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Utilization of Brown Rice Flour and Peanut Paste in Cake Production

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Abstract Interest in gluten free and partially replaced wheat products have increased in recent years, hence the need for ingredients that can replace wheat in bakery products without compromising sensory and textural characteristics. The study evaluated the effect of partially and totally substituting wheat flour and margarine with brown rice flour and peanut paste on the sensory, nutritional and textural characteristics of the cake formulations. Total substitution of wheat flour with brown rice flour, and margarine with peanut paste was to produce a gluten free product with increased nutritional value. The study followed a 2 x 2 factorial design with replacement of wheat flour by brown rice flour (partially and totally) and replacement of margarine with peanut paste (partially and totally) as factors. Cake products with partially replaced margarine rated better in taste and overall acceptability than formulations in which margarine was totally replaced with peanut paste. However the gluten free formulation with high peanut proteins had higher sensory scores for texture confirmed by results for springiness, cohesiveness and resilience. Total replacement of margarine with peanut paste significantly increased crumb hardness of cake products. The crumb hardness, cohesiveness and springiness of the cake product (B) with total margarine replacement with peanut paste but partial wheat replacement with brown rice flour was not statistically different from the control. The peanut substituted brown rice cake products had significantly higher protein, fat and fibre content than the control product. Partial and total replacement of margarine with peanut paste and wheat with brown rice flour in cake formulations notably influenced the sensory, texture and nutritional characteristics of the products.

Keywords: *gluten free product, brown rice cake, peanut cake, partial wheat substitute, sensory characteristics, texture characteristics, proximate characteristics*

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1. Introduction

Cake is a popular bakery product consumed for its palatable taste. The main ingredients used in cake production include wheat flour, margarine, eggs, sugar and baking powder. Among the different ingredients used in the production of cake, wheat flour constitutes a major component. Wheat flour is critical in baking products due to its gluten content. Gluten is the functional protein in wheat flour required for the quality characteristics of bakery products since the protein impacts on cell formation, crumb and crust structure, volume, porosity and other high quality attributes such as tenderness, shelf life and tolerance to stalling [1]. Nonetheless the presence of gluten in baking products is a serious health threat to genetically predisposed individuals with HLA haplotyres DQ2 and [2]. This health condition referred to as Celiac disease (CD) is a systemic immune-mediated disorder caused by the ingestion of gluten containing grains or products by genetically susceptible individuals [3].

Several studies have shown an increase in CD in different geographical areas-Europe, Middle East, India and North Africa. In Sub-Saharan Africa there are reasons to believe that the condition is not common since the staple cereals frequently consumed are naturally gluten free [2,3,4].

However virtually all of Sub-Saharan Africa’s wheat consumption is through imports from primarily the US, Canada, Argentina and the EU. Hence whereas total replacement of wheat with gluten free flour products is the only prescribed treatment for Celiac disease in the Western world, partial or total replacement of wheat with staple cereals (such as millet and rice) reduces a nation’s wheat import bill in Sub-Saharan Africa. The increasing cost and limited supply of wheat has redirected efforts towards the use of indigenous food sources like brown rice and peanut for the production of bakery products [5]. The supplementation of these carbohydrate based flour products with proteins from legumes also solve issues pertaining to protein-energy malnutrition in developing countries [6,7].

Flour and starches from rice, corn, cassava, millet, potato; proteins from vegetable sources; and hydrocolloids have been used as gluten replacement ingredients by the food industry [8]. Rice flour is a suitable replacement for wheat flour in the production of gluten free cakes because of the absence of gluten, low amounts of fat, sodium, fiber but high amounts of digestible carbohydrates [9]. Brown rice increases the nutritional value of a food product as it contains considerably higher amounts of proteins and minerals than polished rice [10,11]. Additionally brown rice provides higher functional values due to the presence of biologically active compounds and antioxidants in the whole grain [12]. Rice is an important cereal crop in Ghana and other African countries. The cereal is cultivated under varied agro-climatic conditions ranging from upland to lowland and irrigated to rain-fed situations [13]. Worldwide production of rice is estimated at approximately 480million Mt, while that of Ghana is 491600 MT and the total area under cultivation was 162400hacters in 2010 [14].

