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EFFECTS OF VARIOUS TRADITIONAL PROCESSING METHODS ON THE QUALITY PARAMETERS OF CORN AND PEANUT FLOUR

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ABSTRACT

Corn and peanut were subjected to germination, fermentation and roasting. Highest protein (11.83 %), crude fibre (1.98 %) and ash (2.10 %) content was recorded in germinated corn flour as compared to raw flour which had 9.96 % protein, 1.83 % crude fibre and 2.04 % ash content. Protein (26.86 %), crude fibre (3.44 %) and ash (2.93 %) were also highest in germinated peanut flour as compared to raw flour. Germination and fermentation resulted in decrease in crude fat and carbohydrate content of grains. The significant increase was observed in crude fat (48.32 %), ash content (2.74 %) and carbohydrate (21.25 %) content as a result of roasting of peanuts while protein (22.17 %) and crude fibre (2.61 %) decreased as compared to raw. These pre-processing treatments also caused decline in tannins and phytic acid, increased mineral content and improved functional properties.

Keywords: corn, peanut, germination, fermentation, roasting and processing

Introduction

Cereals, in general and Corn or maize (*Zea mays* L.), in particular constitute a solution to the high food demand throughout the world. Indeed, it is one of the staple foods in Africa, Asia and Latin America (Mariame, *et al.*, 2013). Together with rice and wheat, maize provides at least 30% of the food calories to more than 4.5 billion people in 94 developing countries (Sharma, 2013). Corn is an important source of carbohydrates, proteins, vitamin B, and minerals (Latham, 1997). Nutritionally, maize is a relatively poor cereal when it comes to the quality of its protein, because it has limiting amount of two essential amino acids, lysine and tryptophan (Azevedo *et al.* 1997). Peanut or groundnut (*Arachis hypogaea* L.) seed contains 44 to 56% oil and 22 to 30% protein on a dry seed basis and is a rich source of minerals (P, Ca, Mg and K) and vitamins (E, K and B) (Savage and Keenan, 1994). Groundnut is used to improve protein content and quality of several cereal-based food products in world.

A variety of methods are used to process cereals and making them more edible with improved flavour, texture, extended shelf life and lesser toxins. Germination is an inexpensive and effective technology for improving availability of nutritionally valuable substances such as antioxidants, minerals, vitamins, and dietary fibres and diminishing the anti-nutritional factors in cereals and legumes (Kaukavirto-Norja *et al.*, 1998; Daramola *et al.*, 2008; Sodipo and Fashakin, 2011). Fermentation, a desirable process of biochemical modification of primary food matrix brought about by microorganisms and their enzymes provides a natural way to destroy undesirable components enhances the nutritive value and appearance of the food and reduces the energy required for cooking (Simango, 1997; Yasmine, 2002; Parveen and Hafiz, 2003). Fermentation of cereals and legumes increases the level of some nutrients, improves digestibility and bioavailability, decreases the level of anti-nutrients, increases nutrient density and imparts some antimicrobial property (Onweluzo and Nwabugwu 2009a). Roasting can also provide an increased bioavailability and functionality of certain nutritional components (Van *et al.*, 2010). Roasting is central to the development of color, flavor and texture through chemical reactions, heat transfer and drying (Simsek, 2007; Donno *et al.*, 2013).

The preference for naturally preserving as well as health enhancing foods are driving factors for research and development in the area of functional foods owning to the increasing cost of healthcare. Therefore an attempt was made to evaluate the effect of traditional processing methods (roasting, germination and fermentation) on the properties of the flour made from corn and peanut.

Materials and Methods

Germination, fermentation and roasting of raw materials

Corn and peanut grains were obtained from a local market and cleaned manually. The corn and peanut were germinated as described by Griffith *et al.* (1998b) and milled to flour. Another batch of corn was kept for fermentation for 3 days as described by Mbata *et al.* (2009) and Steve *et al.* (2011) and milled to flour. Other batch peanuts were roasted at 120° C for 10 min. On cooling, the hulls of the nuts were manually rubbed off and winnowed followed by milling to flour (Emmanuel and Okorie, 2002). The germinated corn and peanut flour, fermented corn flour and roasted peanut flour were sieved and packed in plastic container sealed with aluminum foil and stored at room temperature for further analysis.

