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EFFECT OF BLENDS AND PROCESSING METHODS ON THE NUTRITIONAL QUALITY OF PROTEIN RICH SUPPLEMENTARY POWDER

Kour Harleen *et al.*,

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KOUR HARLEEN, KAUL RAJKUMARI, NASEER AHMAD*[1], ANISA ANJUM, CHAUHAN HARMEET AND GUPTA PRERNA[2]
[1]Division of Food Science and Technology,
Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu Main Campus, Chatha - 180 009, Jammu
[2]Centre of Food Science and Technology,
Choudhary Charan Singh Hisar Agriculture University Hissar, Haryana - 125 004
e-mail: ewsjammu@gmail.com

ABSTRACT

The substitution of chickpea and soy bean flour significantly (Pd• 0.05) increased the bulk density, rehydration ratio, water absorption index and water solubility index, with the highest value of 0.83g/mL, 5.92, 1.55 and 56.62 recorded in treatments T_2, T_8, T_2 and T_5. The highest protein, ash and moisture content of 20.17, 3.62 and 8.31% was recorded in T_5 (25:25:25:25:: MBF:MWF:MSF:MCF). Crude fibre content of 5.85% was highest in T_1 (100:0:0:0: MBF:MWF:MSF:MCF) whereas, the highest crude fat of 8.62% was observed in T_{10} (25:25:25:25: RBF:RWF:RSF:RCF). The highest calcium, zinc and iron content was recorded in T_5(25:25:25:25: MBF:MWF: MSF: MCF). Sensory evaluation revealed that T_8 (45:45:5:5: RBF: RWF: RSF:RCF) scored highest of 8.37.

***Corresponding author**

INTRODUCTION

Since the consumer always demands healthy and nutritious foods, finding nutritional products is a food producer's unchangeable target. A large mass of people in developing countries are faced with the problems of malnutrition mainly due to deficiency of protein and other vital nutrients. In India protein malnutrition is a serious problem due to cereal based dietary pattern. The use of protein source of vegetable origin can be used as a solution to this problem. Cereals are usually fortified with lysine or pulse proteins. Legumes are an important source of food protein and other nutrients (Thakur and Saxena 2000). Legume proteins are rich in lysine and deficient in sulphur containing amino acids, whereas cereal proteins are deficient in lysine, but have adequate amounts of sulphur amino acids. Therefore, the combination of grain with legume proteins would provide better overall essential amino acid balance, helping to overcome the world protein calorie malnutrition problem. Legumes as a supplement bring a variety of tastes and textures to cereal-based diets. Eating cereals and legumes during same meals provide impetus to the quality of protein, though their relative proportionality is a subject to be mooted. Chickpea *(Cicer arietinum* L.) is the most important *rabi*pulse crop. In India, it accounts for more than one third of the area and about 50% of the production of pulses. India accounts for 65% of the world acreage and 67% production of chickpea at present (Sethi *et al*. 2016). Soybean (*Glycine max*) is one of the most important oil and protein crops of the world. Soybeans contain 30 to 45% protein. It has protein content of about two times of other pulses, four times of wheat, six times of rice grain, four times of egg, twelve times of milk and has been referred to as "the protein hope of the future". Chickpea (*Cicer arietinum*) occupies first position among pulses. It is a rich source of carbohydrates, dietary fiber, vitamins and minerals. It contains 19.2% of proteins and is of best quality among the legumes. It has high protein digestibility, rich in phosphorous and calcium and widely used in different countries as a protein source in preparation of different food products (Rababah *et al.,* 2006). Soybean is a fascinating crop with innumerable possibilities of not only improving agriculture but also supporting industries(Ahirwar *et al*., 2016). Barley (*Hordeum vulgare*) which is the world's fourth most important cereal is an excellent source of dietary fiber, vitamins and minerals. In Western countries barley is used in breakfast cereals, soups, bakery flour blends and baby foods (Gupta *et al.,* 2010). Wheat (*Triticum aestivum*) is the major food produce among all the cereal crops. It is a staple food of large segment of world population and staple diet common to Pakistan, India, and some parts of Africa.

