004). Maize flour has higher content of ash, moisture, fat and dietary fibre which explains the slight increases in these components with increased substitution (Whistler et al., 1984).

5.9 Storage studies

The best accepted instant missi mixes were selected for storage studies. Instant mixes were packed in polypropylene, low density polyethylene and aluminium foil bags and stored at ambient temperature for 90 days. The overall acceptability of mixes was significantly affected by different processing variables and declined with increased in storage period. The highest mean scores for overall acceptability was found in polypropylene bag for instant mix up to 90 days. The overall acceptability of instant mix flour stored in polypropylene had better results as compared to low density polyethylene and aluminium bags. Thus, on the basis of results given in table it has been concluded that storability of products were better in polypropylene pouch for period of 3 months. Similar result has been reported by Malleshi et al., (1989) with regards to composite flour. The overall acceptability of instant mix flour stored in polypropylene had better result as compare to low density polyethylene and aluminium foil. The minimum value in aluminium foil might be due to high moisture absorption and permeability of atmospheric gasses involved in reduction of colour and flavor (John, 2010).

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

Missi roti is a delicious Indian flatbread made with a mixture of gram flour and wheat flour and seasoned with spices. Chapati is either leavened or unleavened flat bread consumed throughout the Indian subcontinent and other parts of Middle East. Chapaties constitute an important source of dietary proteins, calories, some of the vitamins and minerals for a large section of Indian population. In present study composite flour mixes including coarse cereals, legumes, dried leafy vegetable and spices were formulated so as to make the product available for people in general. Therefore the present study was conducted to the test of suitability and optimization of different cereals (bajra/jowar /maize) and soybean flour in missi roti mixes. The obtained results on various parameters i.e. sensory, physical, functional, nutritional and storage studies have been made and summarized in the following points.

1. In Bajra and jowar based missi roti B2 and J2 were found most acceptable with the ratio of Wheat (45): , chickpea (25) ,Bajra,/jowar (20): soybean (5), whereas chapatti prepared from wheat 35, chickpea 15, maize 30, soybean 15 was most acceptable in maize based missi roti. Mixed flour roti was found most acceptable with wheat 25, chickpea 15, bajra15, jowar 15, maize 15 and soybean 5. 5% dried spices were added in all combinations.
2. A Non-significant difference was observed in case of all physical parameters such as bulk density of flour, number, weight, area, circumference and diameter of missi roti.
3. Hunter colour analysis of all instant missi roti mixes and roti showed decreased in L-value in all samples with supplementation of various cereals and pulse flours to mixes.
4. The water absorption capacity was found to be maximum in B_4, J_4, M_4 and Mix_3 prepared from bajra, jowar, maize, mixed flour respectively.

5. The in vitro starch digestibility was found to be maximum in B3, J3, M4 and Mix1 of different composite flours.
6. All instant missi roti mixes prepared from cereals and soybean were nutritionally superior in terms of protein, fiber, ash, fat and minerals i.e. iron and phosphorus.
7. The highest amount of phosphorus exhibited by B4, J4, M4, Mix4; calcium by B4, J4, M4, Mix3 and Iron by B4,J4,B1,Mix4 formulations.
8. Polypropylene was found to be the best as compared to other packaging materials for storage of instant mix up to 90 days.

Conclusion

In the present investigations, different kinds of composite flours were made from wheat flour, bajra flour, jowar flour, maize flour, chickpea flour, full fat soy flour, dried spices and subjected to sensory evaluation in the form of chapatti. The results showed that bajra and jowar 20%, maize 30% and bajra, jowar and maize each 15% in mixed missi roti combinations could be considered best due to excellent sensory quality characteristics. All instant missi roti mixes prepared from cereals and soybean were nutritionally superior in terms of protein, fiber, ash, fat and minerals i.e. iron and phosphorus. The supplementation of soy flour in wheat flour for missi roti preparation revealed that 5-15% processed soy flour were good without changing in the sensory characteristics of the roti. The storage of different kinds of flours in polypropylene bags revealed that there were no changes in the sensory quality of the flours during storage periods. These results will have considerable relevance in future years, when like bread, the large scale mechanized production and marketing of missi roti is likely to become a reality in the Indian subcontinent.

Suggestions for further work

Although the present investigation has given much useful information on various aspects of “instant missi roti mix and roti”, yet some more work should be carried out on the following aspects.

1. Economic feasibility of instant missi roti mixes and roti should be evaluated.
2. Assessment for micronutrient availability, and *in-vitro* protein digestibility should be studied.
3. Assessment of microbial load at various stages of processing and storage should be evaluated.
4. Similar kind of studies can be planned with other products to get more information on traditional foods.