Analysis

Proximate analysis was carried out on the raw and processed flours. The moisture content percentage crude protein, crude fat, crude fiber and ash content were determined based on the official methods of analysis (AOAC, 1998). Percentage carbohydrate was determined by difference.

Functional properties such a bulk density was determined using the method of Wang and Kinsella (1976). Swelling capacity was determined with the method described by Tester and Marrison (1994). Dispensability was measured by method described by Kulkarni *et al.*, (1991)**.**

Iron and zinc were determined by wet digestion with nitric and perchloric acids. The samples were digested following the procedures of Jackson (1973) using diacid mixture of nitric acid and perchloric acid (HNO_3:$HClO_4$) in 9:4 ratio. The amount of iron and zinc were determined by atomic absorption spectrophotometer. Calcium was estimation by titration method given by Jaiswal (2003)

An anti-nutritional compound, phytic acid was extracted as described by Wheeler and Ferrel (1971) and tannin content was determined by the Folin-Denis method (Sadasivam and Manickam, 1996).

Statistical analysis

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

Results and Discussion

Proximate composition of corn and peanut flour

There were marked variations in the composition of the samples as a result of germination, fermentation and roasting. The proximate composition of corn and peanut flour processed by different methods is presented in Table-1. The moisture (9.47 per cent), fat (4.04 per cent) and carbohydrate content of raw corn flour was significantly higher (72.65 per cent) except moisture which was non-significantly higher than germinated and fermented corn flour. Protein and ash content increased significantly in case of fermented and germinated than that of raw. While fibre content of raw corn flour was 1.83 per cent which increased in germinated corn flour (1.98 per cent) and decreased in fermented (1.67 per cent) corn flour. On the other hand, the protein (26.86 per cent), crude fibre (3.44 per cent) and ash content (2.93 per cent) was significantly high in germinated peanut flour. The fat content increased to 48.32 per cent during roasting. Carbohydrate decreased significantly from 15.75 per cent in raw peanut flour to 13.32 per cent in germinated peanut flour while it increased to 21.25 per cent in roasted peanut flour. Mbaeyi and Onweluzo (2010) reported that the variation in the moisture content is due to drying level and the ability of the dehydrated samples to absorb moisture in the environment of high range of relative humidity of 80.4%-85.6%. Drying is the final stage of the malting process and is required for stopping further growth of the kernels, reducing the moisture content and water activity, hence producing a shelf-stable product with active enzymes (Hoseney, 1994). The observed decrease in the fat content of the germinated seeds might be due to the increased activities of the lipolytic enzymes during germination. They hydrolyze fats to simpler products which can be used as a source of energy for the developing embryo. Similar observation was made for bambara groundnuts (Elegbede, 1998) and malted millet (Inyang and Zakari, 2008). The decreased carbohydrate levels of the germinated seeds might be due to increase in α-amylase activity (Lasekan, 1996). α-amylase breaks down complex carbohydrates to simpler and more absorbable sugars which are utilized by the growing seedlings during the early stages of germination. The reduction in fat and carbohydrate content of the fermented corn flour could be attributed to the activities of micro-organisms on these nutrients in utilizing them to synthesize protein for their growth (Steve and Olufunmiayo, 2011). In peanut flour it was found that roasting increased the fat and carbohydrate content. The increase in crude fat during roasting could be attributed to the concentration of the constituents during roasting brought about by loss of moisture (Adekanmi *et al.*, 2009). The results were conformed with those reported by Eke-Ejiofor *et al.* (2012) who investigated increase in carbohydrate due to roasting in groundnut seeds. The protein content of both germinated and fermented corn flour was higher than raw flour. The increase in protein content during germination and fermentation may be due to synthesis of enzymes or a compositional change following the degradation of other constituents (Steve and Olufunmiayo, 2011). The increase in protein content could also be attributed to a net synthesis of enzymic protein (e.g. proteases) by germinating seeds (Nzeribe and Nwasike, 1995). However, roasting of peanuts decreased the protein content which could be attributed to their denaturation when heated (Ademulegun and Koleosho, 2008). The decrease in crude fibre content was observed in case of fermented flours. The decrease in content was due to fermentation, was also reported by Onoja and Obizoba (2009) in case of fibre of cereals, legumes, tubers and root flour. Decrease in fibre content during fermentation could be attributed to the partial solubilisation of cellulose and hemicellulose type of material by microbial enzymes (Chavan and Kadam, 1989). Ademulegun and Koleosho, (2008) reported that weakening of fibre occurs during toasting and its enzymatic breakdown during fermentation caused a reduction of crude fibre content while the utilization of carbohydrates in the seed during sprouting leaves a high fibrous seed. Total ash determines the level of mineral element present in the samples. Toasting caused an increase in ash content due to volatilization of organic content. The microbial release of bound minerals will lead to increase in ash content in case of fermentation (Ademulegun and Koleosho, 2008).