Traditional methods employ roasting, germination, and fermentation of grains. These technologies are often used separately or in combination (Griffith *et al*. 1998). Malting has been shown to be one of the most effective and convenient ways for improvement of nutritional value of cereals (Adeyemo *et al.,* 1992; Akpapunam *et al.,* 1996; Gernah *et al.,* 2011). Roasting improves the flavour, texture, nutritive value of the grains. Considering the above mentioned facts a protein rich supplementary powder was developed from malted and roasted cereal and legume and evaluated for functional, nutritional and sensory parameters.

MATERIALS AND METHODS

Malting and roasting of raw materials

The dried grains of both the cereals (wheat and barley) and legumes (soybean and chickpea) were divided into two equal lots. One lot of each was soaked in water twice their volume for 12 hours. After soaking the grains were drained, spreaded and wrapped in moist muslin cloth for germinate. The cereals were kept for 72 hours while legumes were kept for 24 hours at ambient temperature (30 ± 2æ%C). During this period the grains were kept moist by sprinkling water twice daily. The germinated grains were washed and dried in hot air oven at a temperature of 65 ± 5æ%C till the moisture content reached to 10 per cent. After drying they were milled into flour which was stored in an air tight container till further use (Adetuyi 2009). As per the procedure given by Emmanuel and Okorie (2002) the second lot of both the cereal and legumes were roasted in hot air oven at 120° C for 10 min and then cooled and milled into flour which was packed in an air tight container till further use.

Product development

The method of Salve (2011) was followed for developing protein enriched supplementary powder. Malted/ Roasted cereals/legumes flour is taken along with 5g brown sugar, cardamom, almond and walnut powder (1g). Than mixed properly and packed in the suitable packaging material and then stored.

Functional and physico-chemical analysis

The functional properties of the supplementary powder were assessed by the methods decribed by Edema *et al.* (2005), Ranganna (1986) and Charunuch *et al.* (2003) for determining bulk density, rehydration ratio, water absorption and water solubility index respectively. The proximate composition viz: moisture, ash, crude fat, crude fibre, crude protein (N x 6.25) and carbohydrate (by difference) were determined in accordance with AOAC methods (1995). Calcium was estimated by titration method (Jaiswal, 2003) while, zinc and iron was determined by Atomic absorption spectrop hotometer. The minerals were expressed in mg/100g sample. The colour was evaluated by measuring L, a*, b* parameters by means of Hunterlab colorimeter. Colour was expressed in CIE-Lab parameters as L (whiteness/ darkness), a* (redness/ greenness), and b*(yellowness/blueness) (Akesowan, 2010).

Sensory evaluation

Supplementary powder was prepared with 10g powder in 150ml of milk and stirred well. The freshly prepared drink was given to the panel of judges for sensory evaluation on the basis of taste, appearance, texture and overall acceptability using 9-point Hedonic scale assigning scores 9- like extremely to 1- dislike extremely. A score of 5.5 and above was considered acceptable (Amerine *et al.,* 1965).