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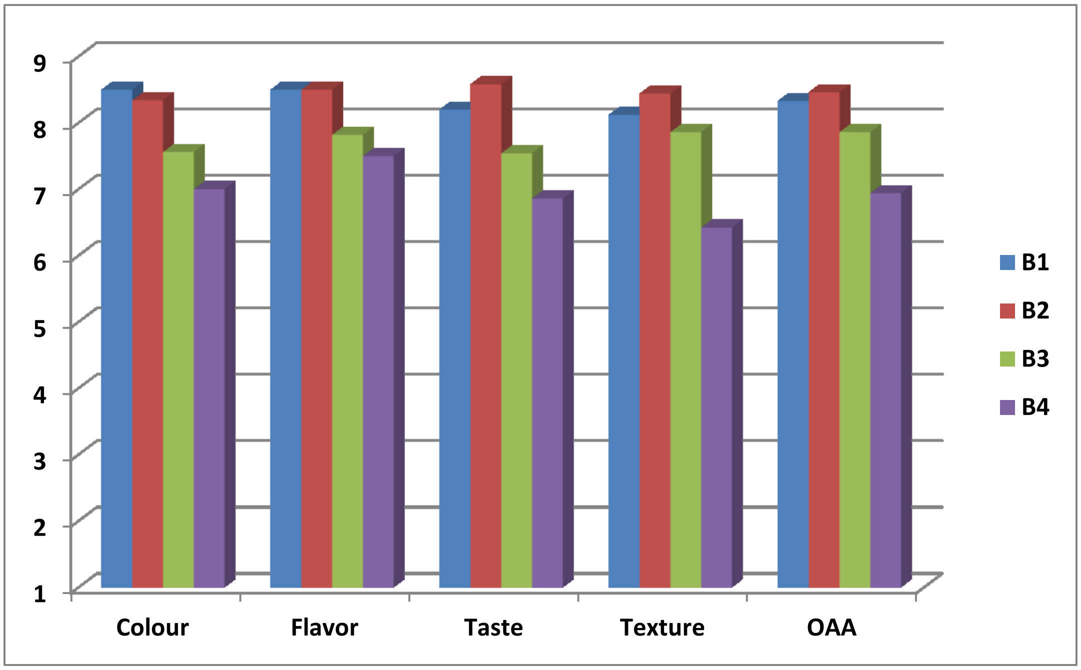

Fig. 1 Sensory attributes of Missi roti fortified with Bajra and Soybean.

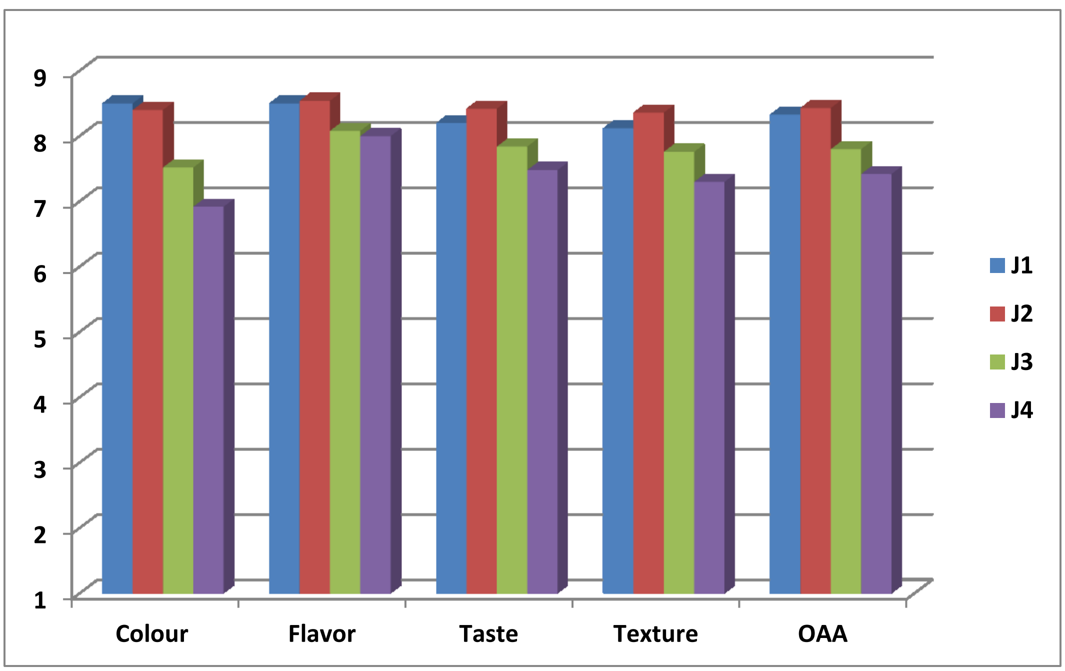

Fig. 2 Sensory attributes of Missi roti fortified with Jowar and Soybean.

