Development of Nutritious Beverage from Barley with Peanut and Bengal gram

By

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CERTIFICATE – I

This is to certify that this research work report entitled, "**Development of nutritious beverage from Barley with Peanut and Bengal gram**" submitted for the degree of **Master of Science** in the subject of **Food Science and Technology**, to the **Chaudhary Charan Singh Haryana Agricultural University, Hisar**, is a bonafide research work carried out by **Sheetal Mishra** under my supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE – II

This is to certify that this research work report, entitled **"Development of nutritious beverage from Barley with Peanut and Bengal gram"**, submitted by **Sheetal Mishra** to the **Chaudhary Charan Singh Haryana Agricultural University, Hisar,** in partial fulfillment of the requirement for the degree of **Master of Science** in the subject of **Food Science and Technology**, has been approved by the Student's Advisory Committee, after an oral examination on the same.

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Place: Hisar **Sheetal Mishra**

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CHAPTER – I

INTRODUCTION

Cereals are the primary staple food in the world since ancient times. Legumes and oilseeds have high food value and play important roles in the diet of most of the people in the world. These grains are second only to cereals as a source of human and animal food. Since long time, cereals and legumes have been an integral part of the staple diet of most Indians because amino acid composition of legumes and cereals are complementary (Duszkiewicz-Reinhard *et al.,* 1988). Pulses have also been called "the poor man's meat" because of their high protein content. Besides protein, legumes are also important sources of calories as well as certain minerals and vitamins essential to human nutrition (Bahnassey *et al*., 1986).

Protein quality of cereals is poor. However, when mixed with pulses and oilseeds like peanuts and soybean, the quality of total dietary protein can match to that of milk proteins. The proteins present in cereals are deficient in some essential amino acids such as lysine and threonine while pulses contribute higher amounts of these amino acids, a combination of cereals and pulses can bring a balance in amino acid composition for better utilization by human body. Pulses occupy an important place in human nutrition particularly in developing countries.

Barley (*Hordeum vulgare* L.) is the world's fourth most important cereal after wheat, rice and maize. Its annual production in India is 1.74 million tonnes which is largely confined to U.P., Punjab and Haryana. It is an important winter season (rabi) cereal crop. In Haryana, barley crop cover 58,000 hectares of land area and total yield is 60,000 tonnes. Major portion (75%) is consumed as livestock feed, 20% for malting and 5% for direct food use. Barley has an attractive nutrient profile which makes it an excellent food for health conscious people. The average composition of Indian barley is 12.5% moisture, 11.5% proteins, 1.3% lipids, 1.5% minerals, 3.9% fibre and 69.3% carbohydrates. Barley is rich in β-glucan, which influences digestion and cholesterol level in blood and liver tissues. Diets those include grains with a high β-glucan content are healthful and functional diets because of hypocholesterolemic and hypoglycaemic effects. Thus it may decrease the risk of heart attack (Knuckles *et al*., 1992). Barley tea is a common drink in Japan, especially during the summer. The non-caffeinated, non-tannin drink is valued for its high content of β-glucan and the presence of antioxidant compounds (Kulkarni *et al*., 2008). Removal of husk of barley, which is largely unpalatable and indigestible, is an important part of the milling process.

Peanut (*Arachis hypogea* L.) is an annual crop. It is the third most cultivated oil seed crop in the world and is grown in almost all the tropical and subtropical countries of the world. It is grown over an area of 24.7 million hectares with a total production of 5.3 million tones (Singh *et al*., 1991). Peanut contains 25.3% proteins, 40.1% fat, 2.4% minerals, 3.1% fibre and good sources of Ca, P and Fe (Gopalan *et al*., 1998). But in addition, peanut is also endowed with flatulence factor and some anti-nutrients like phytic acid, trypsin inhibitors and lectins (Singh *et al*., 1991). Peanut is consumed as raw, boiled, roasted and in the form of confectionary items and sweets. Nearly 1.5% of total annual production i.e. approximately 90,000 tones of peanut is roasted and consumed. In developing countries a major portion of peanut is utilized for oil extraction. Peanut cake obtained after oil extraction is used as food ingredient. Few attempts have been use it as a source of proteins for human consumption (Silva *et al*., 2003).

The cake can be blended with cereals and pulses for fortification and balancing of nutrients (Narayan *et al*., 1971). Peanut cake can be processed to prepare the peanut defatted flour, protein concentrate and isolates. By these processes level of phytic acid can be reduced (Kanu *et al*., 2007). Peanut proteins perform many functions such as foaming, water absorption and emulsification which are desirable functional properties for food ingredients. Peanut flours represent potentially valuable ingredients in the formulation of protein-fortified food products (Beuchat *et al*., 1975).

Pulses are the edible dicotyledons seeds of plants belonging to the family Leguminosae. This is the second largest family of seed plants, containing about 600 genera with 13,000 species (Bahnassey *et al*., 1986). Chickpea (*Cicer arietinum* L.) or Bengal gram is the third most important grain legume in the world with 7.85 million tonnes of global output from 10.38 million ha. Chickpea is the most important pulse crop in India with 6.82 million ha area and 5.25 million tone production (Ali and Kumar, 2005). It is a multipurpose pulse crop. Its tender foliage are largely used as green leafy vegetable, the unripened grain being eaten raw or boiled, spiced and cooked as a vegetable. Gram is commonly used pulse and split cotyledons (dal) are made out of it which is a very popular item in majority of the Indian households.

Roasted gram alone or in combination with popped rice, is commonly eaten in South India (Argikar, 1970). Chickpea is a very good source of carbohydrates and proteins, which together constitute about 80% of the total dry seed weight. Starch is the principal carbohydrate constituent with 4.80 to 8.53% soluble sugar. Legumes not only add variety to human diet, but also serve as an economical source of supplementary proteins for a large

human population in developing countries like India where majority of the population is vegetarian (Sood *et al*., 2002).

Sattu is flour mixture of roasted cereals, mainly barley and combination with pulses and used as ready to eat (RTE) snacks with sugar or salt as slurry made with water or milk in most parts of India, particularly in rural areas. In summer, a soft food "sattu" is supposed to have a cooling effect on human body (Dabas, 2001).

Nutritional awareness and public education has posed great challenges to the food scientists for developing inexpensive food that is nutritionally superior and highly acceptable to intended consumers. A proper admixture of cereal, oilseeds and pulses provides the necessary calories and protein with a fairly well balanced amino acid composition. Keeping the above points in view the work has been planned with the following objectives:

1. To prepare Barley drink fortified with Peanuts and Bengal gram.
2. To assess shelf-life of developed beverage.

CHAPTER – II

REVIEW OF LITERATURE

Sattu is a popular traditional food of northern India. It is preferred item in the breakfast in some of the states particularly in Bihar and Uttar Pradesh. Sattu, in drink form, is considered as one of the best food in breakfast during the summer season due to its cooling effect and good digestibility. Sattu is basically a product, prepared from roasted cereals or combination of cereal and legumes with added flavoring agents (Mridula *et al.*, 2004). Roasting which is a simple and most commonly practiced household and village level technology, pre-cooks the dry ingredients which have long shelf-life. Roasting improves the flavour, texture and nutritive value of the grains and also eliminates most of the anti-nutritional or toxic factors present in legumes, either partially or wholly (Liener, 1976).

Amongst various legumes, bengal gram is the preferred one for making sattu, but no legume or cereal alone can provide amounts of essential amino acids. However, mixing of legume with cereal can improve the digestibility of the product. Supplementing various types of cereals with bengal gram has shown good improvement in the protein efficiency ratio. Addition of legume and oilseeds to sattu will not only improve the protein quality but also improves the taste and flavor. Earlier sattu was considered as poor man's food but nowadays the popularity of barley and bengal gram sattu amongst the diabetics is increasing day by day due to its low glycemic index.

2.1 SUPPLEMENTATION OF CEREALS WITH LEGUMES

Dabas *et al*., (2005) reported increase in protein and reducing sugars on roasting. Replacement of roasted barley flour with chickpea in sattu was acceptable at all level but a 40% substitution was suggested to be optimum from nutritional point of view.

Cereal pulse based preparations vary from region to region and community to community. Khichadi, dalia, missi-roti, dosa, idli, sattu etc. are some of the common example of such dishes. Goyal and Mathews (1985) found no significant loss of protein content in cereals, pulses and combination preparations due to various methods of cooking, whereas a significant loss was observed in case of lysine, tryptophan and sugar contents.

In rural areas, traditional weaning food, sattu consists of a mixture of chickpea and wheat (1:3) with jaggery. Devi *et al* (1990) prepared new forms with additions of green gram, groundnuts and soybeans and observed that energy content, protein and calcium increased substantially on these addition. Supplementation of cereals with legumes improved calcium utilization (Gupta and Kwatra, 1992).

Mridula *et al* (2010) standardized sattu making procedure and fortified as per FDA using wheat flour with thiamine, riboflavin, niacin, Ca and Fe and stored at 25^{O}C/65%, 35^{O}C/65% RH and at ambient condition (16-39^{O}C/18-98% RH) in low density polyethylene and aluminium laminated pouches. Alcoholic acidity was increased by 0.04% in different sattu sample during 180 days storage but was within the acceptable limit as per the BIS standard. Free fatty acid content (as oleic acid) also increased from 0.06% (in fresh) to 0.14%; however it did not affect sensory acceptability of sattu stored under different conditions. Storage temperature and packaging material did not affect the overall quality of fortified sattu except moisture content and total microbial load during six month storage. Fortified bengal gram sattu, retained the acceptable sensory quality when used in drink form.

The maximum chemical score value of the protein in a wheat-pulse combination, was obtained when the pulse content was around 10%. With rice, maize or barley, the maximum values were obtained when the content of pulse was around 20% of the mixture (Chatterjee and Abrol, 1975).

While the Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Biological Value (BV) improved with chickpea supplementation, there was no adverse effect on organoleptic acceptability of wheat bread up to the tested level of 20% supplementation (Akbar *et al*., 1986). Supplementation of maize flour bread with peanut and/or chickpea flour improved the nitrogen retention by 2-3 times in adult Human being (Khalil and Chughtai, 1987).

Sattu is sieved flour of roasted (popped) barley grain. This is consumed either in the form of a drink, consisting of the water, fresh lemon and sugar added in the required proportion, or in the form of a dough consisting of sattu and flour of roasted bengal gram with salt or sugar added to taste (Chatterjee and Abrol, 1977).

Bangoura and Guo-Nong (2006) found that aside from the beany flavor, the most common problem that limits the consumption of peanut beverage is its short shelf-life, particularly if processing is done at temperatures below 85^{O}C. Refrigeration of the peanut beverage would help to overcome this problem but refrigeration is not readily available in developing countries. Use of higher processing temperature for a longer time would extend the shelf-life of the peanut beverage and sensory qualities also be maintained.

Deshpande *et al* (2004) blended Soybean, Barley and Bengal gram in various proportions to prepare a nutritious and readymade snack food soysattu. Grains were moistened up to 30% moisture content, roasted and then powdered. Product was analysed for proximated composition, shelf life and organoleptic acceptability. Shelf life studies indicated that soysattu could be safely stored in metallic containers upto 60 days in ambient conditions

of summer and rainy seasons. They also found that, increased soy fortification increased the water holding capacity in soysattu; no urease activity was observed at any level of fortification of soy in soysattu. Increase in free fatty acids and moisture content was observed with the increase in storage period and with increased level of soy fortification. Sensory evaluation indicated that the soysattu prepared upto 30% soy fortification was acceptable.

