International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: (RJIF 5.72)
www.allsubjectjournal.com
Volume 3; Issue 3; March 2016; Page No. 22-28

Potential use of germinated soy flour and flaxseed oil in formulation of functional bread

Dr. Neha Mishra

Faculty, Department of Home Science, University of Allahabad, Uttar Pradesh, India.

Abstract
Increasing awareness of consumers regarding health and nutrition has led to experimentations for modification and development of bakery products to prepare value added health foods. This research intended to explore the possibility of replacing traditional shortening butter by flaxseed oil and fortifying the germinated soy flour at level of 5%, 10% and 15% to formulate the functional bread which may have functional properties. Firstly the chemical composition of refined wheat flour, germinated soy flour and non-germinated soy flour is evaluated to find out the effect of germination of nutritional value of flour. It was found that upon germination nutritional value of soy flour increases as through germination fiber, protein and ash content increases. Then farinograph testing of dough such as water absorption, dough development time, dough stability was determined by Brabender Farinograph. The water absorption capacity of dough loafs increases with supplementation from 58.6% to 62.5%. Dough stability which indicates the dough strength, decreased from 2.5 min to 3.9 min. whereas dough development time increases with increases from 5.2 min to 6.9 min. Prepared bread is subjected to sensory and nutritional analysis to evaluate the suitability of bread for consumption. Nine-Point Hedonic Score System was used for sensory evaluation of prepared bread which is generally decreases with increasing the level of substitution. From overall acceptability rating, treatments T1 (5% germinated soy flour with 100 % flaxseed oil) bread obtained the highest rating compare to other treatments at $p \geq 0.05$. The result of the nutritional analysis of functional bread shows it is more nutritious than traditional bread. The moisture, ash, protein, fat and fiber content of bread increases with the supplementation of germinated soy flour from 30.51% to 32.29%, 1.7% to 1.95% and 7.5% to 10.05%, 3.2% to 4.58, 0.18 to 3.31% respectively, whereas carbohydrate content and energy value decreases from 56.91% to 47.82% and 272.2Kcal to 260.7Kcal. Thus it may be concluded that a functional bread could be develop by replacing butter with flaxseed oil and fortifying germinated soy flour at level of 15%.

Keywords: germinated soy flour, flaxseed oil, functional bread

Introduction

Functional food is a healthy food which has health-promoting or disease-preventing property along with the basic nutrition (Bech-Larsen & Grunert, 2003). From last few year demand of functional food has being increased as it leads to healthier life without changing the eating habits of the consumer. Today people wants ready to eat, convenient healthy functional food which provides health benefits beyond the basics nutrients. Bread is most popular convenient snack food with longer shelf life and easy availability at fairly low cost (Gandhi *et al*., 2001). but couldn't consider as a healthy food. Especially for cardiovascular disease (CVD), consumption of traditional bakery products is not recommended (Qu´ılez, *et al*., 2006). Worldwide attempt has been made to improve the nutritional value of bread and functionality by modifying their nutritional composition. Refined wheat flour and saturated fat is one of the main ingredients of bread which makes it nutritionally poor. Refined wheat flour is deficient in lysine, an essential amino acid, fiber, vitamin B1, B2, niacin, minerals.

Soy flour successfully used in bakery products by many researches to obtain protein enriched bakery products with improved amino acid profile (Bojnanska *et al*., 2012). It is an excellent source of protein with high content of lysine protein and deficient in sulphur containing amino acid tryptophan which complements wheat flour as they are deficient in lysine and rich in sulphur amino acids. Soy flour also rich in linoleic acid, fiber, vitamin, minerals, phytoesterogen and may provide many functional properities to food and may reduce the risk of many disease like CVD, DM, cancer, osteoporosis,. But soyabean contains many antinutritional factors like enzymatic inhibitors, phytates, polyphenols, lectins, oligosaccharides which limits its nutritional value (Egounlety and Aworh, 2003; Ahia, 2003). To overcome this problem germination is an appropriate and convenient process has been developed to obtain more palatable, digestible and nutritious soya. Germination is a complex metabolic process during which the lipids, carbohydrates, and storage proteins within the seed are broken down in order to obtain the energy (Jachmanian and Mukherjee, 1995). Thereby it improves the nutritional value of soy by increasing the bioavailability of protein, carbohydrates, vitamins, minerals (Oloyo, 2004) and decreasing anti-nutritional factor (Sathe *et al.,* 1983). During germination enzymatic activities like alpha amylase, lipase, alpha galactosidase, slightly lecithin and ascorbic acid also increases (Bau *et al.,* 2000) which also improves the dough volume and texture of bread.