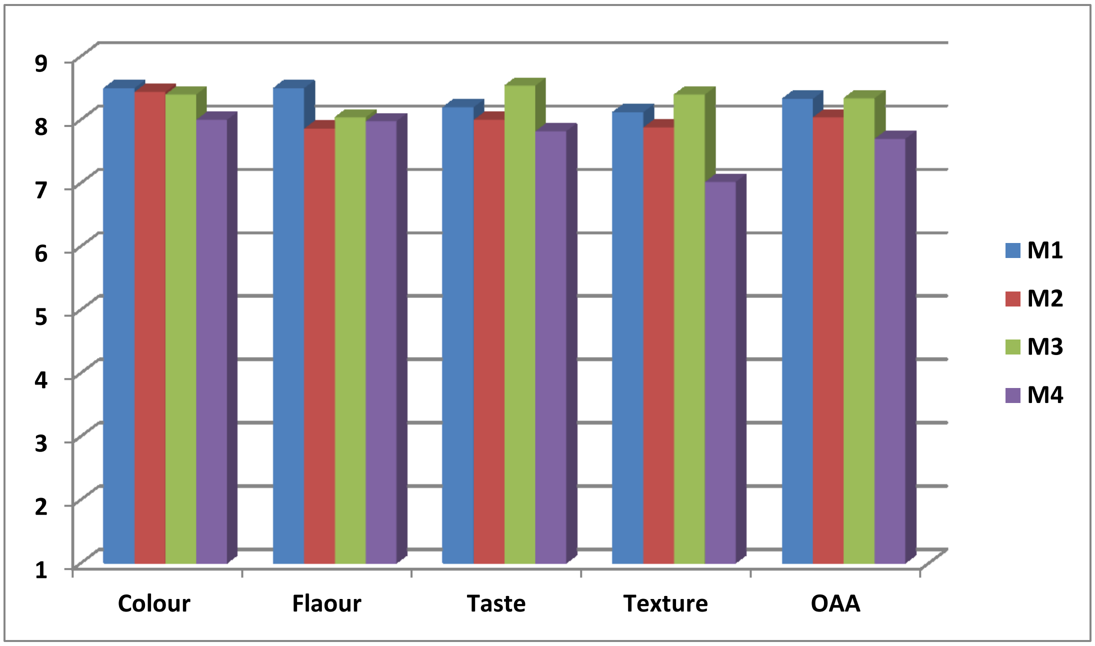

Fig. 3 Sensory attributes of Missi roti fortified with Maize and Soybean.