Mineral content of corn and peanut flour

The influence of germination, fermentation and roasting on the mineral composition of corn and peanut flour is presented in Table-2. It was observed that highest calcium (13.03 mg/100g), iron (2.89 mg/100g) and zinc content (2.72 mg/100 g) was present in germinated corn flour. In peanut flour, it was seen that highest calcium, iron and zinc content was found in germinated peanut flour. The calcium, zinc and iron contents of corn flour were increased on germination and fermentation. Similar results were reported by Ijarotimi and Keshinro (2012a) in African locust bean. This observation is similar to other investigators who reported that germination increases retention of all minerals and B-complex vitamins compared to other processing methods (Egli 2001, Helland *et al.*, 2002, El-Adawy 2002). Fermentation also provides optimum pH conditions for enzymatic degradation of phytate which is present in cereals in the form of complexes with polyvalent cations such as iron, zinc, calcium, magnesium and proteins. Such a reduction in phytate may increase the amount of soluble iron, zinc, calcium several folds. In case of peanut flour germination was observed to increase the mineral content as compared to roasting. Asibuo *et al.* (2008) repoted that roasting groundnut does not lead to reduction in the levels of mineral elements but rather increases the levels since volatile compounds are lost through heating.

Anti-nutritional factors in corn and peanut flours

There was significant decrease in the anti-nutritional factors in corn and peanut flour due to germination, fermentation and roasting (Table-3). The tannin concentration was 2.55 g/100 g for the raw corn flour which decreased to 0.85 g/100 g for fermented and 1.45 g/100g for germinated corn flour. The concentration of the phytic acid was 0.81 g/100g in raw corn flour which reduced to 0.54 and 0.70 g/100g in fermented and germinated corn flour respectively. In peanut flour, tannin concentration of raw flour was 0.83 g/100 g which decreased to 0.54 in germinated and to 0.62 g/100g in roasted flour, while phytic acid concentration was 0.97 g/100 g in raw peanut flour which decreased to 0.78 and 0.56 g/100g in germinated and roasted peanut flour respectively. Germination, fermentation and roasting decreased the phytic acid and tannin content in flours. Similar results were obtained by Mbaeyi and Onweluzo (2010) in sorghum-pigeon pea composite flour. Adekanmi *et al.* (2009) also reported that toasting reduced anti-nutrients more than soaking. The reduction of tannins in toasted tiger nut showed that tannin is heat labile and can be destroyed during toasting. Scientific studies have established that processing methods such as cooking, dehulling, soaking, fermentation and germination improve the nutritional quality of food products by reducing or eliminating the anti-nutrient composition of the food products (Anju and Khetarpaul, 2008; Syed *et al.*, 2011). They observed that decrease in phytate level in flours was probably due to the activities of the enzyme-phytase which causes the degradation of the phytate in cereals and legumes (Mbaeyi and Onweluzo, 2010). The reduction in tannins during fermentation can be attributed to the microbial degradation compounds or due to less extractable tannin-protein complex (Emmambux and Taylor, 2003). Loss of tannins during germination may be due to the leaching of tannins into the water (Shimelis and Rakshit, 2007) and binding of polyphenols with other organic substances such as carbohydrates or proteins (Saharan *et al*, 2002).