Saturated fat is the main ingredient of breads affects flavor, texture, mouth feel and appearance of finished product. But there is a high correlation between the excess fat in diet and risk of CVD (Akoh, 1998). CVD is one of the leading causes of death worldwide. Saturated fatty acids cause an increase in plasma cholesterol, mainly LDL cholesterol, and in the total HDL cholesterol ratio, with a subsequent increase in cardiovascular risk (Mensink *et al.,* 2003). For maintaining good health the ratio of ώ-6/ ώ-3 should be 4/1 to 1/1 so consumers and food industries are searching healthier bakery

products with low saturated fat without compromising much with sensory qualities. Flaxseed oil are rich in alpha linolenic acid (ALA), have important role in reducing many human disease, especially CVD (Hurteau, 2004). It reduces risk of atherosclerosis due to its ability to reduce serum cholesterol and platelet aggregation (Jenkins *et al.,* 1999). ALA are converted into EPA in the body, precursor of prostaglandin that interfere with blood clotting and thus sudden cardiac arrest.

Therefore in present study effort was made to increase the nutritional value of bread by composite flour technology and replacing traditional saturated fat by flaxseed oil. The aim of the study is to formulate the functional bread and to analyze the effect of this change on sensory and nutritional characteristic of breads.

Materials & Methods:

The present experimental work "Potential use of germinated soy flour and flaxseed oil in formulation of functional bread" was carried out in the research laboratory of Department of Food and Dairy Technology, Warner School of Food and Dairy Technology, Sam Higginbottom Institute of Agriculture, Technology and Sciences with appropriate methodology.

Raw Material

Refined wheat flour, soy flour, sugar, flaxseed oil, milk powder, salt are purchased from the local market of Allahabad. The equipment & chemical for preparation and analysis were taken from lab of department of Food and Dairy Technology, SHIATS, Allahabad.

Preparation of Germinated Soy Flour Samples

Soya bean seeds were washed and cleaned with 0.7% sodium hypochlorite before soaking in distilled water for 6 h in room temperature (28 °C). For germination, after 6 hr samples were placed under wet muslin cloth and left soaked for 48 hr in room temperature (28 °C) without direct contact with sun light (Yasmin *et al.,* 2008). The muslin clothes allowed oxygen to enter for the germinating seed while minimizing contamination. Seeds were sprayed for every 6hr with distilled water in order to maintain an adequate hydration level. Germinated soy flours were dried in a hot air oven at 65 ^{0}C to about 10 percent moisture content. The dried beans were then dehulled, winnowed and milled using a locally fabricated attrition mill. The obtained flour was packed in air tight container after sieving (Figure 1).

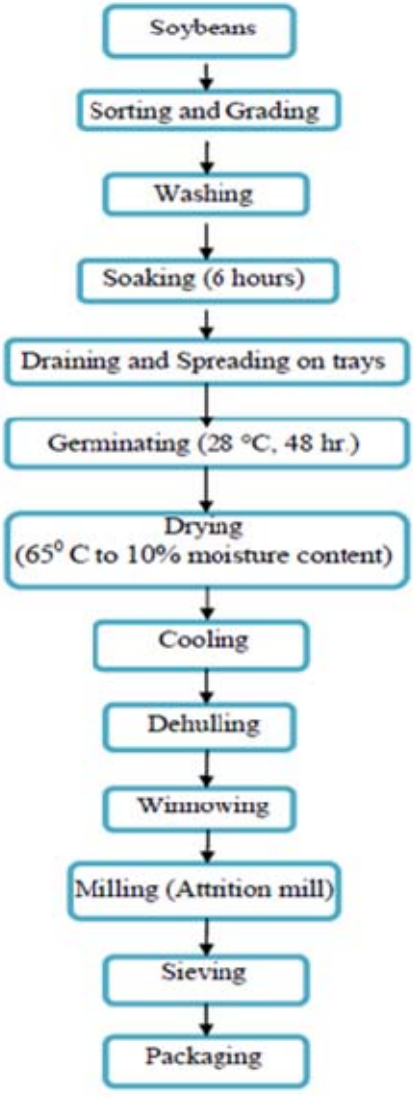

Fig 1: Flow sheet for the preparation of germinated soy flour

Formulating Composite flour

Wheat & soy flours sieved through a metal sieve of 160 mm pore size before being mixing into different ratio to obtain different flour blends. Composite flour were prepared by substituting 5%, 10% & 15% wheat flour by germinated soy flour in the ratio of 95:5, 90:10, 85:15 as shown below:

Treatments:

T0 - Bread made by 100% wheat flour
T1 -5% Soy flour + 95% wheat flour.
T2 –10% Soy flour + 90% wheat flour.
T3 -15% Soy flour + 85% wheat flour.