However the protein content of rice is very low which widely contributes to protein malnutrition, hence the need to improve the nutritional quality of these cereal based products with proteins from legumes. Peanut (*Arachis hypogaea L.*) is an important crop legume with approximately 24% protein in the seed and the third-most important source of plant protein, contributing 11% of world's protein supply [15]. Peanuts also called groundnuts are staple foods in many developing countries and grow well in semi-arid regions. Legumes have been reported to contain adequate amounts of lysine, leucine, aspartic acid, glutamic acid and arginine, hence effectively complement cereals rich in S-containing amino acids (methionine, cystine and cysteine) by providing a balanced essential amino acid profiles [16,17]. Groundnut seed contains 44 to 56% oil and 22 to 30% protein on a dry seed basis and is a rich source of minerals (phosphorus, calcium, magnesium, and potassium) and vitamins (E, K, and B group) [18]. Peanut oil is usually composed of 80% unsaturated fatty acids which consist of 45% oleic (18:1) and 35% linoleic (18:2) acids [19]. The monounsaturated fatty acids such as oleic acid have been shown to offer protection against cardiovascular disease by lowering low density lipoprotein while raising high density lipoprotein levels; the polyunsaturated fatty acids however tend to lower both [20]. Hence the essence of formulating cake products by partially and totally substituting wheat and margarine with brown rice and peanut paste was to improve the nutritional value of the bakery product and also provide alternative ingredients for formulating the product to meet the needs of all cake consumers.

2. Material and Methods

2.1. Materials

Wheat flour (*Triticum aestivum*), brown rice (*Oryza sativa*) and peanut (*Arachis hypogaea L.*) paste were used as the main ingredients for the cake product. The raw materials were purchased from Ho, Ghana. Other ingredients purchased included margarine, eggs, nutmeg, vanilla essence and sugar.

2.2. Preparation of Brown Rice Flour

The brown rice flour was prepared by first sorting to remove any foreign material present in the cereal. The rice was dry-milled to fine powder and sieved to obtain the flour.

2.3. Experimental Design

A 2x2 factorial design was used as a basis for the formulations and the factors were; (a) Wheat flour substitution with brown rice flour (partially and totally) and (b) Margarine substitution with peanut paste (partially and totally). A total of 5 cake formulations were developed which consisted of the 4 formulations from the factorial design and 1 control (formulated with 100% wheat and 100% margarine).

2.4. Preparation of Brown Rice-Peanut Cake Products

A single-bowl mixing procedure was used for making the brown rice-peanut cake products. The recipe for both the total and partial replacement of wheat flour with brown rice flour, and margarine with peanut paste have been detailed in Table 1. Two of the formulations (C and D) were gluten free products. All ingredients were mixed during 12 min at speed 6 using a Kitchen-Aid Professional mixer- KPM5. Cake batter (350 g) were placed into rectangular (225 mm x 100 mm) metallic, greased pan and were baked in an electric oven for 30 min at 190^{o}C. The cakes were removed from the pans after baking, left at room temperature on a rack for 1 hr to cool down, and put into plastic pouches to prevent drying.

2.5. Sensory Evaluation of Cake Products

Cake samples were analysed for colour, taste, flavour, texture and overall acceptability after 6 hrs upon cooling at room temperature. A total of seventy (70) panellists were recruited from the Department of Hospitality and Tourism Management, Ho Polytechnic, Ghana. The criteria for recruitment were that they were cake eaters and willing to participate in the sensory evaluation. The five (5) different cake samples were randomly coded, presented and ranked based on a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely) using a sensory affective test.

2.6. Proximate Characteristics of Cake Products

The proximate composition of the most preferred cake samples (A, C and E) were analyzed according to the method of Association of Official Analytical Chemists [21]. These analyses included moisture content by hot air oven method (934.01), crude fat by Soxhlet extraction method (963.15), crude fibre (945.38), crude protein by Kjeldahl method (using N x 6.25), and ash (923.03). All analyses were done in duplicates. The available carbohydrate content of the samples were calculated by difference.

2.7. Texture Characteristics of Brown Rice-Peanut Cake Products

Crumb texture was determined 24 h after baking using a TA-XT plus Texture analyser (Stable Microsystems Ltd, Surrey, UK) provided with the software "*Texture Expert*". An Aluminium 25mm diameter cylindrical probe was used in a "*Texture Profile Analysis*" Double compression test (TPA) to penetrate to 50% depth, at 2 mm/s speed test with 30 s delay between first and second compression. Texture evaluation were carried out after removing the crust in (40 x 40 x 20) mm sized samples. Hardness, springiness, cohesiveness and resilience were calculated from the TPA graph [22].