Deshpande *et al* (2008) developed a process for a chocolate-flavoured peanut-soy beverage. The low and high bound constraints were determined for peanut (30.6 to 58.7%), soya (28.3 to 43.5%) and chocolate syrup (13.0 to 25.9%) based on lysine content, viscosity and visual stability index values of 51mg/gm protein, 36.9 mPa.s and 1.0 respectively.

Gupta and Kwatra (1992) developed new forms of traditional weaning foods, sattu with addition of green gram, groundnuts and soybeans and observed that energy content, protein and calcium increased substantially on these additions. Supplementation of cereals with legumes improved calcium utilization.

Rustom *et al* (2006) prepared strawberry-flavored and chocolate-flavored peanut beverage in a pilot plant. The product was UHT sterilized at 137^{o}C for 4 and 20sec, aseptically filled and stored at 5, 20 or 35^{o}C. Microbiological and physiochemical properties of the beverage were periodically assessed for up to 6 months. No microbial growth was observed. The pH decreased while homogenization and sedimentation indices increased with time in all beverages at all temperatures. Color lightness decreased during the first six weeks and remained constant afterwards. Viscosity of the strawberry-flavored beverage was constant whereas, chocolate-flavored beverages gelled after 19 weeks at all temperatures. Proteolysis was less than < 6% in gelled beverages.

Bijlani *et al* (1993) assessed acute post prandial and long term metabolic response to a traditional mixture of barley, bengal gram and wheat. Post prandial glycemic and insulinaemic responses were attenuated with cereal pulse mixture as compared to those with white bread. The glycaemic indexes were 68.6 and 64.9 and insulinaemic index were 88.1 and 66.0 in healthy and Non-Insulin Dependent Diabetes Mellitus (NIDDM) subjects, respectively.

2.2 COMPOSITION AND NUTRITIVE VALUE

2.2.1 Proteins

Lysine is the first limiting amino acid in cereals. Legumes like chickpea that contain excess of lysine can balance its deficiency in cereal proteins and improve their nutritional value (Steineke and Hopkins, 1983).

Bhatia *et al* (1966) assessed the processes for the production of peanut protein isolate. Fundamental studies on the sub-cellular fractions of peanut have shown that fractions containing between 75 and 85% protein can be isolated by gravity separation.

Tsen *et al* (1971) reported that a mixture of wheat flour fortified with 12% defatted soy flour (DSF) increased the lysine content by two times that of the wheat flour alone and the protein content of the bread made from such a blended flour increased by approximately 35%. In a cereal pulse combination, the proteins of respective nutritionally components complement each other.

Figurela *et al* (1987) studied the effect of the addition of 5 to 15% chickpea flour on nutritional and biological quality of wheat flour bread. Protein Efficiency Ratio (PER) values for pure wheat and the 15% chickpea blend breads were 0.9 and 1.34 respectively.

Ali (1997) developed soy supplemented sattu blends using soybean, bengal gram and barley in different proportions. Organoleptic evaluation of soy based sattu containing 15-24% protein showed good acceptability.

Gayle *et al* (1984) found that supplementation of 10-30% of peanut and chickpea flour (PCF) into wheat and maize breads increased the protein content by 20-60%. Chemical scores of proteins and nutritional value of proteins improved by addition of PCF. Supplementation of 20% level was considered adequate (Khalil and Chughati, 1984).

Attia *et al* (1994) reported that decortications of chickpea seeds caused considerable increased in their protein contents.

Three chickpea based formulae deviced by Valencia *et al* (1988) met the FAD/WHO requirements for lysine and sulphur amino acids. These were at par with casein for NPR and PER but achieved at a lower cost.

Ramanathan and Chandrasekhar (1987) standardized the process for the preparation of high protein breakfast food based on groundnut calcium proteinate. They prepared proteinate from groundnut flour by extraction at alkaline pH and subsequent precipitation of proteins with calcium chloride at neutral pH.

Kaur and Hira (1988) supplemented wheat flour with bengal gram flour at 10 to 40% levels in chapati and parantha. They found highest overall acceptability at 10% supplementation in which lysine availability increased by 18-34%.

Singh and Jambunathan (1981) reported a highly significant and negative correlation between the *in vitro* protein digestibility and the concentration of polyphenolic compounds in seed samples. Trypsin and chemotrypsin inhibition activities were positively correlated with the amount of polyphenols. Attia *et al* (1994) reported a significant increase in *in vitro* protein digestibility on decortication and cooking (Hend and shastri, 1998).

Protein content is the second major component of the barley grain with carbohydrates being the number one. Barley protein has a low content of essential amino acids (lysine, threonine, valine and isoleucine). Prolamine accounts for about 50% of total grain protein (Duffus and Cochrane, 1992).

Santosh and Rissi (1996) recorded a positive correlation between protein content and total β-amylase activity in barley. A wide range of 6-20% of crude protein has been reported in barley grains by many researchers (Verma *et al*., 1996; Chloupek *et al*., 1990).

Peanuts are traditionally processed into a variety of food products by means of dry heat processes such as oven roasting or frying in hot oil. These methods result in desirable quality changes such as moisture reduction, browning, textural improvement and development of typical roasted peanut flavour. Processing of peanuts with hot water or steam, though not as common as dry heat processing, has been found to result in products which are lacking in typical peanut flavour but have a potential application in a variety of food products such as meat analogs, beverages and confection (McWatters and Heaton, 1974).

2.2.2 Carbohydrates:

Carbohydrates are generally divided into starches, sugars and non-starchy polysaccharides. Starch is often the major components of many grain legumes (Sainy and Knights, 1984). The amylose fraction is primarily responsible for its special physicochemical behaviour in starch water systems. The oligosaccharides present in chickpea are of raffinose family i.e. α-galactosyls of sucrose viz. raffinose, stachyose and verbascose (Rao and Belavady, 1978) and have been shown to be responsible for flatulence following consumption of pulses. (Rossi *et al*., 1984).

The chemical composition of native starch is reported to contain 9.1 moisture, 0.26 nitrogen, 0.10 fat, 0.10 ash, 0.012 phosphorus and 33.2% amylose. Gelatinization temperature of bengal gram dhal was higher because of more amylose in it (Geervani and Theophilus, 1983).

Carbohydrates comprise about 80% of barley kernel and are major source of available energy (Englyst *et al*., 1983). Starch is the major constituent of barley endosperm. Barley grain contains 46.9 to 62.5% starch and hulled varieties have slightly less starch than hull less ones (Bhatty *et al*., 1975; Knuckles *et al*., 1992). Similarly waxy barley had less starch but more free sugars than non-waxy barley (Xue *et al*., 1997). Starch content in various genotypes of barley has been reported to vary from 55.7 to 72.7% (Mishra *et al*., 1974; Verma *et al*., 1996).

Barley contains low contents of soluble sugars. Out of total soluble sugars in immature barley grains, Laberge *et al* (1973) found that 80 percent of it was reducing sugars. But in the mature grains (at harvest), total soluble sugar reduced to two percent, 90 percent of which was non-reducing with about two third of it being sucrose. Henry (1988) reported small amounts of free sugars such as sucrose, raffinose and ketoses. Total soluble sugar in barley grains varied from 1.63 to 3.44 percent with soluble sugars ranging from 0.13 to 0.89 percent (Verma *et al*., 1996).

Goblirsch *et al* (1996) documented that unmalted barley contains considerable amount of β-amylase while α-amylase is formed during germination. The 50 percent β-amylase activity is located in acrospires unlike α-amylase activity which is located in endosperm i.e. 65-70 percent (Beta *et al*., 1995).

The non starch polysaccharides found in mature barley grains include fructans, β-(1,4)-D-glucan (cellulose), β-(1-3; 1-4)-D-glucan, arabinoxylan and glucomannans. The covered and naked barley differ in average contents of non starch polysaccharide (Oscarsson *et al*., 1996, 1997). Barley β-(1-3; 1-4)-D-glucans are generally regarded as undesirable components in the malting and brewing processes as these are negatively associated with the extract and causes haze formation in beer (Bamforth, 1985). However, β-glucan has been demonstrated to have hypercholesterolemic effects in animals and human beings (Newman *et al*., 1989). Similarly cellulose is also known for its beneficial effects (Jenkins *et al*., 1986).

2.2.3 Fat contents:

Fat content of chickpea varies from 7.0 to 7.8%, in which free fat comprise of 4.1-5.3% free fat and 2.3-2.9% bound fat (Murthy and Urs, 1979). Linoleic acid was the main unsaturated fatty acid present in chickpea (Dodok *et al*., 1993; Krishna *et al*., 1997). Murthy and Urs (1979) reported decrease in free lipid and corresponding increase in bound lipid content of bengal gram indicating the binding of some of the free lipids to other constituents, probably proteins, during heat treatment. Main compounds in neutral lipids of chickpea meal and its derived protein isolates were triacylglycerol, free fatty acids, free fatty alcohols and free sterols.

Attia *et al* (1994) reported a significant increase in ether extract on decortication. Decortication of chickpea resulted in higher values of triglycerides but lower quantities of polar lipids than in whole seed (Attia *et al*., 1996).

Barley generally contains 2-3% lipids (Welch, 1978). Crude fat in huskless barley types was found in general to be higher than that of husked types. Higher lipid content reduces the swelling potential of the starches, thus affecting food processing characteristics (Duffus and Cochrane, 1992).

2.2.4 Minerals:

In addition to being an important source of proteins, legumes are reported to be a good source of minerals.

Meiners *et al* (1976) observed that calcium, copper, iron, magnesium, manganese, phosphorous, potassium, sodium and zinc in chickpea were 103.1, 0.86, 5.82, 91.7, 1.71, 35.4, 69.3, 12.69 and 2.86 mg/100g respectively. Minerals in cooked chickpea were about one third to one half of the values for raw chickpea.

Annapurna and Murthy (1985) reported that total iron (mg/100g) in pulses was highest in soybean (11.61) followed by bengal gram (10.32) but the available iron was highest in bengal gram 3.77mg/100g.

Dodok *et al* (1993) found that mineral content is dominated by phosphorus and potassium in chickpea; levels of vitamin B_1 and B_2 are also high.

Gopalan *et al* (1998) found that peanut is good source of minerals like Ca, P and Fe. But in addition, peanut is also endowed with flatulence factor and some anti-nutrients like phytic acid, trypsin inhibitors and lectins (Singh *et al*., 1991).

2.2.5 Antinutritional factors:

Legumes have several antinutritional factors such as enzyme inhibitors, lectins, phytates, saponins, flatulence factor and polyphenols due to which nutritional quality of legumes is lower than animal foods. Liener (1976) reported of 220 units/g antitryptic activity in chickpea.

Legume contain a significant amount of phytic acid; it has antinutritional properties because of its ability to chelate several metals and thereby reduce their bioavailability resulting in mineral deficiency, it is decreased during processing (Beal and Mehta, 1985; Duhan *et al*., 1989). Khan *et al* (1988) reported the phytic acid content of whole seeds, hulls and dehulled brown gram as 1.22, 0.20 and 1.32% respectively.

The saponin contents of chickpea was determined after various treatments like soaking, soaking with cooking, cooking, soaking with autoclaving, soaking with sprouting, all of which reduced saponin levels in chickpea; sprouting with cooking showed the maximum reduction (Jood *et al*., 1986).

Mulimani and Rudrappa (1994) reported a decrease in α-amylase activity on heat treatment and germination; negligible inhibitor activity was observed on 6^{th} day of germination. Cooking did not result in significant decline in micro nutrient content of chickpea (Attenza *et al*., 1998).