Statistical analysis

The results obtained were statistically analyzed using completely randomized design (CRD) for interpretation of results through analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The functional properties of supplementary powder are presented in Table 1. The experimental values of the bulk density (BD) of the supplementary powder ranged from 0.39 to 0.89g/ml. This increase in bulk density was due to the incorporation of legume flour which increased the absorption of more water in the developed product by being rich in protein. The above results are corroborated with the findings of Yu *et al.* (2013) who also reported similar findings with the incorporation of soya protein isolates while working on the development of extruded products using the blended soy protein isolates and corn flour. The highest mean bulk density of 0.89g/ml was recorded in treatment T_2 (0:100:0:0:: MBF: MWF: MSF: MCF) and the lowest as 0.39 was observed in T_7 (0:100:0:0:: RBF: RWF: RSF: RCF). The highest rehydration ratio of 5.92 was recorded in treatment T_8 (45:45:5:5:: RBF: RWF: RSF: RCF) followed by the treatments T_3 (45:45:5:5:: MBF: MWF: MSF: MCF) and T_9 (35:35:15:15:: RBF: RWF: RSF: RCF) with the values of 5.52 and 5.24 respectively while as the lowest rehydration ratio of 4.56 was observed in treatment T_2 (0:100:0:0:: MBF: MWF: MSF: MCF). The rehydration ratio differed significantly among the treatments and it was observed that with the incorporation of legume flours in the supplementary powder rehydration ratio decreased. This might had resulted due to increase in protein content with relative decrease in starch content which influenced the extent of starch gelatinization leading to decrease in water absorption relatively. Yagci and Gogus (2008) also reported similar findings in extruded snack foods developed from food-by-products. The

Table 1: Functional properties of protein rich supplementary powder

Treatments	Bulk density(g/ml)	Rehydration ratio	Water absorptionindex	Water solubility index
T_1 (100:0:0:0::MBF:MWF:MSF:MCF)	0.66	4.64	1.55	54.88
T_2 (0:100:0:0::MBF:MWF:MSF:MCF)	0.89	4.56	1.54	54.18
T_3 (45:45:5:5::MBF:MWF:MSF:MCF))	0.72	5.52	1.38	55.27
T_4(35:35:15:15::MBF:MWF:MSF:MCF)	0.78	4.88	1.33	56.18
T_5 (25:25:25:25::MBF:MWF:MSF:MCF)	0.83	4.74	1.28	56.62
T_6 (100:0:0:0::RBF:RWF:RSF:RCF)	0.47	4.78	1.55	53.13
T_7 (0:100:0:0::RBF:RWF:RSF:RCF)	0.39	4.50	1.46	51.14
T_8 (45:45:5:5::RBF:RWF:RSF:RCF))	0.51	5.92	1.38	53.26
T_9(35:35:15:15::RBF:RWF:RSF:RCF)	0.57	5.24	1.27	54.42
T_{10} (25:25:25:25::RBF:RWF:RSF:RCF)	0.55	4.92	1.19	55.38
C.D. (p=0.05)	0.02	0.06	0.06	0.02

Table 2: Proximate composition (%) of protein rich supplementary powder

Treatments	Moisture content	Crude fat	Crude protein	Crude fibre	Ash	Carbohydrate
T_1 (100:0:0:0::MBF:MWF:MSF:MCF)	7.16	1.81	10.73	5.85	2.77	71.59
T_2 (0:100:0:0::MBF:MWF:MSF:MCF)	9.16	2.16	12.89	1.73	1.74	72.32
T_3 (45:45:5:5::MBF:MWF:MSF:MCF))	8.31	4.22	14.53	4.58	3.13	65.23
T_4(35:35:15:15::MBF:MWF:MSF:MCF)	8.11	6.29	16.20	4.25	3.40	61.75
T_5 (25:25:25:25::MBF:MWF:MSF:MCF)	8.02	8.62	20.17	4.13	3.62	55.44
T_6 (100:0:0:0::RBF:RWF:RSF:RCF)	1.36	1.76	10.58	5.78	2.47	78.05
T_7 (0:100:0:0::RBF:RWF:RSF:RCF)	1.65	2.12	11.63	1.67	1.04	81.89
T_8 (45:45:5:5::RBF:RWF:RSF:RCF))	2.38	4.13	13.42	4.49	2.75	72.84
T_9(35:35:15:15::RBF:RWF:RSF:RCF)	2.31	6.23	15.95	4.12	3.12	68.27
T_{10} (25:25:25:25::RBF:RWF:RSF:RCF)	2.24	8.48	19.82	3.96	3.43	62.06
C.D. (p=0.05)	0.08	0.04	0.02	0.03	0.02	0.10