Functional properties of corn and peanut flour

The functional properties of flours play an important role in the preparation of products. The raw corn flour had bulk density of 0.75 g/ml which was significantly higher than that of germinated and fermented corn flour (Table-4). The processed corn flour had a higher dispensability in the range of 69.30- 70.13 per cent which was significantly higher than that of raw corn. Swelling capacity of raw corn flour was 0.49 per cent, which decreased significantly in germinated and fermented corn flour. The raw peanut flour had significantly higher (0.45 g/ml) bulk density than germinated and roasted peanut flour. The dispensability increased significantly from 38.28 per cent in raw to 40.21 per cent in germinated peanut flours, while there was significant decrease in dispensability of roasted (37.32) peanut flour. On the other hand swelling capacity of raw peanut flour was 0.36 per cent which decreased in germinated and roasted peanut flour. The bulk density values of the raw flours were higher than processed flours which may be due the fact that germination there is break down of starch into simple sugars due to the activity of amylase enzyme, which was produced by the activity of microorganisms. Hansen *et al.* (1989) also reported that the energy density increased two to three times by germination which also involved a considerable reduction in viscosity. The reduction in bulk density by fermentation has been documented by Elkhahalifa *et al.* (2004) in sorghum flour and reduction in bulk density in germination and fermentation in African locust bean has been reported by Ijarotimi and Keshinro (2012a). The swelling capacity of raw corn flour was higher than germinated and fermented flour. Higher protein content in flour may cause the starch granules to be embedded within a stiff protein matrix, which subsequently limits the access of the starch to water and restricts the swelling power. Flours lower in protein and higher in total starch content have a higher swelling ability (Aprianita *et al.*, 2009). The results are in conformity with findings of Adebowale and Maliki, (2011) and Gernah *et al.* (2011) who reported that in germinated and fermented flours starch is been dextrinized and thus could not swell as much. Dispensability is a measure of reconstitution of flour or flour blends in water, the higher the dispensability the better the flour reconstitutes in water (Kulkarni *et al.*, 1991). The dispensability was highest in fermented corn flour. The result was in conformity with the previous findings of Shittu and Lawal (2007) who observed that longer steeping time produced fermented cocoyam flour with better dispensability value which indicates better reconstitution ability of the fermented flour.

Conclusion

The present study evaluates the proximate composition, Mineral content, anti-nutritional factor and functional property in corn and peanut flour. The result established that processing techniques, such as, germination, fermentation and roasting improved on the proximate, functional property and mineral composition and also, decreased the anti-nutritional factor of the processed flour. In view of this, the germinated, fermented and roasted corn and peanut flour may be used in the formulation of complementary foods.

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References

Adebowale, O.J. and Maliki. 2011. Effect of fermentation period on the chemical composition and functional properties of Pigeon pea (*Cajanus cajan)* seed flour. *International Food Research Journal*, **18**(4): 1329-1333.

Adekanmi, O. K., Oluwatooyin, O. F. and Yemisi, A. A. 2009. Influence of processing techniques on the nutrients and antinutrients of tigernut (*Cyperus esculentus* L.). *World Journal of Dairy & Food Sciences,* **4** (2): 88-93.

Ademulegun, T. I and Koleosho, A. T. 2008. Effects of processing method on the nutrients composition of maize/soya complementary food. *IOSR Journal of Pharmacy and Biological Sciences,* **4** (1): 39-43.

Anju, N. P. B. and Khetarpaul, N. 2008. Effect of domestic processing and cooking methods on some anti-nutritional factors of moth bean. *Journal of Dairying Foods,* **27**(2):114 - 119.

AOAC (1998). Official Methods of Analysis 16th edn. Arlington, VA: Association of Official Analytical Chemists. Vol 1 and 2.

Aprianita, A., Purwandari, U., Watson, B. and Vasiljevic, T. 2009. Physico-chemical properties of flours and starches from selected commercial tubers available in Australia. *International Journal of Food Research,* **16:** 507-520.

Asibuo, J. Y., Akromah, R., Safo-Kantanka, O., Adu-Dapaah, H. K., Ohemeng-Dapaah, S. and Agyeman, A. 2008. Chemical composition of groundnut, *Arachis hypogaea* (L) landraces. *African Journal of Biotechnology,* **7** (13): 2203-2208.