2.3 PROCESSING OF CEREALS AND LEGUMES

Legumes in India are processed and consumed in variety of forms. The primary processing such as dehulling of the pulses results in the reduction of the fiber and tannin contents and improvement in the appearance, cooking quality, palatability and digestibility (Singh, 1993). Secondary processing such as soaking, ordinary-cooking, sprouting, pressure-cooking, boiling, roasting and fermentation are used for the elimination of undesirable heat labile compounds (anti-nutritional factors) thus improving the bioavailability of nutrients (Singh, 1995; Bishnoi and Kheterpal, 1999).In India the most common domestic method for processing of legumes include soaking for cooking ,germination parching and roasting. These processing method have been reported to be beneficial for enhancing the nutritive value of various food legumes as they reduce the content of anti-nutritional factors and improve the digestibility of carbohydrates and proteins (Kataria *et al*., 1989).

2.3.1 Roasting and flavor enhancement:

Commercial production of cereal and pulse based foods involves various operations which improve the nutritive value, flavor, modifies texture.

Chopra and Hira (1995) studied the effect of roasting on protein quality of peanut. Raw and roasted peanuts was analyzed for proximate principles, methionine, available lysine and trypsin inhibitor activity. They reported decrease in available lysine and trypsin inhibitor activity considerably and increased the digestibility, relative nitrogen utilization and protein efficiency ratio values after roasting. However they found significant decrease ($p \leq 0.05$) in biological value of groundnut on roasting.

Mostafa and Rahma (1988) studied the functional property of peanut flour as affected by different heat treatments. They reported that water and fat absorption of peanut flour increased due to heat treatments; increase was more at high temperature and longer time of heating. They also found decrease in foaming properties due to dry heat and moist heat treatments but the decrease was less in irradiated samples.

Murthy and Urs (1979) found that treatment of bengal gram during roasting and puffing resulted in a decrease of free lipids by 15-18% and a corresponding increase in bound lipids. Both roasting and puffing retarded development of free fatty acids during storage.

Roasting and puffing reduced lysine availability by 12.3 to 13.8%, respectively whereas in raw bengal gram all lysine is in available form (Murthy and Urs, 1980).

Geeravani and Theophilus (1980) observed that roasting had no effect on Protein Efficiency Ratio (PER) of bengal gram while parching improved it because of short cooking time of parching and also due to soaking of bengal gram before parching. Digestibility coefficient and biological value also increased during roasting (Attia *et al*., 1994).

Gera (1981) reported a slight reduction in protein content on roasting, also a decrease in ether extract, crude fibre and ash content occurred. Goyal and Mathew (1985) and Khader and Rao (1980) reported an increase in protein content on roasting. Heat treatment decreased the activities of both trypsin inhibition and hemagglutinin (Bansal *et al*., 1988; Attia *et al*., 1994).

Roasting of raw ingredients (wheat, barley and green gram) of weaning foods resulted in about 40, 45 and 50% decrease in phytic acid, saponins and polyphenols, respectively. Roasting also enhances the taste, flavour and nutritional quality of formulation (Gahlawat and Sehgal, 1993; Srivastav *et al*., 1994).

Srivastav *et al* (1990) roasted the grain at 12% initial moisture content at 180, 215 and 250°C for 1.5, 2.0 and 2.5 min and found that breaking strength of the roasted grains decreased with the increase in heat treatment given.

Wang and Sakurai (1968) studied flavour components of roasted barley and found that most favourable aroma was produced when barley was roasted approximately at 160°C for 20 min. The flavour components were found to be mono and dicarbonyls, H_2S and organic sulphur compounds. Various time-temperature combinations have been possible for getting maximum puff volume of different products.

Yoon and Kim (1989) roasted soaked and unsoaked barley at 250°C to a light or dark brown product. Solid content of barley teas increased with soaking and degree of roasting. Intensity of odour and taste was improved by soaking, roasting and crushing.

Marlett (1991) analyzed that the total fiber reduced during processing of barleys from 15.7 to 12.2-12.4% although (1-3); (1-4) β-D-glucan content were same i.e. 5.1 and 4.8-5.4% respectively. Results suggest that processing barley into a ready-to-eat product increase analytical solubility of dietary fiber.

Puyed and Prakash (2006) studied the functional properties of thermally treated peanut flour. They found that the water absorption capacity of peanut flour increased from 110 to 121 ml/100gm whereas the foam capacity and emulsification capacity decreased on heat treatment.

2.3.2 Soaking:

Legumes normally used in human nutrition need to be processed prior to consumption to reduce the levels of antinutritional factors. The traditional domestic methods such as soaking, germination, cooking and roasting make the legumes tender and help in their detoxification.

Rao and Deosthale (1982) reported that on overnight soaking in water, 50% of tannin was lost in chickpea, when germination was continued for 48 h, a further 10% loss of tannin was observed.

Jood *et al* (1986) reported a reduction of 14 and 21%; 7 and 24% of total soluble sugars and starch respectively on six and 12 h soaking. on six and 14 hours soaking.

Trypsin inhibitor activity for desi bengal gram reduced significantly after soaking for 24 hours; germination of soaked seeds caused only a slight decline in activity. Haemagglutinin activity reduced to half on soaking the seeds for 24 hours and the activity of soaked seeds disappeared completely in eight days old seedlings (Banal *et al*., 1988).

2.4 SHELF LIFE:

Murthy and Urs (1979) reported that both roasting and puffing of chickpea retarded the development of free fatty acids during storage over a period of 48 weeks. Puffing resulted in the retardation of the oxidation of unsaturated fatty acids, but roasting had no such beneficial effect.

Alonso and Zapico (1995) reported an increase in reducing sugar upto one year in infant foods (fruit based). This increase was attributed to hydrolysis of sucrose. After one year, levels of lysine had decreased by >50% at all temperatures which showed that a maillard browning reaction between reducing sugars and lysine occurred.

CHAPTER – III

MATERIAL AND METHODS

The present investigation was carried out for the development of "Nutritious beverage from Barley with Peanut and Bengal gram''. This chapter contains relevant information pertaining to research design and methodological procedures used for the present investigation to achieve the foregoing objectives:

3.1 MATERIALS

3.1.1 Grain sample:

The Barley grain, Bengal gram and Peanuts were procured from local market, Hisar.

3.1.2 Chemicals:

All chemicals used during the present investigation were of analytical grade and were purchased from either of the following: SRL, Mumbai; Qualigens Fine Chemicals, Mumbai and SD Fine-Chem. Ltd., Mumbai.

Diastase α-amylase (activity 1300 IU/g) was procured from HiMedia Lab. Pvt. Ltd, Mumbai.

3.2 METHODS:

3.2.1 Preparation of Beverages:

3.2.1.1 Roasting of grains and kernels:

3.2.1.1.1 Cleaning: Grits and weeds were removed by screening through sieve. The bigger weeds, pods, husk, straw and stones were hand picked.

3.2.1.1.2 Roasting: The barley grains and peanut kernels were roasted at different temperatures (120^{O}C, 150^{O}C and 180^{O}C) for different time periods (3-10min) till golden brown colour was appeared. Roasting was done in Iron pan with sand. Temperature was regularly checked with infrared remote sensing digital thermometer and temperature were controlled by increasing or decreasing flame.

3.2.1.1.3 Soaking: 100g barley was soaked for 4, 8 and 12h in 1 l water in a 2 l beaker, at room temperature.

3.2.1.1.4 Draining: Soaked barley was then washed 2-3 times with clean water and then kept for draining for 10 minutes on four folds of newspaper to remove excess of water.

3.2.1.1.5 Wet-grinding: Barley was wet-grinded with different ratio of water (1:8, 1:10 and 1:12). Then barley water was collected in beaker by filtering through muslin cloth.

3.2.1.1.6 Dry-grinding: Bengal gram and peanuts were individually grinded. However, required amount of sugar was mixed while grinding the peanuts to avoid sticking of peanuts to grinder surface due to high fat content.

3.3 Processing of Barley

Barley was cleaned and then roasted in sand at 150^{O}C for 6min which resulted in golden brown colour and crunchy texture. The roasted barley was soaked for 10h in tap water. Excess water was drained and blotted on four folds of newspaper. Then the grains were wet-grinded in mixer-grinder with water in the ratio of 1:10. After wet-grinding, barley water (filtrate) was filtered through muslin cloth and collected in another beaker.

3.4 Processing of Bengal gram

Roasted bengal gram were procured from local market and de-husked by hands and winnowed. Cleaned roasted bengal gram was grinded in mixer-grinder and good quality flour was obtained. The flour was added in definite proportion (i.e. 15, 20 or 25g to the barley water from 100g grains).

3.5 Processing of Peanuts

Peanuts were cleaned and then roasted in sand at temperature of 150^{O}C for 6min. Roasted peanuts were de-skinned by hands and winnowed. Peanuts were grinded with sugar to avoid clumping and sticking of flour to the grinder surface. The peanut flour was added in definite proportion (i.e. 15, 20 or 25g to the barley water from 100g grains).

3.6 Analysis of grains and beverages

3.6.1 Total soluble solid (TSS)

Total soluble solids in the beverages were determined by hand Refractometer (range 0-32%) by placing a drop of beverage on its prism and read in per cent TSS directly on its scale. It is set to zero by using distilled water.

3.6.2 Crude protein

Estimation: Crude protein content was estimated by Micro-Kjeldahl method (AOAC, 1995) with slight modifications.

Reagents:

1. **Sulphuric acid : 98%**
2. **HCl : 0.1N**
3. **NaOH : 40%**
4. **Digestion mixture : $CuSO_4$ & K_2SO_4 in ratio of 1:5**
5. **Mixed indicator:** One part 0.2% methyl red in methanol and 5 parts 0.2% bromocresol green in 85% methanol were mixed**.**

Flow diagram for preparation of beverage:

BARLEY GRAINS

↓

ROASTING (150^{O}C for 6 min)

↓

SOAKING (8 hours)

↓

WET-GRINDING

(Grain-to-water ratio = 1:10)

↓

GRINDING TEMPERATURE

(Hot water = 60^{O}C)

↓

FILTRATION

(Through muslin cloth)

↓

BARLEY WATER

↓

DRY-GRINDING OF ROASTED & DEHULLED
BENGAL GRAM AND PEANUTS ALONGWITH SUGAR

↓

ADDITION OF 25g BENGAL GRAM & 15g PEANUTS
PER EXTRACT FROM 100g BARLEY

↓

SUGAR ADDITION TO 12^{O} BRIX

↓

ADDITION OF 2mg α-amylase

↓

COOKING FOR 10-15min

(To attain cooking consistency)

↓

BEVERAGE

↓

BOTTLING

(Hot filling in 200 ml. glass bottles)

↓

AUTOCLAVING

(15 Psi/15min)

↓

STORAGE

(At room temperature)

↓

ANALYSIS

(At 15d intervals)

Digestion: A 10 ml of sample (beverage) was accurately taken in Kjeldhal's flask of 300 ml capacity. Approximately 5 ml of concentrated H_2SO_4 was added and boiled to concentrate the contents. Concentrated mass was digested with 20 ml H_2SO_4, pinch of digestion mixture and some glass beads. The flask was kept in an inclined position on the heater and heated strongly until solution became transparent giving a bluish-green tinge. After cooling the content of flasks were dissolved with distilled water and transferred to a 100 ml. volumetric flask and volume was made up to mark with distilled water.

$$\textbf{Protein} + \textbf{H}_2\textbf{SO}_4 \rightarrow \textbf{(NH}_4\textbf{)}_2\textbf{SO}_4\textbf{ (aq)} + \textbf{CO}_2\textbf{ (}\uparrow\textbf{)} + \textbf{SO}_2\textbf{ (}\uparrow\textbf{)} + \textbf{H}_2\textbf{O(l)}$$

Distillation: Distillation of ammonia from digested sample was carried out in a steam distillation apparatus. Ten ml of the digest was transferred into a distillation flask attached to the apparatus and 10-12ml of 40% NaOH solution was allowed to flow into the flask to neutralize the acid and make it alkaline to liberate ammonia for steam distilled. The liberated ammonia was absorbed in 10 ml of 4% boric acid solution containing two-three drops of mixed indictor. About 70 ml of the distillate was collected. The amount of ammonia absorbed by boric acid was determined by titrating against 0.1 N HCl. A blank was run under similar conditions. Blank sample was prepared by taking only sulphuric acid and the digestion mixture. The percentage of nitrogen was calculated from the difference between the volume of 0.1 N HCl used for titration of librated ammonia from the digested sample taken for ammonia distillation and acid used for blank titration.