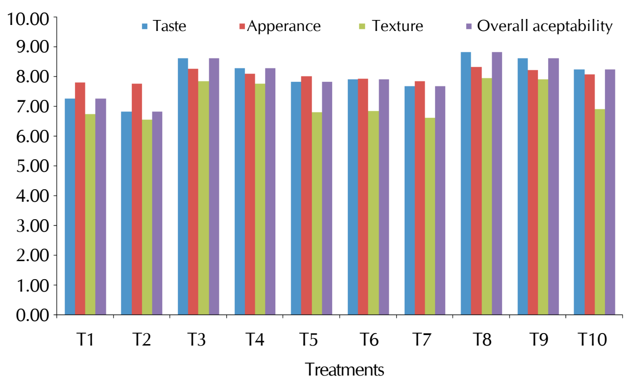


Figure 1: Sensory evaluation of protein rich supplementary powder

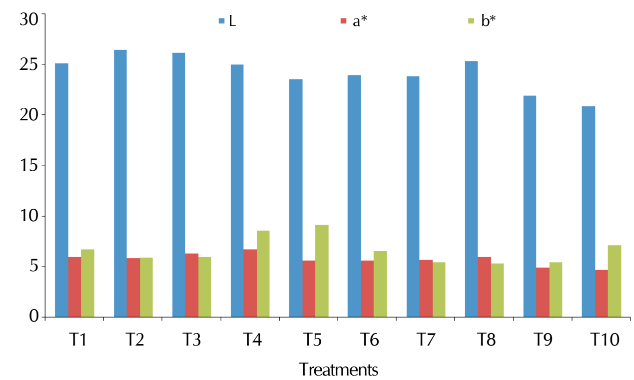
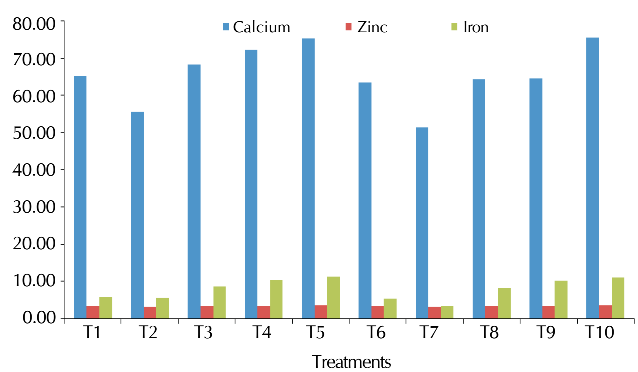


Figure 2: Colour (Hunter Colour Lab meter) analysis of protein rich supplementary powder

highest water absorption index of 1.55 was recorded in treatment T_2 (0:100:0:0:: MBF: MWF: MSF: MCF) and the lowest of 1.19 was observed in treatment T_{10} (25:25:25:25:: RBF: RWF: RSF: RCF). WAI shows a maximum level when the starch granules are sufficiently damaged for these to imbibe water without disintegration (Mitchell *et al.,* 1997). Treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) recorded the highest water solubility index of 56.62 whereas the lowest as 51.14 was recorded in T_7 (0:100:0:0:: RBF: RWF: RSF: RCF). Yu *et al.* (2013) reported that the moisture content was the most significant factor that affected the WSI, and higher moisture content resulted in a higher WSI. They reported that the increase could be due to fact that there might not be enough water for the starch gelatinization and protein denaturation to be completed due to which there was gradual increase in water solubility index with increase in moisture content.

Results of proximate composition of supplementary powder are given in Table 2. The moisture content was significantly influenced by treatments and the treatment T_1 (100:0:0:0:: MBF: MWF: MSF: MCF) revealed the highest moisture content of 9.16 per cent where as treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF) recorded the lowest as 2.24 per cent. Ndife *et al.* (2011) reported that the moisture contents of the composite breads prepared from whole wheat and soya bean flour blends increased with soy flour substitution by a range of 33.0 to 39.50 per cent. The treatments significantly influenced protein content of supplementary powder. Treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) recorded highest protein content of 20.17 per cent and the lowest as 10.58 per cent was recorded in the treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF).