Preparation of Bread

Functional bread was prepared by Straight dough method (Gomez, 2011). It is the easiest method of making dough in which all ingredients are mixed at same time in mixer. The formula for bread making is given in Table 1. Firstly the water, compressed yeast and sugar were mixed properly in a separate bowl. And was left for 10-15 min till it forms slump and bubbles, this indicates that yeast is activated (Bhatt and Gupta, 2015). All the flours were mixed with all other ingredients along with sugar-yeast solution in a mixer by hand and then kneaded for 10min to form homogenous dough. The amount of water added to each treatment was determined, based on the water absorption values obtained from the farinograph to obtain dough of good consistency. The dough was left to ferment for 15min.this called as rest time where the first fermentation takes place. The loaves were transferred to previously oiled molder and proofed at temperature 30–35 °C and 85% relative humidity for 45 min. When the height of dough had risen to about 1 - 2 cm above the initial height, indicates the proofing had done. Then proofed dough were placed in preheated conventional oven (180 °C) for 30min. The loaves were allowed to cool at room temperature (37 ^{0}C) for 2 h before being packed in polyethylene bags and stored at room temperature for further analysis.

Table 1: Recipe of Manufacturing of Bread

Ingredients	Amount
Flour/Composite flour	100g
Grinded sugar	6g
Butter/Flaxseed oil	4 ml
Yeast	2g
Salt	1.5g
Dry milk powder	7g

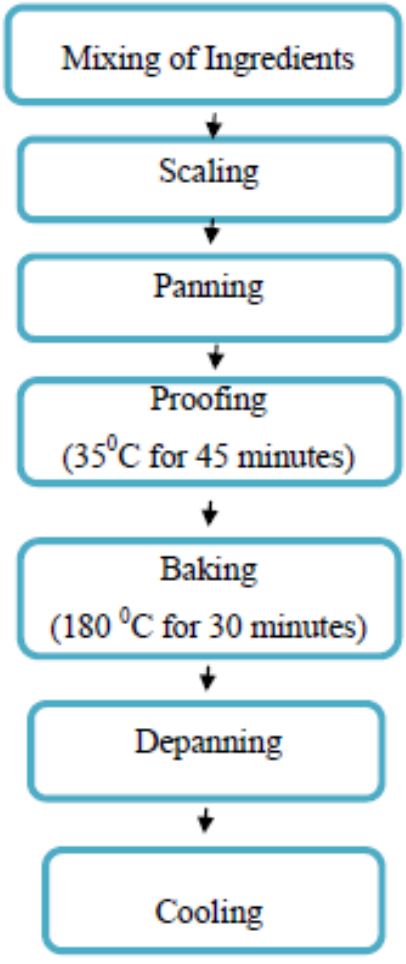

Fig 2: Flow sheet for preparation of bread

Determination of Dough Rheology

The effect of different flour levels on dough rheology such as water absorption, dough development time, dough stability was determined by Brabender Farinograph (C. W. Brabender, Duisburg, Germany), according to the standard methods (A.A.C.C., 2000).

Sensory Analysis

The sensory analysis of functional bread was done by using nine point hedonic scale system as describe by Iwe, 2002. The 20 semi-trained panelist were selected from the staff of department of Food and Dairy Technology, SHIATS, Allahabad for the sensory analysis like crust color, crumb color, flavor, texture overall acceptability of all samples. All the products were coded and presented to the panelist to gives score 9-1 to the product, ranging from 'like extremely' to 'disliked extremely' to find out the most suitable composition of bread.

Nutritional Analysis

Proximate composition includes moisture content; total ash, crude protein, fat, carbohydrate and crude fiber were determined using AOAC method (2000).

Statistical Analysis

The experiment was conducted by adopting completely randomized design. The mean squares of triplicate scores were determined and subjected to analysis of variance (ANOVA) using SSPP (Statistical package for social Statistics). Difference among means were compared using Duncan's Multiple Range Test at significant level 95% ($p \leq 0.05$).