2.8. Data Analysis

Data obtained were analysed using Statgraphics (Graphics Software System, STCC, Inc. U.S.A.). Comparisons between the cake formulations were done using analysis of variance (ANOVA) with a probability, $p<0.05$. Fisher's least significant difference (LSD) was used to discriminate among means when ANOVA indicated significant F values. All treatments were conducted in duplicates and mean values reported.

Table 1. Formulations of brown rice-peanut cakes (g/100 g flour)

Formulation	A	B	C	D	E
Brown rice flour	50	50	100	100	0
Wheat flour	50	50	0	0	100
Groundnut paste	50	100	50	100	0
Margarine	50	0	50	0	100
Baking powder	1.6	1.6	1.6	1.6	1.6
Vanilla essence	8	8	8	8	8
Sugar	50	50	50	50	50
Eggs	84.32	84.32	84.32	84.32	84.32
Total (g)	343.92	343.92	343.92	343.92	343.92

C and D - Total wheat replacement formulations (Gluten free formulations); A and B- Partial wheat replacement formulations; B and D – Total margarine replacement formulations; A and C – Partial margarine replacement formulations; E – 100 % wheat-100 % margarine (Control sample).

3. Results

3.1. Sensory Characteristics of Brown Rice-Peanut Cake Product

Cake consumers usually define the quality of a cake products in terms of its sensory characteristics, hence making sensory evaluation a critical stage of product development. The photographs of the five different cake products developed are shown in Figure 1. The cake products developed were evaluated on the basis of colour, taste, texture, flavour and overall acceptability. The mean scores for colour ranged from 6.48 to 7.52 with the control product (100% wheat and 100% margarine) significantly recording a higher appeal. The colour of formulations in which margarine was totally substituted with peanut paste (B and D) were relatively more brown when compared with products with 50 % replacement of margarine with peanut paste- A and C (Figure 1). Although formulation A which contained partially replaced wheat and margarine rated best among the substituted cake products, the mean score was not statistically different ($p>0.05$) from the other brown rice-peanut cake formulations. Generally the gluten free products (C and D) had lower sensory ratings for colour. The presence of margarine in the formulations significantly influenced the taste of the cake products. Products with partially replaced margarine (A and C) rated better in taste than cake products in which margarine was totally replaced (B and D). The gluten free product C with partially replaced margarine was also rated higher than its D counterpart in which margarine was totally replaced with peanut paste. Formulations in which margarine was totally replaced with peanut paste (B and D) were not significantly different ($p>0.05$) in taste. The presence of gluten positively influenced the mouth feel of cake products, however the sensory scores of the gluten containing brown rice-peanut cake products were not statistically different from the gluten free products. Among the gluten free products (C and D), the formulation with total replacement of margarine with peanut paste (D) had a higher sensory texture score than the formulation with 50 % peanut paste. Although rice is noted for preparing gluten free products, quality problems such as low gas retention, poor texture, colour and crumb structure have been associated with the products [4]. Hence food additives such as hydrocolloids and vegetable proteins have been used to resolve this problem. Gluten free formulation with high peanut proteins scored higher for sensory texture analysis (Table 2), confirmed by instrumental textural characteristics results for springiness, cohesiveness and resilience (Table 4). Considering the effect of peanut paste on the flavour characteristics of brown-rice cake product, the presence of peanut in the cake products did not negatively influence the flavour of the products since the peanut containing products A (50 % peanut), B (100 % peanut) and C (50 % peanut) were all liked by the consumers. Mean scores for flavour ranged from 5.72 to 7.75 and were statistically significant.