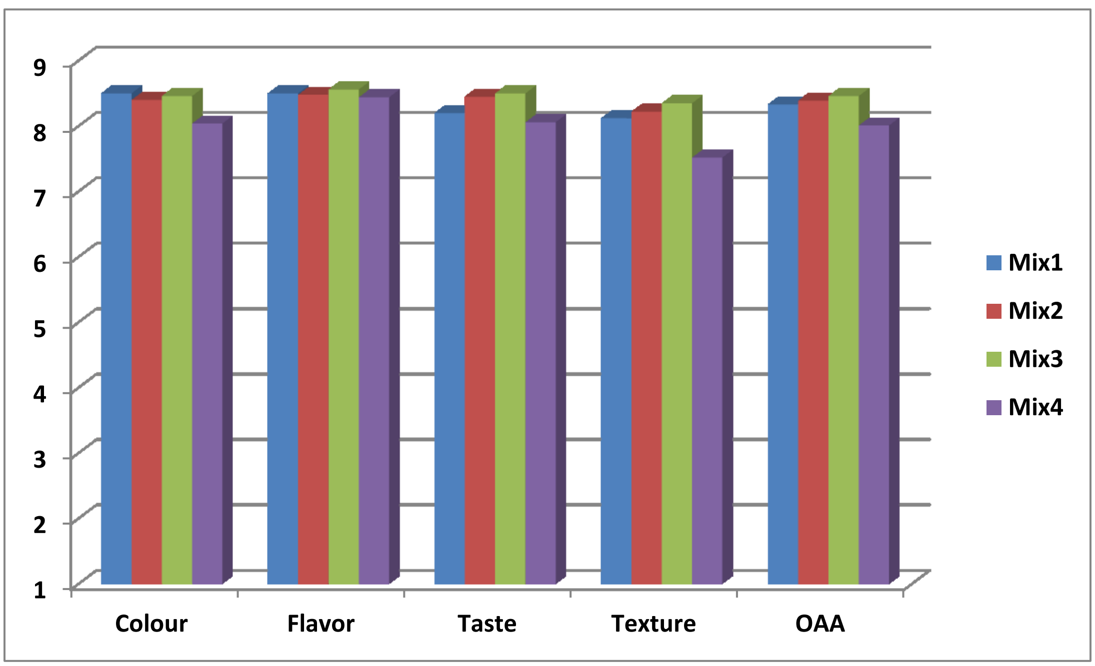

Fig. 4 Sensory attributes of missi roti prepared from Mixed flour.

ABSTRACT

Title of the thesis	:	**"Formulation and Quality evaluation of composite flour for Missi roti"**
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ABSTRACT

Composite flour technology refers to the process of mixing various cereal based flours to produce high quality food products in an economical way. Formulation of composite flour is vital for development of value-added products with optimal functionality (Rehman et. al. 2007). It has not only better nutritional quality but also the necessary attributes for consumer acceptance. Use of composite flour based on wheat and coarse cereals in process products is becoming popular because of the economic and nutritional advantages. The composite flours containing wheat and legumes are being utilized in many parts of the world.

Missi roti is a delicious Indian flatbread made with a mixture of gram flour and wheat flour and seasoned with spices. Chapati is either leavened or unleavened flat bread consumed throughout the Indian subcontinent and other parts of Middle East. Chapaties constitute an important source of dietary proteins, calories, some of the vitamins and minerals for a large section of Indian population. In present study composite flour mixes including coarse cereals, legumes, dried leafy vegetable and spices were formulated so as to make the product available for people in general. Therefore the present study was conducted to the test of suitability and optimization of different cereals (bajra/jowar /maize) and soybean flour in missi roti mixes. The obtained results on various parameters i.e. sensory, physical, functional, nutritional and storage studies have been made and summarized.

In Bajra and jowar based missi roti B2 and J2 were found most acceptable with the ratio of Wheat (45) : chickpea (25) : Bajra,/jowar (20) : soybean (5), whereas chapatti prepared from wheat 35, chickpea 15, maize 30, soybean 15 was most acceptable in maize based missi roti. Mixed flour roti was found most acceptable with wheat 25, chickpea 15, bajra15, jowar 15, maize 15 and soybean 5. 5% dried spices were added in all combinations. A Non-significant difference was observed in case of all physical parameters such as bulk density of flour, number, weight, area, circumference and diameter of missi roti. Hunter colour

analysis of all instant missi roti mixes and roti showed decreased in L-value in all samples with supplementation of various cereals and pulse flours to mixes. The water absorption capacity was found to be maximum in B_4, J_4, M_4 and Mix_3 prepared from bajra, jowar, maize, mixed flour respectively. The in vitro starch digestibility was found to be maximum in B3, J3, M4 and Mix1 of different composite flours. All instant missi roti mixes prepared from cereals and soybean were nutritionally superior in terms of protein, fibre, ash, fat and minerals i.e. iron and phosphorus. The highest amount of phosphorus exhibited by B4, J4, M4, Mix4; calcium by B4, J4, M4, Mix3 and Iron by B4,J4,B1,Mix4 formulations. Polypropylene was found to be the best as compared to other packaging materials for storage of instant mix up to 90 days.

In the present investigations, different kinds of composite flours were made from wheat flour, bajra flour, jowar flour, maize flour, chickpea flour, full fat soy flour, dried spices and subjected to sensory evaluation in the form of chapatti. The results showed that bajra and jowar 20%, maize 30% and bajra, jowar and maize each 15% in mixed missi roti combinations could be considered best due to excellent sensory quality characteristics. All instant missi roti mixes prepared from cereals and soybean were nutritionally superior in terms of protein, fiber, ash, fat and minerals i.e. iron and phosphorus. The supplementation of soy flour in wheat flour for missi roti preparation revealed that 5-15% processed soy flour were good without changing in the sensory characteristics of the roti. The storage of different kinds of flours in polypropylene bags revealed that there were no changes in the sensory quality of the flours during storage periods. These results will have considerable relevance in future years, when like bread, the large scale mechanized production and marketing of missi roti is likely to become a reality in the Indian subcontinent.

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a. Fruit Processing Technology
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For the partial fulfilment of the master's degree programme she was allotted a research work on "Formulation and development of instant traditionalfood mix based on millet" which was successfully conducted by her and being submitted in the form of the thesis.