Liberation of ammonia:

$$NH_4SO_4\ (aq) + 2NaOH \rightarrow Na_2SO_4\ (aq) + 2H_2O\ (l) + 2NH_3\ (\uparrow)$$

Capture of ammonia:

$$H_3BO_3 + NH_3 \rightarrow NH_4H_2BO_3\ + (NH_4)_2HBO_3.$$

1ml of 0.01 N HCl ≡ 0.14 mg of nitrogen.

The crude protein content of beverages was calculated by multiplying the nitrogen percentage by protein factor of 6.25.

Formula: Per cent nitrogen was calculated following the formula:

$$\text{Nitrogen (\%)} = (S\text{-}B) \times \frac{V}{V_1} \times \frac{100}{W} \times 0.00014$$

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

Where, W = Weight or volume of the sample taken (g or ml)

V = Volume of digest made (ml)

V_1 = Volume of aliquot taken for distillation (ml)

S = Volume of standard acid (0.1 N HCl) used for titration (ml)

B = Volume of 0.1 N HCl used for blanks (ml)

3.6.3 Fat:

Fat content of the grains and kernels was determined by standard method of A.A.C.C. (1984).

Extraction solvents

n-Hexane (65^{o}C bp.) or petroleum ether (60-80^{o}C)

Apparatus

1. Soxhlet apparatus with heating mantles
2. Oven (60 ± 2^{o}C)
3. Pestle and mortar
4. Thimble
5. Fat-free cotton

Estimation

Transferred the 2g moisture free samples i.e. flours of barley, bengal gram and peanut to a thimble and plug the top of the thimble with fat-free cotton. Dropped the thimble into the fat extraction tube of a soxhlet apparatus. Attach the bottom of the extraction tube to a round bottom flask and the top to the soxhlet condenser. Place about 100ml solvent siphoned through the extraction tube into the flask. Switch on the heating mantle to boil the solvent and extract the sample for 6 to 8h. The solvent which volatilizes from the flask condenses and drops continuously upon the sample. At the end of extraction period, thimbles were removed from the apparatus and left in air for some time and then dried overnight in oven at 60 ± 2^{o}C.

Formula

$$\text{Crude-fat (\%)} = (W_1 - W_2) \times \frac{100}{W}$$

Where,

W = weight of the sample taken (g)

W_1 = Weight of the thimble before extraction (g)

W_2 = Weight of the thimble after extraction (g)

Fat content of the beverage was determined by the Gerber method (BIS, 1989).

1. Gerber sulphuric acid (To 10 ml of cold distilled water in a 500 ml conical flask placed in a sink was carefully added 90 ml of concentrated sulphuric acid (sp. gr. 1.84) and cooled with running tap water). Density of Gerber H_2SO_4 should be 1.807 to 1.812 g/ml at 27^{o}C.
2. Amyl alcohol. Density of amyl alcohol should be 0.816 to 0.822 g/ml at 27^{o}C

Apparatus

1. Milk pipette 10.75 ml
2. Milk butyrometer
3. Gerber centrifuge
4. Butyrometer lock stopper
5. Butyrometer stand
6. Hot water bath (65 ± 2^{o}C)

Estimation

Ten ml sulphuric acid was taken in a milk butyrometer, 10.75 ml of well mixed beverage at 27^{o}C was transferred slowly, in such a way that the milk forms a separate layer on the surface of H_2SO_4 without mixing with the acid. Then 1 ml of amyl alcohol was added into it to reduces the surface tension of beverage to set the the fat free from the remaining liquid. The butyrometer was firmly closed with a rubber lock stopper with the help of a lock stopper key. Butyrometer was shaken in horizontal position, till the curd was completely dissolved. Then inverted and reverted the butyrometer few times and mixed the contents thoroughly. The butyrometers were transferred to a water bath at 65 ± 2^{o}C, keeping the stopper side of the butyrometer dipped in the water for at least five minutes. Butyrometers were placed the in the Gerber centrifuge keeping the stoppered end towards the periphery, placing two butyrometers symmetrically to balance the centrifuge. Closed the centrifuge with its lid and roated it at its maximum speed of 1000 to 1200 rpm for five minutes. After stopping the lid was opened and the butyrometers transferred to a water bath (65 ± 2^{o}C) with stopper downward and kept for at least three minutes. The fat in the butyrometer was adjusted with the help of lock stopper key and the fat content read in per cent directly in its scale (i.e., fat column).

3.6.4 Sugars (Total and Reducing sugars):

Sugars of the grains, kernels and beverages were estimated by the method of Hulme and Narain (1931).

Reagents

1. Potassium ferricyanide solution (0.025N)

Potassium ferricyanide	8.25g	Sodium carbonate	10.6g
Volume	1000 ml		

2. Potassium iodine solution

Potassium iodide	12.5g	Zinc sulphate	25.0g
Sodium chloride	125.0g	Volume	500ml

3. 5% acetic acid solution

Glacial acetic acid	50 ml	Volume	1 l

4. Sodium thiosulphate solution (0.01N)

Sodium thiosulphate	2.482 g	Volume	1000 ml

5. Starch solution (indicator)

Soluble starch	1.0 g	Sodium chloride	20.0 g
Volume	100 ml		

Extraction

Flours of barley, bengal gram and peanut were used for the extraction of total and reducing sugars with distilled water. A ratio of 1:30 was used for barley to water and 1:60 were used for bengal gram as well as peanut for extraction of sugars. For this, 3.333g flour of barley or 1.667g flour of bengal gram or peanut were placed in one side of a 250 ml conical flask, with gentle tabbing wetted with alcohol and about 90 ml distilled water was added and whirled to mix and kept it in water bath (60^{o}C) for some time for better extraction.

Beverage was directly used for the estimation of total and reducing sugars. It was first diluted to appropriate concentration for estimation. A 125x dilution of nutritious beverage was prepared for sugar estimation. For this, 8ml beverage was taken in a 100 ml volumetric flask and filled it upto mark with distilled water. It was once again diluted ten fold with distilled water before use in sugar analysis. Following procedure was adopted for the estimation-

Procedure

1. Total sugar

To 25ml of sugar extract in test-tube, 4ml of concentrated hydrochloric acid was added and kept for 10 minutes in water bath at 65-68^{o}C. After hydrolysis, acidity was neutralized by adding a little anhydrous sodium carbonate till effervescence stopped, diluted with water and contents transferred in a volumetric flask and the final volume was made to 100ml. Into 5.0ml of extract in a test tube (1″x7″) was add 5.0ml of potassium ferricyanide solution. The tubes were covered and kept for 15 minutes in boiling water bath. The tubes

were then cooled under running tap water and to this, 5ml of potassium iodine solution was added, followed by 3ml of acetic acid solution (5% v/v). The liberated iodine was titrated against sodium thiosulphate (0.01N) using starch as an indicator. The end point was indicated by disappearance of blue color and appearance of milky white color. A blank with 5ml of distilled water was also run simultaneously. The results were calculated as shown under procedure for estimation of reducing sugar below.

2. Reducing sugar

Into 5.0ml of extract in a test tube (1″x7″) was add 5.0ml of potassium ferricyanide solution. The tubes were treated as shown under estimation of total sugars above. The results were calculated by the following formulae and expressed as mg sugar per 100g or 100ml.

Formula:

Total sugar = 6.76 x (V_2 - V_1) x dilution factor for sugar extract

Reducing sugar = 6.76 x (V_2 - V_1) x dilution factor for sugar extract

Where,

V_1 = ml of sodium thiosulphate used in blank

V_2 = ml of sodium thiosulphate used in unknown

3.6.5 Acidity

Acidity of the beverage was calculated as per the method described by Ranganna (2007).

Procedure

Five ml of the beverage was taken in conical flask. It was titrated against 0.1N NaOH standard solution using phenolphthalein as indicator. From the volume of the alkali used, acidity was calculated and the results were expressed as g of citric acid per 100ml.

Formula

% acidity = 0.128 x V

Where,

V = Volume of 0.1 N NaOH

3.6.6 Viscosity

Viscosity of the beverage was determined by using viscometer (Rheology International, Shannon, Ireland) and expressed in mPa.s. The spindle No. 3 and spindle speed 50 rpm were used. First of all the instrument was auto zeroed in air after fixing the spindle. Reading was taken after every five minutes to get stable readings.

3.6.7 Rancidity

Rancidity in beverages was checked by the estimation of peroxide value

Peroxide Value: Peroxide Value of the beverage was estimated by iodimetric method (Ranganna, 2007). It is expressed as milli-equivalents of peroxide per 1kg of fat.

Reagents

1. Solvent for extraction of fat - Chloroform - methanol mixture (1:2, v/v)
2. Glacial acetic acid
3. Saturated potassium iodide solution: Dissolved 4 parts of pure potassium iodide in 3 parts of distilled water. Kept the solution in a brown bottle.
4. 0.1 N Sodium thiosulphate solution
5. 0.5% Starch indicator

Extraction

Fat from the sample was extracted by a modification of the Bligh and Dyer (1959) procedure. To 50ml beverage taken in separating funnel was add monophasic solvent mixture of 125 ml methanol & 62.5 ml chloroform. After shaking it two-three times and release the gas consequently again 62.5 ml chloroform was added, mixed well and allowed to stand for phase separation. Salt solution (0.9% NaCl) was gently added from sides of funnel to facilitate phase separation. Allowed to stand overnight for the separation of aqueous and chloroform layers. Chloroform extract was withdrawn through anhydrous sodium sulfate placed on a filter paper in a funnel. From the chloroform extract, 50ml was put in the hot air-oven at 60 ± 2^{o}C for overnight, to estimate the fat content in corresponding extract. Another 50 ml chloroform extract was run for peroxide estimation.

Procedure

An aliquot (20 ml) of the chloroform extract was placed into a conical flask. Then 40 ml glacial acetic acid was added into it followed by the addition of 1 ml of saturated potassium iodide solution. Stoppered the flask and allowed it to stand for two-four minutes in dark. Then 150 ml water was added into it for the better liberation of iodine in it. Liberated iodine was titrated against 0.01 N Sodium thiosulphate solution by using two-three drops of 0.5% starch indicator. In last it was vigorously shaken to remove the last traces of iodine from the chloroform layer. Blank was also run simultaneously along with sample.

Calculation

Peroxide value (meq. O_2 per kg of fat) = 10 x (V1 - V2)/mg fat dry wt. for estimation

Where,

V_1 = ml of 0.01 N $Na_2S_2O_3$ used for the titration of sample

V_2 = ml of 0.01 N $Na_2S_2O_3$ used for the titration of blank

3.6.8 Sensory evaluation

Nine combinations of nutritious beverage were organoleptically examined by a panel of semi-trained judges who had some experience of sattu, for colour, appearance, aroma, flavor and overall acceptability on a nine point hedonic scale. One of the most acceptable combination was selected for further studies.