Result and Discussion

Chemical composition of Flour

The chemical composition of the composite flours affect both physico-chemical properties and nutritional quality of their products (Dhingra and Jood, 2001; Akhtar *et al.,* 2008). The obtained result has been presented in Table 2.

Table 2: Chemical composition of wheat flour and Soy flour (% on dry weight)

Parameters	Refined wheat flour	Non germinated	Germinated Soy Flour
Moisture (%)	12	3.7	5.2
Crude Protein (%)	11.6	37.2	42
Crude fat (%)	1.41	21	15.2
Total Ash (%)	0.5	7.8	9.7
Fiber (%)	0.81	5.4	10.2

*Data are the means of triplicates ± standard deviation.

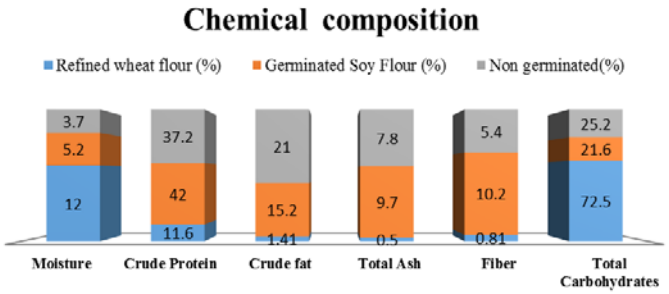

Fig 3: Chemical Composition of flour

Figure 3 shows germinated soy flour are more nutritious than non-germinated soy flour and refined wheat flour as it is high in fiber, protein and ash content. Upon germination, energy and fat content decreases significantly as it use as an energy source. Whereas fiber, protein and ash content increases significantly upon germination. Same observation observed by Mostapha *et al.,* 1987 and Bau *et al.,* 1997.

Effect of substitution on dough rheology

Effect of substitution of flaxseed oil and germinated soy flour has presented in Table 3. The water absorption capacity of dough loafs increases with supplementation from 58.6% to 62.5% might be because of more water retention capacity of treatments as a result of higher protein and fiber content of soy as compared with wheat flour. Same result observed by Selvaraj & Shurpalekar (1982), showed that water absorption increased by about 1% for every 2% increase of soyflour in wheat flour. Rosell *et al*., (2001) reported that the differences in water absorption are mainly caused by the greater number of hydroxyl groups which exist in the fiber structure and allow more water interactions through hydrogen bonding. Dough stability which indicates the dough strength, decreased from 2.5 min to 3.9 min. whereas dough development time increases with increases from 5.2 min to 6.9 min. This might be due to dilution of gluten with increasing fiber content of treatments. In formulation of functional breads traditional shortening is replaced by flaxseed oil with a liquid character, prevents water-flour interaction by coating flour particles, which develops less gluten and increases dough development time.

Table 3: Farinograph reading of functional bread

Samples	Water absorption (%)	Dough Stability(min)	Dough development time(min.)
T0	58.6	2.5	5.2
T1	59.8	3.2	6.2
T2	61	3.5	6.5
T3	62.5	3.9	6.9

Sensory Analysis

For the consumer acceptability of any product sensory analysis is important. The sensory scores obtained from control and different treatments of functional bread were presented in Tables 4.

With increasing level of substitution, the crust color of bread turned from light brown to dark brown, leading to lower acceptance **(**Latidoyeop and Sobowale, 2011). Browning color of bakery product like bread, biscuit might be due to caramelization, dextrinisation of starch or maillard reaction (Sudha *et al.,* 2007) Soyabean has reported to be rich in lysine protein undergo mailard reaction with reducing sugar molecules, give characteristic brown color (Decker *et al.,* 2002 & Tsuji *et al.,* 2001). Taste is the important criteria make the product like or dislike by consumers. Mean score for taste has been shown in Table 4, elucidated decrease in the quality score for taste from 7.5 to 6.3 with the increase in the level of substitution. This difference observed could be as a result of substitution of soy flour and flaxseed oil. Soy flour has a beany flavor which can affect the taste of the bread. Drobot & Stabikone (1976) found similar finding of decreasing score for taste with soy incorporation.