MWF- Malted wheat flour ; RWF-Roasted wheat flour ; MBF- Malted barley flour RBF- Roasted barley flour; MSF- Malted soybean flour; RSF- Roasted soybean flour; MCF- Malted chickpea flour ; RCF- Roasted chickpea flour

Figure 3: Mineral content of protein rich supplementary powder

Mashayekh *et al.* (2008) also reported a similar increase in protein content of the bread as a result of the addition of soy flour. Other studies have also recorded a similar increase in protein content in sorghum-soy composite flours (Singh *et al.,* 2000 and Awadelkareem *et al.,* 2008). The highest crude fat content of 8.62 per cent was recorded in treatment T_{10} (25:25:25:25:: RBF: RWF: RSF: RCF) while the treatment T_1 (100:0:0:0:: MBF: MWF: MSF: MCF) recorded the lowest as 1.76 per cent. The crude fat content increased with the gradual increase in legume flour incorporation. Banurekha and Mahendran (2009) also reported similar increase in fat content while working on formulation of wheat-soybean biscuits and their quality characteristics. Crude fibre content was recorded highest as 5.85 per cent in treatment T_1 (100:0:0:0:: MBF: MWF: MSF: MCF) and a lowest of 1.67 per cent was observed in treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF). The crude fibre content of the supplementary powder increased significantly as the ratio of both the malted and roasted blended flour increased. While evaluating nutritional and sensory quality of breads produced from whole wheat and soy bean flour blends Ndife *et al.* (2011) reported that the crude fibre content increased as the whole wheat flour was substituted with soy bean flour. Ash content was recorded highest in treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) having value as 3.62 per cent while as the lowest value as 1.04 per cent was observed in treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF). All the blends varied significantly in per cent ash resulting from differences among individual ratios. Ash content increased with the incorporation of legume flour in supplementary powder (Table 2). Similar results have been attributed by Alabi and Anuonye (2007) while studying the nutritional and sensory attributes of soy-supplemented cereal meals. The data revealed that the treatments influenced significantly (P d" 0.05) the carbohydrate content of supplementary powder with a decrease in carbohydrate from 81.23 per cent to 55.44 percent as the legume flour proportion increased. Treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF) recorded the highest carbohydrate content of 81.23 per cent and the lowest as 55.44 per cent was recorded in treatment T_5 (25:25:25:25:: MBF: MWF). Similar decrease in carbohydrate content have been reported by Griffth *et al.* (1998) while studying the effects of blend and processing methods on nutritional quality of weaning foods made from cereals and legumes. The mineral composition (Fig. 3) of supplementary powder increased with the incorporation of legume flour. The highest calcium, zinc and iron content was resent in treatment T_5 (25:25:25:25:: MBF: MWF) having values as 75.63, 3.74 and11.32mg/100g and the lowest was observed in treatment T_7 (0:100:0:0:: RBF: RWF: RSF: RCF) with the recorded values as 51.60, 3.32 and 3.41mg/100g respectively. A similar trend of increase was reported by El-Adawy (2002).

Colour is one of the most vital attributes of any food product for consumer acceptability considerations (Fig. 2). When considering colour evaluation, it was evident that addition of legume flour decreased the *L* (lightness) values, whereas the values for *a* (redness) and *b* (yellowness) increased. In Table-3 it could be seen that highest value of L (26.44) was recorded in treatment T_2 (0:100:0:0::MBF:MWF:MSF:MCF) and a* (6.72) was recorded in T_4(35:35:15:15::MBF:MWF:MSF:MCF) while as highest value of b* (9.14) was recorded in T_5 (100:0:: FCF: RPF). Results of our study were supported by the findings of Borijindakul and Phimolsiripol (2013).