Azevedo, R. A., Arruda, P., Turner, W. L. and Lea, P. J. 1997. The biosynthesis and metabolism of the aspartate derived amino acids in higher plants. *Journal of Phytochemistry*, **46:** 395-419.

Chavan, J. K. and Kadam, S. S. 1989. Nutritional improvement of cereals by fermentation. *Critical Reviews in Food Science and Nutrition,* **28**: 349-400.

Daramola, B., Osanyinlusi, S. A. and Asunni, O. A. 2008. Effect of grain germination on some physical, chemical and sensory qualities of Kunun produced using selected cereals. *American-Eurasian Journal of Agriculture and Environmental Science,* **3**(2): 221-226.

Donno, D., Beccaro, G. L., Mellano, M. G., Di Prima, S., Cavicchioli, M., Cerutti, A. K. and Bounous, G. 2013. Setting a protocol for hazelnut roasting using sensory and colorimetric analysis: Influence of the roasting temperature on the quality Tonda Gentile delle Langhe cv. hazelnut. *Czech Journal of Food Science,* **31**: 390–400.

Egli, I. M. 2001. *Traditional food processing methods to increase mineral bioavailability from cereal and legume based weaning foods.* Ph. D dissertation. Swiss Federal Institute of Technology. Zurich.

Eke-Ejiofor, J., Kiin –Kabari, D. B., and Chukwu, E. C. 2012. Effect of processing method on the proximate, mineral and fungi properties of groundnut (*Arachis hypogea*) seed. *Journal of Agriculture and Biological Sciences*, **3**(1): 257 –261.

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.

Elegbede, J. A. 1998. Legumes. In: Osagie, A. U. and Eka, O. U. (eds.). *Nutritional quality of plant foods.* pp: 120-133. Post harvest research unit, department of Biochemistry, University of Benin, Benin City, Nigeria.

Elkhalifa, A. E. O., Schiffler, B. and Bernhard, R. 2004. Effect of fermentation on the starch digestibility, resistant starch and some physicochemical properties of sorghum Flour. *Nahrung/Food.* **48**: 91 – 94.

Emmambux, M. N. and Taylor J. R. N. 2003. Sorghum kafirin interaction with various phenolic compounds. *Journal of Science of Food and Agriculture*, **83**(5):402-407.

Emmanuel, C. Nawanekezi and okorie, S. U. 2002. Quality evaluation of malted and fermented maize-groundnut infant weaning foods. *Journal of 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 functional properties of maize (*Zea mays*). *American Journal of Food Technology*, **6**(5): 404-412.

Griffith, L. D., Castell-Perez, M. E. and Griffith, M. E. (1998b). Effects of roasting and malting on physicochemical properties of select cereals and legumes. *Cereal Chemistry,* **75** (6): 780–784.

Hansen, M., Pedersen, B., Munck, L. and Eggum, B. O. 1989. Weaning foods with improved energy and nutrient density prepared from germinated cereals. Preparation and dietary bulk of gruels based on barky. *Food and Nutrition Bulletin,* **2**(2):40-45.

Helland, M. H., Wicklund, T. and Narvhus, J. A., 2002. Effect of germination time on alpha-amylase production and viscosity of maize porridge. *International Journal of Food Research,* **35**: 315-321.

Hoseney, R. C. 1994. *Principles of cereal science and Technology,* American Association of Cereal Chemists, Inc, USA.

Ijarotimi, O. S. and Keshinro, O. O. (2012a). Comparison between the amino acid, fatty acid, mineral and nutritional quality of raw, germinated and fermented African locust bean (*Parkia biglobosa*) flour. *Acta Scientiarum Polonorum Technology Aliment.* **11**(2): 151-165.

Inyang, C. U. and Zakari, U. M. 2008. Effect of germination and fermentation of pearl millet on proximate, chemical and sensory properties of instant "Fura"- A Nigerian cereal food. *Pakistan Journal of Nutrition* **7** (1): 9-12.

Jackson, M. L. 1973. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi.