3.6.9 Shelf-life studies

The best combination obtained on the basis of sensory evaluation was kept for shelf-life studies. The beverages were stored at room temperature in crown corked 200 ml glass bottles after autoclaving at 15 Psi for 15 min. The beverage was then evaluated for sensory properties as well as for proximate composition and stability parameter at fortnight interval.

3.6.10 Statistical method:

The data was tabulated and statistically analyzed.

CHAPTER – IV

RESULTS

Roasted barley grains and flours from roasted peanut and bengal gram were evaluated for their nutritional composition. Various combinations of peanut and bengal gram (15, 20 and 25g each per extract from 100g barley) were used for beverage preparation. All combinations were evaluated for their sensory characteristics and the best acceptable combination was evaluated for their nutrient composition and shelf-life studies.

4.1 Proximate composition:

The data presented in table 1 depicts the results obtained for the proximate composition of roasted grains for moisture, crude protein, fat and sugars.

Table 1: Proximate composition of roasted barley, bengal gram and peanut flours

Components	Barley	Bengal gram	Peanut	CD (≤ 5%)
Moisture (%)	5.44 ± 0.13	5.45 ± 0.06	8.49 ± 0.14	**0.416**
Crude Fat (%)	2.79 ± 0.06	5.69 ± 0.13	44.50 ± 0.25	**0.591**
Crude Protein (%)	8.61 ± 0.06	17.6 ± 0.11	34.76 ± 0.03	**0.272**
Total sugar (g/100g)	5.56 ± 0.21	8.28 ± 0.14	9.76 ± 0.05	**0.524**
Reducing Sugar (g/100g)	1.73 ± 0.03	2.48 ± 0.22	2.54 ± 0.05	**0.465**

4.2 Optimization of processing parameters for beverage preparation:

4.2.1 Roasting:

Barley, peanut and bengal gram were roasted at different temperatures (120, 150 and 180^{o}C) for different intervals (6 to 10 min) and evaluated on a five point roasting quality scale. Best quality crispy, soft textured & brown colored was produced by roasting at 150^{o}C for 6 min for both barley grains and peanut kernels (Table 2).

Table 2: Effect of time and temperature of roasting on weight and degree of roasting of barley & peanut kernels

Temperature (^{o}C)	Time (min)	Weight (%)	Roasting*	Weight (%)	Roasting*
		Barley		**Peanut**	
120^{o}C	10	96	1	95	1
150^{o}C	6	93	3	93	3
180^{o}C	3	90	4	90	4

***Degree of roasting:**

1. Under roasted (Pale)
2. Lower roasted (light brown)
3. Well roasted (Brown)
4. Over roasted (Dark brown)
5. Roasted to burn (Black)

4.2.2 Steep ratio:

It is the ratio of wet weight of grains after soaking to the weight of the grains before soaking. The steep ratio asymptotically increased with increasing period of soaking (Table 3).

Table 3: Effect of soaking period on steep-ratio of barley grain

Soaking hours	Steep ratio
4	1.70 ± 0.15
8	1.90 ± 0.01
12	2.00 ± 0.01

4.2.3 Wet-grinding (grain:water ratio)

Yield of the barley extract increases with increase in the ratio of grain to water (Table 4). But at higher grain to water ratio the viscosity decreased and it caused watery mouthfeel. So 1:10 ratio was optimum for the extraction of barley water with desirable viscosity.

Table 4: Yield and viscosity of barley extracts

Grain:water ratio	Barley extract* (g)	Viscosity (mPa.s)
1:8	575 ± 5	25.2 ± 1.2
1:10	799 ± 21	24.1 ± 0.5
1:12	970 ± 14	20.2 ± 1.2

*** Dry weight of barley grains = 100 g**

As the soaking period increases, at a given viscosity of the barley extracts also increases. It was highest in case of 12h soaking irrespective of grain: water ratio (Table 5).

Table 5: Effect of soaking period on viscosity of barley extract at two grain to water ratio

Soaking Period (h)	Extract (g)		Viscosity (mPa.s)	
	(1:8)	(1:10)	(1:8)	(1:10)

4	675	890	21.4 ± 0.5	14.2 ± 1.7
8	690	893	23.2 ± 1.4	25.5 ± 1.2
12	702	900	32.9 ± 2.1	26.6 ± 1.7

4.3 Product development and their organoleptic evaluation:

Nine combinations of peanut and bengal gram (15, 20 and 25g each per extract from 100g barley) were used for beverage preparation with constant level of added sugar (12%). The products were subjected to sensory evaluation with respect to colour, appearance, flavor, taste, mouthfeel and overall acceptability. The data in table 6 depicted that all combinations of nutritious beverage were liked very much and there was no significant difference among them.

Treatments* BG + P	**Colour**	**Appearance**	**Flavor**	**Taste**	**Mouthfeel**	**Overall acceptability**
25 25	8.0 ± 0.2	8.0 ± 0.2	7.6 ± 0.3	7.7 ± 0.2	7.6 ± 0.3	7.8 ± 0.2
25 20	8.0 ± 0.2	8.0 ± 0.2	7.5 ± 0.2	7.6 ± 0.3	7.5 ± 0.3	7.7 ± 0.3
25 15	8.0 ± 0.2	8.1 ± 0.1	7.9 ± 0.2	8.3 ± 0.2	8.1 ± 0.2	8.1 ± 0.2
20 25	8.0 ± 0.2	8.0 ± 0.2	7.4 ± 0.3	7.6 ± 0.3	7.6 ± 0.2	7.7 ± 0.3
20 20	7.9 ± 0.3	8.0 ± 0.2	7.6 ± 0.3	7.8 ± 0.3	7.6 ± 0.3	7.8 ± 0.2
20 15	8.0 ± 0.2	8.0 ± 0.2	8.0 ± 0.2	8.0 ± 0.2	7.8 ± 0.2	7.9 ± 0.1
15 25	7.9 ± 0.3	8.0 ± 0.2	7.8 ± 0.2	7.8 ± 0.3	7.6 ± 0.3	7.8 ± 0.2
15 20	8.0 ± 0.2	8.0 ± 0.2	7.6 ± 0.2	7.8 ± 0.3	7.7 ± 0.2	7.8 ± 0.2
15 15	8.0 ± 0.2	8.0 ± 0.2	7.3 ± 0.3	7.4 ± 0.3	7.6 ± 0.23	7.7 ± 0.3
C.D. (≤ 0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 6: Sensory evaluation of different combination of Bengal gram and peanut in 100g barley extract

*** Grams of Bengal gram (BG) and Peanut (P) flour per extract from 100g barley.**

4.4 Changes in physico-chemical properties of the beverage during storage:

The data presented in table 7 depicts the physico-chemical change of the most acceptable beverage during storage.

T.S.S. of the beverage remained constant upto 1 month (14%) and then increased to 16% at the end of storage.

Total sugar content of the beverage decreased gradually as the shelf-life progressed. Initially it was set at 12^{o} brix by the addition of sugar. On storage it decreased upto 8.6

g/100g. Reducing sugar content decreased very slowly over the period of storage and changed from 4.87g/100g to 4.35g/100g at the end of storage.

Acidity of the beverage initially increased at fast rate and then slowly as storage period prolonged.

g Barley

remained

od.

e

							Fat (%)
							0.8
							0.8
30	14.0	0.19 ± 0.0	80 ± 0.0	9.7 ± 0.0	4.67 ± 0.57	1.4	0.8
45	15.0	0.23 ± 0.0	79 ± 0.2	9.3 ± 0.0	4.62 ± 0.75	1.4	0.8
60	16.0	0.32 ± 0.0	78 ± 0.1	8.8 ± 0.0	4.47 ± 0.57	1.4	0.8
75	16.0	0.34 ± 0.0	77 ± 0.0	8.6 ± 0.0	4.47 ± 0.57	1.4	0.8
90	16.0	0.36 ± 0.0	76 ± 0.0	8.1 ± 0.1	4.35 ± 0.70	1.4	0.8
CD (≤ 5%)	*	**0.010**	**0.338**	**0.154**	**0.134**	*	*

*** CD could not be calculated, as there was no variation among replicates**

4.5 Organoleptic properties of beverage during storage:

Results of sensory evaluation of beverage are depicted in table 8. The data shows that beverage remained acceptable upto 45 days. There was no change in the colour and appearance scores of the beverage till the end of storage. However, scores of flavor, taste and mouthfeel decreased significantly after 45 days and the product was not organoleptically acceptable after 45 days.

Table 8: Sensory Score of final best acceptable beverage

Parameter→ Days↓	**Colour**	**Appearance**	**Flavor**	**Taste**	**Mouthfeel**	**Overall acceptability**

0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0
15	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0	8.0 ± 0.0
30	8.0 ± 0.0	8.0 ± 8.0	7.7 ± 0.2	7.5 ± 0.2	7.5 ± 0.2	7.7 ± 0.3
45	8.0 ± 0.0	8.0 ± 0.0	7.5 ± 0.2	5.5 ± 0.2	5.5 ± 0.2	6.9 ± 1.3
60	8.0 ± 0.0	8.0 ± 0.0	7.0 ± 0.0	2.7 ± 0.2	2.7 ± 0.2	5.7 ± 2.7
75	8.0 ± 0.0	8.0 ± 0.0	6.5 ± 0.2	2.0 ± 0.0	2.0 ± 0.0	5.3 ± 3.1
90	8.0 ± 0.0	8.0 ± 0.0	6.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0	4.8 ± 3.6
CD (≤ 5%)	**NS**	**NS**	**0.414**	**0.141**	**0.141**	**0.141**

CHAPTER – V

DISCUSSION

One of the challenges of today is to develop inexpensive foods that are nutritionally superior and at the same time acceptable to intended consumers. Traditionally sattu is prepared from roasted barley flour which is poor in protein and fat. Therefore, the nutritional content of sattu product can be improved by the addition of legumes, which are an important and cheap source of protein and essential amino acids. Here the efforts were made to enhance the nutritional value by supplementation with roasted peanut and bengal gram. In this chapter barley, peanut and bengal gram were evaluated and processing parameters were optimized for the development of nutritious beverage.

The results of the present study have been discussed under the following heading:

5.1 Proximate composition of barley, peanut and bengal gram:

5.1.1 Moisture

5.1.2 Crude protein

5.1.3 Fat

5.1.4 Total and reducing sugar

5.2 Optimization of processing parameters for beverage preparation

5.2.1 Roasting

5.2.2 Soaking

5.2.3 Wet-grinding (grain:water ratio)

5.2.5 Barley extract and their viscosity

5.3 Development and sensory evaluation of product

5.4 Physico-chemical properties of the most acceptable product

5.5 Sensory evaluation of most acceptable beverage

5.1 Proximate composition of barley, peanut and bengal gram:

5.1.1 Moisture:

The data presented in table 1 depicts the moisture content of roasted barley as 5.44 percent. Slightly higher values have been reported by various workers in barley grains, Helm (2004) reported 7.6 percent and Varsha *et al*. (2006) reported 6.91 percent moisture in barley.

The moisture content of bengal gram and peanut was 5.45 and 8.49 percent, respectively. The present findings are in agreement with those of the earlier studies by Ene-obong and obizoba (1997) for bengal gram and Gopalan *et al*. (1998) for peanut. There was no significant difference among moisture content of barley and bengal gram. Whereas,

moisture content of peanut was slightly higher. It is because of due to water-holding capacity of the protein.

5.1.2 Crude protein:

The crude protein content was observed to be 8.61 percent in barley. The result obtained are in agreement with the result reported earlier by several workers Sunderberg *et al*. (1994), Yadav *et al*. (2000) and Helm (2004).