As is evident from (Fig. 1) the treatment T_8 (45:45:5:5:: RBF: RWF: RSF: RCF) received the highest scores of 8.83 for taste, 8.34 for appearance, 7.95 for texture and 8.37 for overall acceptability, while as treatment T_2 (0:100:0:0:: MBF:MWF: MSF :MCF) received the lowest score of 6.83,7.76, 6.56 and 7.05 for taste, appearance, texture and overall acceptability parameters respectively. It was observed that the substitution of legume flour at higher level decreased the sensory scores. This might be due to the beany flavour of legume flours (Okoye and Okaka, 2009). Thus, supplementation of soy bean and chickpea flour both at the level of 5 per cent each could also be considered the best from sensory points of view (Salve *et al.,* 2011). Our results are corroborated with the studies of Ndife *et al.* (2011) in functional breads produced from whole wheat and soya bean flour blends. The findings of our research highlights that a supplementation upto 25 per cent of soy bean and chickpea flour can be done successfully for developing nutritionally superior supplementary powder than that of the whole wheat and barley based flour. Organoleptically, treatment T_8 (45:45:5:5::RBF:RWF:RSF:RCF) was found to be the best, whereas biochemically treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) was noticed to be the best from the rest of the combinations. It might be because the treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) had highest content of soy bean and chickpea flour (25 per cent) which being rich in protein, fat and mineral contents. It can be concluded that cereal and legume blended products can be developed which will help in increasing the intake of protein, fibre, fat and other nutrients for eradicating malnutrition.

REFERENCES

Adetuyi, F. O., Badejo, O. F., Ikujenlola, A. V. and Omosuli, S. V. 2009. Storage influence on the functional properties of malted and unmalted maize (*Zea mays* L ssp mays) and soybean (*Glycine max* L Merrill) flour blends. *African J. Food Science*. **3(2):** 056-060.

Adeyemo, S. O., Olayode, O. B. and Odutuga, A. A. 1992. Biochemical analysis of germinating white maize (*Zea mays*). *Nigerian J. Nutrition Science*. **13:** 18-24.

Ahirwar, R., Verma, S., Sahu, T. and Gupta, R. 2016. Relative efficacy of different insecticides against leaf Feeders on soybean crop (glycine max l. Merrill). *The Bioscan*. **11(1):** 421-425.

Akesowan, A. 2010. Effect of konjac incorporated with soy protein isolate on quality characteristics of reduced-fat chiffon cakes. *African J. Biotechnology*. **9(28):** 4386-4391.

Akpapunam, M. A., Igbedioh, S. O. and Aremo, I. 1996. Effect of malting time on chemical composition and functional properties of soybeans and bambara groundnut flour. Intl. *J. Food Science and Nutrition*. **47:** 27-33.

Alabi, M. O. and Anuonye, J. C. 2007. Nutritional and sensory attributes of soy-supplemented cereal meals. *Nigerian Food J.* **25:** 100-110.

Amerine, M. A., Pangborn, R. H. and Rossler, E. B. 1965. *Principles of sensory evaluation of food. Academic press,* New York.

AOAC. 1995. *Official Methods of Analysis*. 16th edition. Association of Official analytical Chemists, Washington, D. C.

Awadelkareem, A. M., Mustafa, AI. and El Tinay, A. H. 2008. Protein, mineral content and amino acid profile of sorghum flour as influenced by soybean protein concentrate supplementation. *Pakistan J. Nutrition*. **7:** 475-479.

Banureka, V. D. and Mahendran, T. 2009. Formulation of wheat-soybean biscuits and their quality characteristics. *Tropical Agricultural Research and Extension.***12(2):** 62-66.

Borijindakul, L. and Phimolsiripol, Y. 2013. Physicochemical and functional properties of starch and germinated flours from *Dolichos lablab. Food and Applied Bioscience J.* **1(2):** 69-80.

Charunuch, C., Boonyasirikool, P. and Tiengpook, C. 2003. Using of extrusion process for preparation of instant cereal powder based on corn and soybean. *Kasetart J. Nature Science*. **37:** 72-83.