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

Kaukovirta-Norja, A., Reinikainen, P., Olkku, J. and Laakso, S. 1998. Influence of barley and malt storage on lipoxygenase reaction. *Journal of Cereal Chemistry,* **75:** 742-746.

Kulkarni, K. D., Kulkarni, D. N. and Ingle, U. M. 1991. Sorghum malt-based weaning formulations: preparation, functional properties and nutritive value. *Food and Nutrition Bulletin,* **13** (4): 322-327.

Lasekan, O. O. 1996. Effect of germination on α- amylase activities and rheological properties of sorghum (*Sorghum biocolar*) and acha (*Digitaria exilis*) grains. *Journal of Food Science and Technology,* **33**: 329-331.

Latham, M. C., 1997. *Human nutrition in the developing world.* Vol 29, FAO Publishing, Rome, Italy.

Mariame C., Rose-Monde M., Kouassi A. S. K., René Y. S. and Sébastien N. 2013. Physicochemical, biochemical and nutritive properties of QPM and regular maize flours grown in Côte d'Ivoire. *International Journal of Research in BioSciences*, 2(2): 26-32.

Mbaeyi, I.E. and Onweluzo, J.C. 2010. Effect of sprouting and pre-gelatinization on the physicochemical properties of sorghum-pigeon pea composite blend used for the production of breakfast cereal. *Journal of Tropical Agriculture, Food, Environment and Extension,* **9** (1): 8-17.

Mbata, T. I., Ikenebomeh M. J. and Ezeibe, S. 2009. Evaluation of mineral content and functional properties of fermented maize (Generic and specific) flour blended with bambara groundnut (*Vigna subterranean* L). *African Journal of Food Science,* **3**(4): 107-112.

Nzeribe, H. C. and Nwasike, C. C. 1995. The brewing potential of acha (Digiteria exlils) malt compared with pearl millet (*Pennisetum glaucum*) malt and sorghum (*Sorghum bicolar*) malts. *Journal of Institute of Brewing,* **101**: 345-350.

Onoja, U. S. and Obizoba, I. C. 2009. Nutrient composition and organoleptic attributes of gruel based on fermented cereal, legume, tuber and root flour. *Journal of Tropical Agriculture, Food, Environment and Extension,* **8**(3): 162 -168.

Onweluzo, J. C. and Nwabugwu, C. C. (2009a). Fermentation of millet *(Pennisetum americanum)* and pigeon pea *(Cajanus cajan)* seeds for flour production: effects on composition and selected functional properties. *Pakistan Journal of Nutrition*, **8** (6): 737-744.

Parveen, S. and Hafiz, F. 2003. Fermented cereal from indigenous raw materials. *Pakistan Journal of Nutrition,* **2** (5): 289-291.

Sadasivam, S. and Mnicham.1996. *Biochemical methods,* pp-187. New age international (P) Ltd, India.

Saharan, K., Khetarpaul, N. and Bishnoi, S. 2002. Antinutrients and protein digestibility of faba bean and rice bean as affected by soaking, dehulling and germination. *Journal of Food Science and Technology,* **39:** 418–422.

Savage, G. P. and Keenan, J. I. 1994. The composition and nutritive value of groundnut kernels. In: Smart, J. (ed.). *The Groundnut crop: Scientific basis for improvement.* pp. 173-213. Chapman and Hall, London.

Sharma, B. 2013. *Standardization and evaluation of maize based convenience foods*. Ph.D. thesis. Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, India.

Shimelis, E. A. and Rakshit, S. K. 2007. Effect of processing on antinutrients and in vitro protein digestibility of kidney bean (*Phaseolus vulgaris* L.) varieties grown in East Africa. *Journal of Food Chemistry*, **103**: 161-172.

Shittu, T. A. and Lawal, M. O. 2007. Factors affecting instant properties powdered cocoa beverages. *Food Chemistry*, **100**: 91–98.

Simango, C., 1997. Potential use of traditional fermented foods for weaning in Zimbabwe. *Journal of Social Science and Medicine*, **44:** 1065–1068.