The protein content of bengal gram was 17.6 percent and that of peanut was 34.76 percent. These values are in close agreement to those reported by Khan *et al*. (1995) for bengal gram and Ramanathan and Chandrasekhar (1987) for peanuts. Significant differences were observed for protein content among the three.

5.1.3 Fat:

Fat content was 2.79 percent in barley. Fat content of bengal gram was observed to be 5.69 percent and that of peanut was 44.4 percent. The result obtained in the present investigation is within the range reported by Bengtsson *et al*. (1990), Singh (2005) and Welch (1978) for barley.

The result obtained for bengal gram are compared with those reported earlier by Ena-obong and Obizoba (1997), Rincon *et al*. (1998) and Murthy and Urs (1979). Gopalan *et al*. (1998) reported fat content of peanut ranged from 40.1 to 46.8 percent which was compared to present result. Significant differences were observed for fat content among barley, peanut and bengal gram.

5.1.4 Total and reducing sugar:

The total sugar content of barley, bengal gram and peanut was 5.56, 8.28 and 9.76 percent respectively.

The reducing sugar content of barley, peanut and bengal gram was 1.73, 2.54 and 2.48 percent respectively. No significant differences were observed for total and reducing sugar content among barley, peanut and bengal gram. The finding of the present study are in line with those of Kalra and Jood (1998) and Xue *et al*. (1997) for barley. Garg and Boora (2004) and Champ *et al*. (1986) for bengal gram and Gopalan *et al*. (1998) for peanut.

5.2 Optimization of processing parameters for beverage preparation:

5.2.1 Roasting:

Quality of roasted products is affected by moisture content of grains before roasting as the thermochemical changes are affected by moisture content. It would take longer time to roast the grains if moisture content is higher. It would allow more reaction of water with organic constituents of grains before the constituents start pyrolytic fragmentation. Therefore, spectrum of volatile aroma and coloring products should be different with initial moisture content. Roasting of grains and kernels were carried out at different temperature (120, 150

and 180^{O}C) for different time intervals (3 to 10 min.) and the degree of roasting was analyzed on five point scale (Table 2). Roasting at 120^{O}C, grains slowly became harder in texture with pale yellow colour and possessed low sensory appeal while at 180^{O}C, grains quickly attained good texture but burnt flavor and bitter taste. So roasting at 150^{O}C was optimum, with golden brown colour with pleasant aroma and taste.

5.2.2 Soaking:

Roasted barley grains were soaked in tap water for different time periods (4, 8 and 12h). Soaking is a treatment to increase the moisture content. Soaking for different periods of time showed that initially the imbibition of water by the grains was rapid, which falls off and reached almost a plateau after 24 h. Fast imbibition of water initially can be attributed to porosity and the low initial moisture content of grains which absorb water quickly at the beginning. But as the time passes, water diffuses deep inside and the interior of grains become more and more saturated with the water. After 24h there is little scope of further absorption/imbibition. Table 3. Shows that upto 8h of soaking the imbibition of water by barley grains was rapid and thus steep-ratio rises rapidly, after which imbibition rate slows down and the rise in steep-ratio was slow. Soaking softens the hull of barley and thus favors the grinding of barley without fine preparation of plasticized hulls.

5.2.3 Wet-grinding:

Roasted barley was wet-grinded with different grain to water ratio (1:8, 1:10 and 1:12) based on initial grain weight. Then barley water was collected in beaker by filtering through muslin cloth. The total soluble solids (T.S.S.) and Viscosity of barley water were recorded. Table 4. Shows that the volume of extract increased with increasing use of water in grinding, viscosity decreases as the ratio of grain:water ratio increases while T.S.S. remained same at 1^{O} brix. However, the difference between viscosity at 1:8 and 1:10 ratio was not significant. So it was taken as optimum for the extraction of barley water.

5.2.4 Barley extract and their viscosity:

At a constant grain to water ratio, viscosity of the barley water increases as the soaking period increases. Table 5. Shows that the viscosity was maximum in case of 12h soaking irrespective of grain:water ratio. It is of due to increase in content of soluble dietary fibre (SDF) in barley extract as the soaking hour progressed. The finding of the present study is confirmed by Newman *et al*. (1989).

5.3 Development and sensory evaluation of product:

The barley water containing different proportions of bengal gram and peanuts (15, 20 and 25g each per extract from 100g barley) sweetened with cane sugar were used for beverage preparation. The sensory evaluation was done by the panelists who were quite familiar with the product quality. The data regarding sensory properties of products are given

in table 6. These nine combinations did not differ significantly differences. But on the basis of mean sensory scores of overall acceptability, one of the best acceptable combination (25g Bengal gram and 15g peanuts per 100g barley extract) was selected.

Heat treatment of beverage: After autoclaving (at 15 Psi/15min) product became gelled like gruel and was not flowing. Hence amylase treatment was included before autoclaving. 2mg α-amylase was added to beverage prepared from per extract from 100g barley. Cooking for 10-15 min was also included for proper development of flavor and consistency.

5.4 Physico-chemical properties of the most acceptable product:

The nutritious beverage containing 25g bengal gram and 15g peanuts per 100g barley grain extract was analyzed for chemical as well as organoleptic characteristic at a fortnight interval (Table 7).

T.S.S. of the beverage increases gradually on storage. It is of due to breakdown of complex polysaccharides into simpler ones.

On storage total sugar content decreased probably due to conversion of sugar into acids and non-acid fermentation products. Reducing sugar content showed slow but gradual decrease probably due to some compensatory hydrolysis of starch and dextrins and loss in fermentation.

Acidity of the beverage also increases progressively on storage. It is of due to conversion of sugars into acids.

Protein content of the barley water was significantly improved by supplementation with peanut and bengal gram due to high protein content of peanut and bengal gram as compared with barley. On storage, protein content of the beverage remained unchanged indicating that there was no putrification during storage.

Fat content of the barley water was very low. A significant difference in fat content was observed after incorporation of peanut and bengal gram. It remained constant throughout the storage, indicating that there was no lipolysis during storage. There was no rancidity in the product and the peroxide in fat was not detectable during storage study.

Viscosity of the beverage decreases progressively, but decrease was maximum during first month of storage. Decrease in viscosity is of due to breakdown of complex polysaccharides into simpler ones.

5.5 Sensory evaluation of most acceptable beverage:

Table 8 shows that during storage, up to 45 days, there was no significant alteration in sensory quality was observed. But after, that significant alteration in taste and mouthfeel was observed. The colour, appearance and flavour scores remained unchanged during storage. Appearance of sour taste, may be due to increase in acidity of the beverage, which may be due to conversion of sugar into acids and other fermentation products.

CHAPTER – VI

SUMMARY AND CONCLUSION

The results of the present investigation are summarized below:

The beverage was prepared by extracting roasted barley grain with hot water and mixing with ground bengal gram and peanut. It was sweetened with sugar and heat sterilized by autoclaving at 15 Psi for 15 min. Parameters for roasting grain and kernels were standardized. Extraction of barley grain was also optimized. Final beverage was analyzed for physico-chemical changes and organoleptic evaluation during storage.

- Optimization of processing parameters for preparation of nutritious beverage from barley fortified with peanut and bengal gram was done.
- Roasting of barley and peanuts at 150^{o}C for 6 min showed that appealing nutty flavor with golden brown colour.
- Soaking of roasted barley for long periods of time (8h) resulted in increased viscosity of the barley water. It softened the outer hull and thus aided in easy and better extraction.
- Supplementation of the extract from 100g barley with bengal gram and peanuts @ 15-25g was acceptable at all the levels with no significant difference in organoleptic scores. However, maximum overall score was recorded in case of 25g bengal gram with 15g peanut powder.
- During storage, upto 45 days, no significant alteration in sensory quality was observed. But after, that there was significant alteration in taste and mouthfeel scores.
- The product was chemically stable with respect to content of protein & fat. However, total sugar decreased gradually.
- The beverage was organoleptically and nutritionally acceptable.

From the results of this investigation it can be concluded that highly acceptable beverage from Barley fortified with Peanut and Bengal gram can be prepared by: Roasting of grains and kernels at 150^{o}C for 6 min; soaking of roasted barley in tap water for 8 h; wet-grinding of steeped barley with water at the ratio of 1:10, to get barley water, mixing with dry-ground roasted bengal gram and roasted peanuts along with calculated sugar (12^{o} brix); addition of 2mg α-amylase to beverage prepared from 100g barley extracts; cooking for ½ h to attain proper consistency and flavor and In-bottle autoclaving at 15 Psi/15min.

LITERATURE CITED

A.A.C.C. (1984). Approved methods of analysis. American Association of Cereal Chemists. St. Paul Minnesota, U.S.A.

A.O.A.C. (1995). Official Methods of Analysis. 15th edn. Association of Official Analytical Chemists. Washington, D.C.

Akbar, S., Siddiq, M. and Iqubal, P. (1986). Nutritional and ogranoleptic evaluation of wheat supplemented with chickpea flour. *Pak. J. Sci. Ind. Res*. **29**(2): 330-332.

Ali, M. and Kumar, S. (2005). Problem and prospectus of pulses research in India. *Indian Farming*. **55**(8): 4-13.

Ali, N. (1997). Decade of research & development in soybean processing and utilization. In course manual for production of soybean based foods and their quality insurance, compiled by A.P. Gandhi and R.T. Patil, C.I.A.E., Bhopal.

Alonso, M.L. and Zapico, J. (1995). Changes in sugars and lysine in baby foods during storage. *J. Biochem*. **18**(6): 393-403.

Annapurna, S. and Murthy, N.K. (1985). Bioavailability of iron by *in vitro* method from selected foods/diets and effects of processing. *Indian J. Nutr. Dietet*. **24**: 95.

Argikar, G.P. (1970). Gram, In (C.P. Kachrod, Ed.) Pulse Crops in India. ICAR, New Delhi, pp. 54-135.

Attenza, J., Sanz, M., Herguedas, A., Alejos, J.A. and Jimenez, J.J. (1998). β-carotene, α-tocopherol and γ-tocopherol contents in dry legumes- influence of cooking. *Food Sci. Technol. Int*. **4**(6): 437-441.

Attia, R.S., Shehata, A.M.E., Aman, M.E. and Hamza, M.A. (1994). Effect of cooking and decortication on the physical properties, the chemical composition and nutritive value of chickpea. *Food Chem*. **50**: 126-131.

Attia, R.S., Shehata, A.M.E., Aman, M.E. and Hamza, M.A. (1996). Effect of ripening stage and technological treatment on the lipid composition and lipoxygenase activities of chickpea (*Cicer arietinum* L.). *Food Chem.* **56**(2): 123-129.

Bahnassey, Y., Khan, K. and Harrold, R. (1986). Fortification of spaghetti with edible legumes. I. Physio-Chemical, antinutritional, amino acid and mineral composition. *Cereal Chem.* **63**: 210-215.

Bamforth, C.W. (1985). Biochemical approaches to beer quality. *J. Inst. Brew*. **91**: 154-160

Bangoura and Guo-Nong (2006). Removal of odors from milk prepared from peanut. *J. Food Sci. Technol*. **43**(2): 205-209.

Bansal, K.K., Dhindsa, K.S. and Batra, V.I.P. (1988). Trypsin inhibitor and Hemagglutinin activities in chickpea (*Cicer arietinum* L.): Effects of heat and germination. *J. Food Sci. Technol*. **25**(1): 46-48.