Mean score for flavor decreases from 7.3 to 6.73 due to the beany flavor of soy flour and nutty flavor of flaxseed oil. Similar result was founded by Onweluzo & Iwezu (1998), reported decreasing trend in the flavor score of the bread enriched with soy flour. Hussain (1993) also reported a decrease in trend in the bread enriched with gram flour. Texture is the quality of the bread that can be decided by touch, the degree to which it is rough or smooth, hard or soft. Mean score for the texture decreases from 7.1 to 6.5 may be

due to the protein and fiber content of composite flour increases, which affect the texture (i.e. increases hardness). Eiman *et al.,* (2008) reported replacement of saturated fat by flaxseed oil may interfere in gas retention, so texture of finished products. Overall acceptability was determined on the basis of quality scores obtained from the evaluation of crust color, taste, flavor, texture of the breads. Mean score regarding overall acceptability of breads from 7.4 to 6.5. All the treatments were rated above average scores so all the samples were acceptable. However in all treatment bread with 5% germinated soy fortified bread had highest overall acceptability.

Table 4: Sensory analysis of functional analysis

Treatments	T0	T1	T2	T3
Crust color	7.4	7.2	6.8	6.5
Crumb color	7.9	7.5	6.9	6.2
Taste	7.5	7	6.9	6.3
Texture	7.1	6.9	6.7	6.5
Flavor	7.3	6.9	6.8	6.73
Overall	7.4	7.2	6.8	6.5

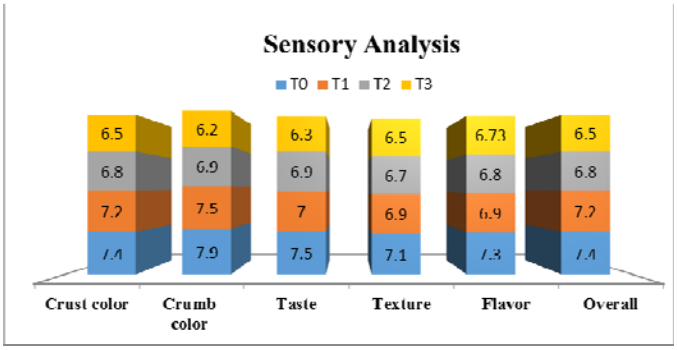

Fig 4: Sensory analysis

Nutritional analysis of Functional Bread

The result of the nutritional analysis of functional bread was shown in Table 5.Analysis of variance shows there is significant difference between each groups.

Table 5: Nutritional analysis of functional bread

Treatments	T0	T1	T2	T3
Moisture (%)	30.51	31.5	32	32.29
Ash (%)	1.7	1.72	1.85	1.95
Protein (%)	7.5	8.78	9.61	10.05
Fat (%)	3.2	3.9	4.31	4.58
Crude fiber (%)	0.18	1.8	2.8	3.31
Carbohydrates (%)	56.91	52.3	49.43	47.82
Energy(Kcal)	272.2	266.3	262.5	260.7