Simsek, A. 2007. The use of 3D-nonlinear regression analysis in mathematics modeling of colour change in roasted hazelnuts. *Journal of Food Engineering*, **78**(4): 1361-1370.

Sodipo, M. A. and Fashakin, J. B. 2011. Physico-chemical properties of a complementary diet prepared from germinated maize, cowpea and pigeon pea. *Journal of Food, Agriculture & Environment*, **9** (3&4): 23-25.

Steve, O. I and Olufunmilayo, O. K. 2011. Determination of amino acid, fatty acid, mineral, functional and choking properties of germinated and fermented popcorn (*Zea mays everta*) flour. *European Journal of Food Research & Review*, **1**(2): 102-122.

Steve, O. I and Olufunmilayo, O. K. 2011. Determination of amino acid, fatty acid, mineral, functional and choking properties of germinated and fermented popcorn (*Zea mays everta*) flour. *European Journal of Food Research & Review*, **1**(2): 102-122.

Syed, A. S., Aurang, Z., Tariq, M., Nadia, N., Sayed, J. A., Muhammad, S., Abdul, A. and Asim, M. 2011. Effects of sprouting time on biochemical and nutritional qualities of Mungbean varieties. *African Journal of Agricultural Research*, **6**(22): 5091-5098.

Tester, R. F. and W. R. Morrison, 1994. Properties of damaged starch granules, composition and swelling of fractions of wheat starch in water at various temperatures. *Journal of Cereal Science,* **20:** 175-181.

Wang, J. C. and kinsella, J. E. 1976. Functional properties of alfalfa leaf protein: foaming. *Journal of Food Science,* **41**: 498 – 501.

Wheeler, E. I. and Ferrel, R. E. 1971. A method for phytic acid determination in wheat and wheat fractions. *Cereal Chemistry,* **48:** 312-320.

Table-1: Proximate composition (%) of corn and peanut flour

	Moisture	Crude fat	Crude protein	Crude fibre	Ash	Carbohydrate
CORN						
Raw	9.47	4.04	9.96	1.83	2.04	72.65
Germinated	9.09	3.85	11.83	1.98	2.10	71.16
Fermented	9.33	3.74	11.73	1.67	1.05	72.49
C.D. (p=0.05)	**NS**	**0.06**	**0.07**	**0.03**	**0.04**	**1.08**
PEANUT						
Raw	8.85	46.33	23.50	3.04	2.53	15.75
Germinated	7.92	45.53	26.86	3.44	2.93	13.32
Roasted	2.91	48.32	22.17	2.61	2.74	21.25
C.D. (p=0.05)	**NS**	**0.04**	**0.05**	**0.08**	**0.03**	**0.17**

Table-2: Mineral content (mg/100g) in corn and peanut flour

	Calcium	Iron	Zinc
CORN			
Raw	12.02	2.34	2.50
Germinated	13.03	2.89	2.72
Fermented	12.36	2.49	2.70
C.D. (p=0.05)	**0.78**	**0.41**	**0.04**
PEANUT			
Raw	51.45	3.80	4.64
Germinated	52.62	3.93	4.93
Roasted	51.94	3.92	4.86
C.D. (p=0.05)	**0.12**	**0.06**	**NS**

Table-3: Anti-nutritional (g/100g) in corn and peanut flour

	Tannin	Phytic acid
CORN		
Raw	2.55	0.81
Germinated	1.45	0.70
Fermented	0.85	0.54
C.D. (p=0.05)	**0.07**	**0.03**
PEANUT		
Raw	0.83	0.97
Germinated	0.54	0.78
Roasted	0.62	0.56
C.D. (p=0.05)	**0.03**	**0.04**

Table-4: Functional properties of corn and peanut flour

	Bulk density (g/ml)	Swelling capacity (%)	Dispensability (%)
CORN			
Raw	0.75	0.49	68.10
Germinated	0.67	0.47	69.30
Fermented	0.59	0.45	70.13
C.D. (p=0.05)	**0.06**	**0.02**	**0.23**
PEANUT			
Raw	0.45	0.36	38.28
Germinated	0.40	0.33	40.21
Roasted	0.41	0.30	37.32
C.D. (p=0.05)	**0.02**	**0.02**	**1.60**