Beal, L. and Mehta, T. (1985). Zinc and phytate distribution in peas. Influence of heat treatment, germination, pH, substrate and phosphorus on pea phytate and phytase. *J. Food Sci*. **50**(1): 96-100.

Bengtsson, S., Aman, P., Graham, H., Newman, C.W. and Newman, R.K. (1990). Chemical studies on mixed-linked β-glucans in hull-less barley cultivars giving different hypercholesterolemia response in chickens. *J. Sci. Food Agric*. **52**: 435-445.

Beta, T., Rooney, L.W. and Waniska, R.D. (1995). Malting characteristics of sorghum cultivars. *Cereal Chem*. **72**: 533-538.

Beuchat, L.R. Cherry, J.P. and Quinn, M.R. (1975). Physiological properties of peanut flour as affected by proteolysis. *J. Agric. Food Chem*. **23**(4): 616-620.

Bhatia, D.S., Parpia, H.A.B. and Baliga, B.P. (1966). Peanut Protein Isolate production and properties. *J. Food Sci. Technol*. **3**(2): 2-10

Bhatty, R.L., Narain, J.P. and Christison, G.I. (1975). Chemical composition of digestible energy of barley. *Can. J. Anim. Sci*. **55**: 759-764.

Bijlani, R.L., Narain, J.P., Shukla, K., Kochar, K.P., Puri, P., Karmakar, M.G. and Bala, S. (1993). Glycaemic and Metabolic responses to a traditional cereal-legume mixture. *Int. J. Food Sci. and Nutr*. **44**(4): 243-251.

BIS (1989). Chemical examination of Milk. **21**: 21. Hand Book of Food Analysis Part XI: Dairy Products Bureau of Indian Standards. Manak Bhawan, New Delhi.

Bishnoi, S. and Kheterpal, N. (1994). Protein digestibility of vegetable and field peas (Pisum sativum): Varietal differences and effect of domestic processing and cooking methods. *Pl. Food Hum. Nutr*. **46**: 71-76.

Bligh, E.G. and Dyer, W.J. (1959). A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol*. **37**: 911.

Champ, M., Brilloaet, J.M. and Rauau, X. (1986). Non starchy polysaccharides of *Phaseolus vulgaris*, *Lens esculantus* and *Cicer arietinum* seeds. *J. Agric. Food Chem*. **34**: 326-329.

Chatterjee, S.R. and Abrol, Y.P. (1975). Amino acid composition of new varieties of cereals and pulses and nutritional potential of cereal-pulse combinations. *J. Food Sci. Technol.* **12**: 221-227.

Chatterjee, S.R. and Abrol, Y.P. (1977). Protein quality evaluation of popped barley grains (sattu). *J. Food Sci. Technol*. **14**(6): 247-250.

Chloupek, O., Seveik, R., Psota, V. and Ehrenbergerova, J. (1990). Analysis of F_2 diallele crosses between malting spring barley varieties. *Genetak a Slechteni*. **33**: 127-128.

Chopra, N. and Hira, K.C. (1995). Effects of roasting on protein quality of chickpea (Cicer arietinum) and Peanut (Arachis hypogea). *J. Food Sci. Technol*. **32**(6): 501-503.

Dabas, D. (2001). Roasting of chickpea for blending with sattu. M.Sc. Thesis, CCS HAU, Hisar.

Dabas, D., Singh, M. and Singh, R. (2005). Processing of barley and chickpea for making sattu. J. Food Sci. Technol. 42(1): 60-64.

Deshpande, R.P., Chinnan, M.S. and Phillips, R.D. (2008). Process development of a chocolate-flavoured peanut soya beverage. *Int. J. Food Sci. Technol*. **43**(5): 886-894.

Deshpande, S., Bargale, P.C., Joshi, K.C., Singh, U. and Varghese, S. (2004). Enhancing the nutritive value of barley based sattu by soy fortification. *Indian J. Nutr. Dietet*. **41**: 146-159.

Devi, R., Boralkar, M.A. and Hamdapurkar, V.R. (1990). Nutritional improvement of a traditional weaning food mix (sattu). *Food Nutr. Bull*. **12**(4): 323-324.

Dodok, L., Ali, M.A., Hozova, G. and Polacek, I. (1993). Importance and utilization of chickpea in cereal technology. *Acta Alimentaria*, **22**(2): 119-129. [Cited in FSTA (1994) AJB4].

Duffus, C.M. and Cochrane, M.P. (1992). Grain structure and composition. *In* "Barley: genetics, biochemistry, molecular biology and biotechnology" (ed Shewry, P.R.) C.A.B. International, Wallingford U.K. p 291-317.

Duhan, A., Malchauhan, B., Punia, D. and Kapoor, A.C. (1989). Phytic acid content of chickpea (*Cicer arietinum*) and black gram (*Vigna mungo*) varietal difference and effect of domestic processing and effect of domestic processing and cooking methods. *J. Sci. Food Agri,* **49**(4): 449-455.

Duszkiewicz - Reinhard, W., Khan, K., Dick, J.W. and Holm, Y. (1988). Shelf life stability of spaghetti fortified with legume flours and protein concentrates. *Cereal Chem*. **65**: 278-281.

Ena-obong, H.N. and Obizoba, S. (1997). Content of antinutrient and *in vitro* digestibility of the African yam bean, chickpea and pigeonpea. *Plant Foods Hum. Nutr*. **43**: 225-233.

Englyst, H.N., Anderson, V. and Cummings, J.H. (1983). Starch and non-starch polysaccharides in some cereal foods. *J. Sci. Food Agric.* **34**: 1434-1440.

Figuerola, R.F.E., Estevez, A.A.M. and Castillo, V.E. (1987). Supplementation of wheat flour with chickpea (*Cicer arietinum*) flour. I. Preparation of flours and their bread making properties. *Arch. Lat. Am. Nutr*. **37**(2): 378-382. [Cited in FSTA (1989) 6M62].

FSTA - Food Science and Technology Abstracts

Gahalawat, P. and Sehgal, S. (1993). Antinutritional content of developed weaning foods as affected by domestic processing. *Food Chem*. **47**: 333-336.

Garg, S. and Boora, P. (2004). Effect of domestic processing and pressure cooking on starch and protein digestibility of chickpea (*Cicer arietinum* L.) cultivars. *J. Arid Legumes* **1**(2): 85-88.

Gayle, P.E., Knight, E.M., Adkins, J.S. (1984). The nutritive value and organoleptic evaluation of wheat flour bread supplemented with pigeon pea flour. *Fed. Proc*. **43**(3): 475.

Geervani, P. and Theophilus, F. (1980). Effect of home processing on protein quality of selected legumes. *J. Food Sci*. **45**: 707-710.

Geervani, P. and Theophilus, F. (1983). Structure, composition and physical properties of legume starches. *Indian J. Nutr. Diet*. **20**: 372.

Gera, S. (1981). To study the effect of parching and pressure cooking on nutritional quality of gram (white and desi). M.Sc. Thesis, CCS HAU, Hisar.

Goblirsch, C.A., Horsley, R.D. and Schwartz, P.B. (1996). A strategy to breed low-protein barley with acceptable kernel colour and diastatic power. *Crop Sci*. **36**: 41-44.

Gopalan, C., Ramasastri, B.V. and Balsubramanium, S.C. (1998). Nutritive values of Indian foods MN, ICMR, Hyderabad.

Goyal, M. and Mathews, S. (1985). A study on effect of cooking on protein, lysine, tryptophan and sugar content of cereals and pulses with special reference to cereal pulse combination preparations. *Indian J. Nut. Dietet*. **21**: 73-79.

Gupta, S. and Kawatra, B.L. (1992). Effect of cereal-legume chapati diets on absorption and retension of calcium. *Plant Foods Hum. Nutr*. **42**(2): 165-173.

Helm, C.V. and Francisco, A. (2004). Chemical characterization of Brazilian Hull-less barley varieties flour fractionation and protein concentration. *Cereal Chem*. **61**(6): 6-10.

Hend, G. and Sastri, P. (1998). Studies on in vitro protein digestibility of some selected Bengal gram products. *J. Food Sci. Technol*. **35**(5): 445-446.

Henry, R.S. (1988). The carbohydrates of barley grains - a review. *Inst. Brew*. **94**: 71.

Jenkins, D.J., Jenkins, A.L., Wolever, T.M.S., Rao, A.V. and Thompson, L.V. (1986). Fiber and starchy foods: Gut function and implication in disease. *Am. J. Gastroenterol*. **81**: 920-930.

Jood, S., Chauhan, B.M. and Kapoor, A.C. (1986). Saponin content of chickpea and black gram: varietal difference and effects of processing and cooking methods. *J. Sci. Food Agri*. **37**: 1121-1124.

Kalra, S. and Jood, S. (1998). Biological evaluation of protein quality of barley. *Food Chem*. **61**(2): 35-39.

Kanu, P.J., Zhu, K., Kanu, J.B., Zhou, H., Qian, H. and Zhu, K. (2007). Biologically active components and nutraceuticals in sesame and related products. *Trends Food Sci. Technol*. **18**: 599-608.

Kataria, A., Chauhan, M.B. and Punia, D. (1989). Antinutrients and protein digestibility (*in vitro*) of mungbean as affected by domestic processing and cooking. *Food chem*. **32**: 9-13.

Kaur, R.P. and Hira, C.K. (1988). Supplementary effect of Aestivum wheat (*Triticum aestivum* L.), Bengal gram (*Cicer arietinum* L.) and soybean (*Glycine max* L.) on protein quality of Durum wheat (*Triticum durum* L.). *J. Sci. Food Agric*. **40**: 201-207.

Khader, V. and Rao, S.V. (1980). Effect of cooking and processing of protein quality of bengal gram, green gram and horse gram. *Indian J. Nutr. Dietet*. **23**: 57.

Khalil, J.K. and Chughtai, M.I.D. (1984).nutritional evaluation of wheat and maize bread supplemented with a mixture of peanut and chickpea flours. Plant Food Hum. Nut. 34(4). 285-296.

Khalil, J.K. and Chughtai, M.I.D. (1987). Nitrogen retention by adult humans on maize bread supplemented with peanut, chickpea and peanut-chickpea flours. *Pak. J. Sci. Res*. **30**(12): 931-934.

Khan, N., Zaman, R. and Elahi, M. (1988). Effect of processing on the phytic acid content of Bengal gram (*Cicer arietinum*) product. *J. Agric. Food Chem*. **36**: 1274-1276.

Khan, N., Zaman, R. and Elahi, M. (1995). Effect of processing on total phenols and proximate of chickpea and their products. *J. Agric. Food Chem*. **36**: 1274-1276.

Knuckles, B.E., Chiu, M.M. and Betschart, A.A. (1992). β-glucan enriched fractions from laboratory scale dry milling and sieving of barley and oats. *Cereal Chem*. **69**: 198-202.

Krishna, A.G.G., Prabhakar, J.V. and Aitzemuller, K. (1997). Tocopherol and fatty acid composition of some Indian pulses. *J. Am. Oil Chem. Soc*. **74**(12): 1603-1606.

Kulkarni, A., Yokota, T., Suzuki, S. and Etoh, H. (2008). Subritical Water Extraction of Barley to Produce a Functional Drink. *Biosci, Biotechnol, Biochem*. 72(1): 236-239.

Laberge, D.E., McGregor, A.W. and Meredith, W.O.S. (1973). Changes in free sugar content of barley kernels during maturation. *J. Inst. Brew*. **79**: 471-477.

Liener, I.E. (1976). Legume toxins in relation to protein digestibility - A review. *J. Food Sci*. **41**: 1076-1081.