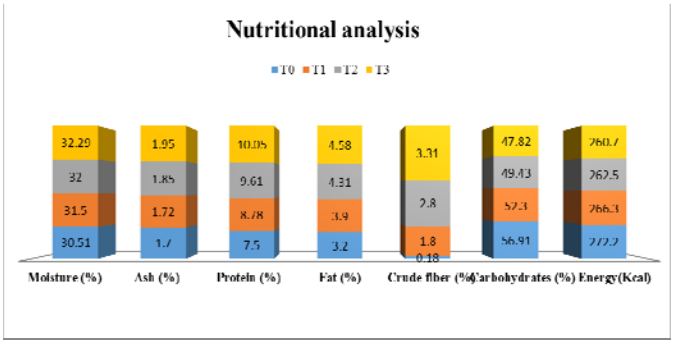

Fig 5: Nutritional analysis

The moisture content of bread increases with the supplementation of germinated soy flour from 30.51% to 32.29%, this could be due to the high water binding capacity of soy flour. The water binding capacity of soy flour is related to its high fiber and protein content. The highest moisture content found in T3 (with 15% GFS bread) followed by T2 (with10% GFS bread) and the lowest moisture was observed in T0 (non supplemented bread).This result is similar to the earliar finding of Zaker *et al.,* 2012. The maximum ash content was observed in T3 (1.95%) followed by T2 (1.85%) and the lowest ash was observed in T0 (1.7%). The linear variation of ash content with GSF may be attributed due the high mineral content of soy flour. The result depicts the protein content of bread increases with supplementation of soy flour from 8.78% to 10.05%. The maximum protein content was observed in T3(10.05%) followed by T2 & T1 whereas control bread has minimum protein content (7.5%). This could be due to high protein value of soy flour. Our result are in agreement of other finding like Awasthi and Yadav (2012), Banureka and Mahendran (2009). Soy flour is high quality protein complement to lysine limited in cereal protein. Soy incorporation enhances the quantity and quality of protein content of food product which increase its potential for the formation of functional bread. Fiber content of bread increases with supplementation, control treatment has lowest fiber content 0.18% and T3 has highest fiber content3.31%. Upon germination fiber content of soy flour increases (Malomo *et al.,* 2012). The dietary fiber play significant role in the prevention of several diseases such as CVD, diverticulosis, constipation, irritable colon, cancer and diabetes **(**Slavin, 2005**,** Elleuch *et al.,* 2011). Many studies have shown the high fiber composite breads aid in the digestion of bread in colon and reduce constipation often associated with bread produced from refined wheat flour **(**Jideani & onwubali 2009**;** Elleuch *et al.,* 2011).

The fat content of bread increases with increases the supplementation of soy flour from 3.2% to 4.58%. The minimum fat content was observed in non supplemented bread T0 (3.20%) which differ significantly from fat content of T1(3.95%). As shown in Figure 6 the carbohydrate content decreases from 56.61% to 47.8%. This variation is due to lower carbohydrate content of germinated soy flour than refined wheat flour. Food energy is the amount of caloric available from food that is available through oxidation. Food energy from fat, proteins and carbohydrates about 9 kcal/g, 4kcal/g, 3.75% respectively. The calorie content of the breads decreasing from 272.2 to 260.7 kcal (Figure 4.17). However, it is worthwhile owing that major source of calories in case of treated samples was contributed by protein and fiber which is superior in terms of nutrition point of view.

Conclusion

The functional bread can be made with substitution of germinated soy flour up to 15% and by replacing butter with flaxseed oil without adversely affecting the sensory characteristic of bread. On the basis of overall acceptability, among the different treatment combinations of functional bread it could be concluded that treatment T1 of ratio of composite flour TA(95:5) was the best combination. The composite bread were found to be nutritionally superior (have higher protein, fiber and ash content) than traditional wheat flour bread. Therefore it could be serve as functional bread to

the consumer's. However, the wheat bread had better acceptability scores than this functional bread. It is recommended that the rheological qualities of functional bread could be improved by the addition of appropriate additives or maybe there is need to adjust the mixing ingredients. There is also need to study the self life and oxidative stability of soy flour-flaxssed oil rich bread.

References:

1. AOAC. Official Methods of Analysis, Association of Official Analytical Chemists, Washington DC, New York USA. 2000.
2. Ahia AC. The influence of solvent extracted soybean flour in sorghum wort beer. Nigerian Food Journal. 2003; 21:94–98.
3. Aleem Z. Effects of defatted soy flour incorporation on physical, sensorial and nutritional properties of biscuits. Journal of Food Processing & Technology. 2012; 3:23-28.
4. Awasthi P, Yadav MC. Effect of incorporation of liquid dairy by products on chemical characteristics of soy fortified biscuits. Journal of Food Sci. Technology. 2000; 37(2):158-161.
5. Banureka VD, Mahendran T. Formulation of wheat-soybean biscuits and their quality characteristics. Sri Lanka Tropical Agricultural Research & Extension. 2009; 12(2):34-36.
6. Bau HM, Villaume C, Mejean L. Effects of soybean (Glycine max) germination on biologically active components, nutritional values of seeds, and biological characteristics in rats. Nahrung, 2000; 44(1):2–6.
7. Bech-Larsen, Grunert. The perceived healthiness of functional foods: A conjoint study of Danish, Finnish and American consumer‘s perception of functional foods. Appetite, 2003; 40(1):9-14.
8. Bhatt SM, R Gupta. Bread (composite flour) formulation and study of its nutritive, phytochemical and functional properties. Journal of Pharmacognosy and Phytochemistry. 2015; 4(2):254-268.
9. Bojňanská T, Chlebo P, Gažar R, Horna A. Buckwheat enrichment bread production and its nutrition benefits. European Journal of Plant Science and Biotechnology. 2009; 3(1):49-55.
10. Decker EAM, Korver O. Minor constituents of rice brain oil as functional foods. Nutrition Review. 1996; 54(11):120-126.
11. Egounlety, Aworh OC. Effect of soaking, dehulling, cooking and fermentation with Rhizopus oligosporus on the oligosaccharides, trypsin inhibitor, phytic acid and tannins of soybean (Glycine max Merr.), cowpea (Vigna unguiculata L. Walp) and groundbean (Macrotyloma geocarpa Harms). Journal of Food Engineering. 2003; 56(2-3):249-254.
12. Elleuch M, Bedigian D, Roiseux O, Besbes S, Blecker C, Attia H. Dietary fiber and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: Food Chemistry. 2011; 124(2):411-421.
13. Hussain A. Protein enriched biscuit from composite flour of gram and wheat. M.Sc. Thesis, Univ Agric Faisalabad, Dept Food Technol. 1990.
14. Gandhi A, Kotwaliwale N, Kawalkar J, Srivastava D, Parihar V, Raghu Nadh P. Effect of incorporation of defatted soy flour on the quality of sweet biscuits. Journal of Food Science Technology. 2001; 38:502–503.
15. Gomez M, Jim´enez S, Ruiz E, Oliete B. Effect of extruded wheat bran on dough rheology and bread quality. LWT-Food Science and Technology. 2011; 44(10):2231–2237.
16. Hurteau MC. Unique new food products contain good omega fats. Journal of Food Science Education. 2004; 3(4):52-53.
17. Iwe MO. Handbook of Sensory Methods and Analysis. Rejoint Publishers, 1st Edition, 2002, 71.
18. Jachmanian V, Mukherjee KD. Germinating Rapeseed as Biocatalyst: Hydrolysis of Oils Containing Common and Unusual Fatty Acids. Journal of Agriculture Food Chem., 1995; 43(11):2997–3000.
19. Jideani V, Onwubali F. Optimization of wheat-sprouted soybean flour bread using response surface methodology. African Journal of Biotechnology. 2009; 8(22):6364-6373.
20. Latidoye OP, Sobowale. Microbiological Quality Analysis of Meat Pies Sold By Street Hawkers: A Case Study of Mainland Local Government Area of Lagos. Nigeria Journal of Medical and Applied Biosciences. 2011; 2:1-8.
21. Malomo Olu, Ogunmoyela AOB, Kukoyi Iretimipo. Effect of Germinated and Ungerminated Soybean Flour on the Rheological Properties of Wheat Bread Dough. British Journal of Science. 2012; 3(1):1-41.
22. Mostafa MM, Rahma EH, Rady AH. Chemical and nutritional changes in soybean during germination. Food Chemistry. 1987; 23(4):257–275.
23. Oloye DA. Sensory Evaluation of and acceptance of composite bread from wheat, cassava starch and cassava flour blends. Thesis in Food Science and Technology Department, Federal University of Technology, Akure. 2006.
24. Onweluzo JC, Iwezu EN. Consumption and characteristics of cassava-soybean and wheat soybean biscuits. Journal of Food Science Technology. 1998; 35(2):128-31.
25. Mensink RP, Zock PL, Kester AD, Katan M. Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: A meta-analysis of 60 controlled trials. The American Journal of Clinical Nutrition. 2003; 77(5):1146–1155.
26. Quílez J, Ruiz JA, Brufau G, Rafecas M. Bakery products enriched with phytosterols, α-tocopherol and β-carotene. Sensory evaluation and chemical comparison with market products. Food chemistry. 2006; 94(3):399-405.
27. Rosell CM, Rojas JA, De Barber CB. Influence of hydrocolloids on dough rheology and bread quality. Food Hydrocolloids. 2001; 15(1):75–81.
28. Selvaraj A, Shurpalekar S. On improving the quality of soy fortified bread. Journal of Food Science and Technology. 1982; 19(6):242–246.
29. Slavin J, Green H. Dietary fibre and satiety. Nutrition Bulletin. 2007; 32(s1):32-42.
30. Sudha ML, Srivastava AK, Vetrimani R, Leelavathi K. Influence of fiber from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. Journal Food Chemistry. 2007; 100(4):1365-1370.

31. Tsuji H, Kimoto M, Natori Y. Allergens in major crops. Nutrition Research. 2001; 21(6):925-934.
32. Yasmin A, Zeb A, Khalil AW, Paracha GMUD, Khattak AB. Effect of processing on anti-nutritional factors of red kidney bean (Phaseolus vulgaris) grains. Food and Bioprocess Technology. 2008; 1(4):415-419.