Edema, M, O., Sanni, L. O. and Sanni, A. I. 2005. Evaluation of maize-soybean flour blends for sour maize bread production in Nigeria. **4(9):** 911-918.

El-Adawy, T. A. 2002. Nutritional composition and antinutritional factors of chickpeas (*Cicer arietinum* L.) undergoing different cooking methods and germination. *Plant Food for Human Nutrition.* **57:** 83-97.

Emmanuel, C. Nawanekezi, and Okorie, S. U. 2002. Quality evaluation of malted and fermented maize-groundnut infant weaning foods. *J. Food Science and Technology*. **39(6):** 690-693.

Gernah, D. I., Ariahu, C. C. and Ingbian, E. K. 2011. Effect of malting and lactic fermentation on some chemical and function properties of maize (*Zea mays*). *American J. Food Technology.* **6(5):** 404-412.

Griffith, L. D., Castell-Perez, M. E. and Griffith, M. E. 1998. Effects of blend and processing method on the nutritional quality of weaning foods made from select cereals and legumes. *Cereal Chemistry,* **75(1):**105-112.

Gupta, M., Abu-Ghannam, N. and Gallaghar, E. 2010. Barley for brewing: characteristics changes during malting, brewing and applications of its by-products. *Comprehensive Reviews in Food Science and Food Safety*. **9:** 318-328.

Jaiswal, P. C. 2003. *Soil, Plant and Water analysis,* Kalyani publication, New Delhi. pp. 279-280.

Mashayekh, M. Mahmoodi, M. R. and Enterazzi, M. H. 2008. Effect of fortification of defatted soy flour on sensory and rheological properties of wheat bread. *International J. Food Science and Technoogy.* **43:** 1693-1698.

Mitchell, J. R., Hill, S. E., Paterson, L. A., Vallès-Pàmies, B., Barclay, F. and Blanshard, J. M. V. 1997. The role of molecular weight in the conversion of starch. *In: Frazier et al (eds) Starch: structure and functionality. The Royal Society of Chemistry, Cambridge.* pp. 68-76.

Ndife, J., Abdulraheem, L. O. and Zakari, U. M. 2011. Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soybean flour blends. *African J. Food Science*. **5**: 466-472.

Okoye, J. I. and Okaka, J. C. 2009. Production and evaluation of protein quality of bread from wheat cowpea flour blends. *Continental J. Food Science and Technnology.* **3:** 1-7.

Rababah, T. M., Al-Mahasneh, M. A. and Ereifej, K. I. 2006. Effects of chickpea, broadbean or isolated soy protein additions on the physicochemical and sensory properties of biscuits. *J. Food Science.* **71:** 438-442.

Ranganna, S. 1986. *Handbook of analysis and quality control for fruits and vegetable products.* Tata Mcgraw Hill Publishing Co Ltd. New Delhi, India.

Salve, R. V., Mehrajfatema, Z. M., Kadam, M. L. and More, S. G. 2011. Formulation, nutritional evaluation and storage study of supplementary foods (Panjiri). *J. Food Processing Technology.* **2:** 1-5.

Sethi, I., Sewhag. M., Kumar, P. and Mahesh. J. 2016. Yield performance of chickpea cultivars as influenced by sowing time and seed rate. *The Bioscan*. **11(1):** 421-425.

Thakur, S. and Saxena, D. C. 2000. Formulation of extruded snack food (Gum Based Cereal) pulse blend: Optimization of ingredients levels using response surface methodology. *Lebensm.-Wiss.u.-Technology.* **33:** 354-361.

Yagci, S. and Gogus, F. 2008. Response surface methodology for evaluation of physical and functional properties of extruded snack foods developed from food-by-products. *J. Food Engineering.* **86:** 122-132.

Yu, L., Ramaswamy, H. S. and Boyce, J. 2013. Protein rich extruded products prepared from soy protein isolate-corn flour Blends. *LWT-Food Science and Technology.* **50:** 279-289.