Marlett, J.A. (1991). Dietary fiber content and effect of processing on two barley varieties. *Cereal Foods World*, **36**(7): 576-580.

McWatters, K.H. and Heaton, E.K. (1974). Influence of moist-heat treatment of Peanuts on Peanut Paste Characteristic. *J. Food Sci*. **39**: 494-497.

Meiners, C.R., Derise, N.L., Lave, H.C., Crews, M.G., Ritchey, S.L., Murphy, E.W. (1976). Content of nine mineral elements in raw and cooked mature dry legumes. *J. Agric. Food Chem*. **24**(6): 1126-1229.

Mishra, A.K. Srivastava, G.P. and Tripathi, R.D. (1974). Malting quality of some new barley strains grown in Uttar Pradesh. *Indian J. Agric. Chem*. **7**: 165-169.

Mostafa, M.M. and Rahma, E.H. (1988). Functional properties of peanut flour as affected by different heat treatments. *J. Food Sci. Technol*. **25**(1): 11-15

Mridula, D., Goyal, R.K., Bhargav, V.K. and Manikantan, M.R. (2004). Effect of Roasting on Texture, Color and Acceptability of Soybean for making sattu. *Am. J. Food Technol*. **2**: 265-272.

Mridula, D., Jain, R. and Singh, K.K. (2010). Effect of storage on quality of fortified Bengal gram sattu. *J. Food Sci. Technol*. **47**(1):

Mulimani, V.H., Rudrappa, G. (1994). α-amylase inhibitors in chickpea (*Cicer arietinum* L.). *J. Sci. Food and Agri*. **64**(4:) 413-415.

Murthy, K.S. and Urs, M.K. (1979). Changes in lipids of Bengal gram (*Cicer arietinum* L.) on heat processing. *J. Food Sci. Technol*. **16**: 87-89.

Murthy, K.S. and Urs, M.K. (1980). Effect of toasting Bengal gram on lysine availability and IVPD of proteins. *J. Food Sci. Technol*. **17**:200-201.

Narayana, R., Rao, R. and Shanthamma, M.S. (1971). Development of predigested protein rich food based on Indian oilsseed meals and pulses. II. *J. Food Sci. Technol*. **9**: 57-61.

Newman, R.K., Newman C.W. and Graham, H. (1989). The hypercholesterolaemic function of barley β-glucans. *Cereal Foods World*, **42**(1): 23-25.

Oscarsson, M., Anderson, R., Salomonsson, A.C. and Aman, P. (1996). Chemical composition of barley sample focusing on dietary fibre components. *J. Cereal Sci*. **24**: 161-170.

Oscarsson, M., Parkkonen, T., Autio, K. and Aman, P., (1997). Composition and microstructure of waxy, normal and high amylose barley samples. *J. Cereal Sci*. **26**: 259-264.

Puyed, S.S. and Prakash, J. (2006). Functional properties of thermally treated defatted soy and peanut flours. *J. Food Sci. Technol*. **43**(3): 286-290.

Ramanathan, G. and Chandrasekhar, H.N. (1987). Studies on high protein break-fast food based on calcium groundnut proteinate. *J. Food Sci. Technol*. **24**(5): 148-149.

Ranganna, S. (2007). Handbook of Analysis and Quality Control for fruits and vegetable product. 2nd edn. TATA McGraw Hill-Pub. Co. Ltd., New Delhi. PP. 1110.

Rao, P.U. and Belavady, B. (1978). Oligosaccharides in pulses: Varietal differences and effects of germination and cooking. *J.Sci. Food Chem*. **26**(2): 316-319.

Rao, P.U. and Deosthale, Y.G. (1982). Tannin content of pulses: Varietal differences and effects of germination and cooking. *J. Sci. Food Agric*. **33**: 1013-1016.

Rincon, F., Martinez, B. and Ibanez, M.V. (1998). Proximate composition and antinutritive substances in chickpea (*Cicer arietinum*) as affected by biotype factors. *J. Sci. Food Agric*. **78**: 382-388.

Rossi, M., Germondari, I. and Casini, P. (1984). A comparision of chickpea cultivars: chemical composition, nutritional evaluation and oligosaccharide content. *J. Agric. Food Chem*. **32**: 811-814.

Rustom, I.Y.S., Lopez-Leiva, M.H. and Nair, B.M. (2006). UHT-Sterilized Peanut Beverages: changes in physicochemical properties during storage. *J. Food Sci*. **60**(2): 378-383.

Sainy, S.H. and Knights, E.J. (1984). Chemical composition of starch and oligosaccharide components of "Desi" and "Kabuli" chickpea. *J. Agric. Food Chem*. **32**: 940-944.

Santosh, M.M.M. and Rissi, P. (1996). Optimized McCleary method for measurement of total β-amylase in barley and its applicability. *J. Inst. Brew*. **102**: 271-275.

Silva, E.M.E., Gzman, M.S.H., Medinal, A.C. and Gonzalez, A.G. (2003). Simplified process for the production of sesame protein concentrates. Differential scanning calorimetric and nutritional, physicochemical and functional properties. *J. Sci. Food Agric*. **83**: 972-979.

Singh, M. (2005). Nutritional evaluation of barley varieties grown under organic and inorganic conditions. M.Sc. Thesis, CCS HAU, Hisar, India.

Singh, U. (1993). Protein quality of pigeonpea (*Cajanus cajan* L.) as influenced by seed polyphenols and cooking process. *Plant Food Hum. Nutr*. **43**: 171-179.

Singh, U. (1995). Methods for dehulling of pulses: A critical appraisal. *J. Food Sci. Technol*. **37**: 81-93.

Singh, U. and Jambunathan, R. (1981). Studies on desi and kabuli chickpea (*Cicer arietinum*) cultivars. Levels of protease inhibitors, levels of oligosaccharides and *in vitro* starch digestibility. *J. Food Sci*. **47**: 510-513.

Singh, U., Singh, B. and Smith, O.D. (1991). Effect of varieties and processing methods on phytic acid and protein digestibility of groundnut. *J. Food Sci. Technol*. **28**(6): 345-347.

Sood, M., Malhotra, S.R. and Sood, B.O. (2002). Effect of processing and cooking on proximate composition of chickpea varieties. *J. Food Sci. Technol*. **39**(1): 69-71.

Srivastav, P.P., Das, H. and Prasad, S. (1990). Effect of roasting process variables on in vitro protein digestibility of bengal gram, maize and soybean. *Food Chem*. **35**(1): 31-37.

Srivastav, P.P., Das, H. and Prasad, S. (1994). Effect of roasting process variables on hardness of bengal gram, maize and soybean. *J. Food Sci. Technol*. **31**(1): 62-65.

Steinke, F.H. and Hopkins, D.T. (1983). Complementary and supplementary effects of vegetable proteins. *Cereal Food World*. **28**(6): 338-341.

Sundberg, B., Abrahamsson, L. and Am, P. (1994). Quality of rolled barley flakes as affected by both of grain and processing technique. *Plant Foods Hum. Nutr*. **45**: 145-156.

Tsen, C.C., Hooven, W.J. and Philips, D. (1971). High protein breads. *Bakers. Dig*. **45**: 20-23.

Valencia, M.E., Tronsco, R. and Higuera, L. (1988). Linear programming formation and biological evaluation of chickpea based infant foods. *Cereal Chem*. **65**(2): 101-104.

Varsha, Grewal, R.B. and Kheterpal, N. (2006). Physico-chemical, proximate composition of coarse cereal grains. *Forage research*, **32**(2): 122-125.

Verma, B.S., Kasana, V.K., Sangwan, N.K. and Dhindsa, K.S. (1996). Biochemical and nutritive changes in malt of high yielding barley varieties as affected by gibberelic acid (GA3). *J. Food Sci. Technol*. **33**: 295-298.

Wang, P. and Sakurai, Y. (1968). Studies on flavour components of roasted barley. I. production of flavour substances. *J. Food Sci. Technol*. (Tokyo). **15**(11): 953-958.

Welch, R.W. (1978). Genotypic variation in oil and protein in barley grain. *J. Sci. Food Agric*. **29**: 953-958.

Xue, Q., Wang, L., Newman, R.K., Newman, C.W. and Graham, H. (1997). Influence of hull-less waxy starch and short awn genes on the composition of barley. *J. cereal Sci*. **26**: 251-257.

Yadav, S.K., Luthra, Y.P., Sood, D.R. and Aggarwal, N.K. (2000). Malting potential of husked barley in relation to proanthocyanidins. *J. Food Sci. Technol*. **38**(1): 71-74.

Yoon, S.K. and Kim, W. (1989). Effect of roasting conditions on quality and yield of barley tea. *Korean J. Food Sci. Technol*. **21**(4): 575-582.

APPENDIX-I

(9 POINT HEDONIC RATING SCALE)

Name ..... **Date .....**

Product ..... **Time .....**

INSTRUCTION : Taste the given sample and check how much you like or dislike each one. Use appropriate scale to show your attitude by assigning poins that best describe your feelings about the sample. An honest expression of your's will help us. Evaluate on the basis of following scale

Score Prefrence	**Code**
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Sample code	**Colour & Appearance**	**Taste**	**Flavor**	**Mouthfeels**	**Overall acceptability**

Signature

ABSTRACT

1. Title of the research project report gram	**:**	**Development of nutritious beverage from Barley with Peanut and Bengal**
2. Full name of the degree holder	**:**	**Sheetal Mishra**
3. Admission No.	**:**	2008FST155M
4. Title of Degree	**:**	Mater of Science
5. Name and Address of Major Advisor	**:**	**Dr. Rajendra Singh** Professor Centre of Food Science and Technology CCS Haryana Agricultural University Hisar - 125004, INDIA
6. Degree awarding University:		CCS HAU, Hisar
7. Year of Award of Degree	**:**	2010
8. Major subject	**:**	Food Science and Technology
9. Total number of pages in project	**:**	34 + vi + I
10. Number of words in abstract	**:**	225

Key Words: Barley, Peanut, Bengal gram, nutritional composition, fortification, sensory evaluation, shelf-life studies.

Traditionally sattu is prepared from cereal and legume combinations (e.g. Barley and Bengal gram). Here the efforts were made to prepare a barley beverage with enhanced nutritional and health value. Since the pulses and cereals are deficient in sulphur containing and lysine amino acids respectively, so the combination leads to improvement in protein quality of the formulated products. Barley grains and peanut kernels were cleaned and roasted at 150^{o}C for 6 min. Roasted barley grains were soaked in tap water for 10h and extracted by grinding with 10X volume of hot water. Various combinations of peanut and bengal gram (15, 20 and 25g each per extract from 100g barley) were used for selection of beverage and the best acceptable combination (i.e., 25g Bengal gram and 15g Peanuts) was selected and evaluated for its nutrient composition and shelf-life studies. One problem was encountered was that it gelled upon autoclaving. To avoid this, α-amylase was used. On storage, fat and protein content of the beverage remained constant. Total sugars gradually decreased and viscosity also decreased. Whereas, T.S.S. increases during storage. Peroxide value remained non-detectible even at the end of the storage. Sensory quality of the beverage remained good for 45 days. The results obtained in the present investigation indicated that the product is highly acceptable and economical and thus the scope of the product and process lies in its commercialization.

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UNDERTAKING OF THE COPYRIGHT

I **SHEETAL MISHRA,** Admn. No. **2008FST155M** undertake that I give copy right to the CCS HAU, Hisar of my project report entitled "**Development of nutritious beverage from Barley with Peanut and Bengal gram**".

I also undertake that, patent, if any, arising out of the research work conducted during the programme shall be filed by me only with due permission of the competent authority of CCS HAU, Hisar.

SHEETAL MISHRA