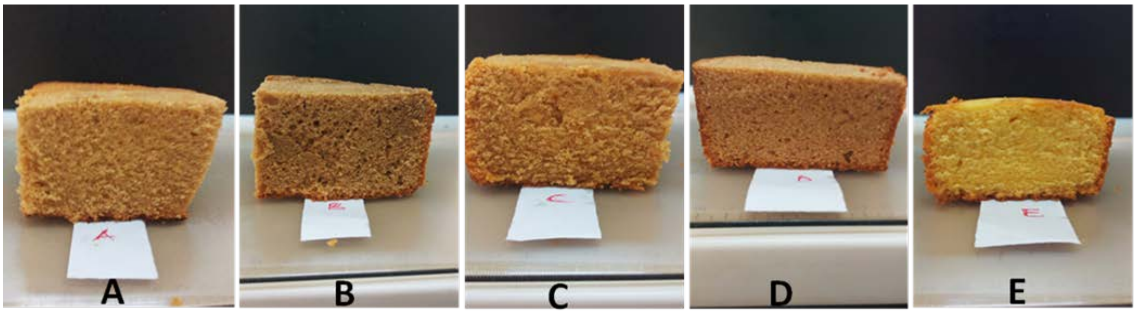

Figure 1. Images of brown rice-peanut cake products

C and D - Total wheat replacement formulations (Gluten free formulations); A and B- Partial wheat replacement formulations; B and D – Total margarine replacement formulations; A and C – Partial margarine replacement formulations; E – 100 % wheat-100 % margarine (Control sample)

The control product (E); the product with partially replaced margarine and wheat (A); and the gluten free product with partially replaced margarine (C) were highly rated in terms of overall acceptability when cake products were subjected to sensory analysis. In order to evaluate the nutritional properties of the most acceptable cake products (A, C and E) their proximate compositions were determined and compared.

Table 2. Sensory evaluation of brown rice-peanut paste cake products

Treatment	Colour	Taste	Texture	Flavour	Overall acceptability
A	6.82(±1.38)[a]	6.92(±1.65)[b]	6.58(±1.53)[a]	6.70(±1.66)[b]	7.11(±1.68)[a]
B	6.60(±1.73)[a]	5.97(±2.07)[a]	6.57(±2.04)[a]	6.40(±1.94)[b]	6.60(±1.86)[a]
C	6.48(±1.79)[a]	6.50(±1.79)[ab]	6.28(±1.89)[a]	6.27(±1.86)[ab]	6.82(±1.68)[a]
D	6.50(±1.68)[a]	6.02(±2.07)[a]	6.55(±1.69)[a]	5.72(±2.15)[a]	6.64(±1.74)[a]
E	7.52(±1.45)[b]	7.61(±1.91)[c]	7.37(±1.72)[b]	7.75(±1.12)[c]	7.72(±1.40)[b]

C and D - Total wheat replacement formulations (Gluten free formulations); A and B- Partial wheat replacement formulations; B and D – Total margarine replacement formulations; A and C – Partial margarine replacement formulations; E – 100 % wheat-100 % margarine (Control sample). Means sharing the same letters in a column are non-significant (P>0.05)

3.2. Proximate Characteristics of Brown-Rice Cake Product

The nutritional composition of the three cake products (A, C and E) which had high overall acceptability scores during sensory evaluation is shown in Table 3. The peanut substituted brown rice cake products had significantly higher protein, fat and fibre contents than the control product which contained 100 % wheat and 100 % margarine. Partial replacement of margarine with peanut in cake formulations greatly improved the nutritional value of the bakery product. Gluten free products have been characterised by relatively low nutritional value because they contain limited amounts of proteins and fibre [23]. In order to enhance the nutritional value of gluten-free products partial replacement of margarine with peanut paste can greatly increase the protein content. Proteins from legume sources have been incooperated in cookies and other bakery products to have higher nutritional value than products obtained from wheat flour [6,24]. The moisture content of brown rice-peanut cake products were significantly lower than the control wheat product. The low moisture content can enhance the shelf-life of the bakery products. Although ash content of the three formulations were not significantly different (p>0.05), it was higher in the partial wheat and partial margarine substituted product (A). The complementary nature of formulation-A which combined minerals from peanut, wheat and brown rice might have contributed to the increased ash content of the cake product. The carbohydrate content of the control cake product was significantly higher than the brown-rice and peanut paste substituted products.

3.3. Texture Characteristics of Brown Rice-Peanut Cake Product

Partial and total replacement of wheat and margarine in cake products significantly influenced the texture profile of the bakery products developed. Table 4 shows results of texture analysis for all brown rice-peanut paste cake formulations and the control sample. Significant differences (p<0.05) were observed in all textural attributes evaluated. Hardness is described by the maximum breaking strength of the cake product. Total replacement of margarine with peanut paste significantly (p<0.05) increased crumb hardness of the cake products. Hardness was extremely high in the gluten free cake product (D) in which margarine were totally replaced with peanut paste. This increased in hardness of bakery products upon inco-operation of legume proteins have also been observed in bread. Texture analysis of bread incooperated with cowpea flour showed that the higher the level of cowpea flour in the bread the higher the texture [25]. Regarding the texture of the gluten free product (C), it was noted that partial replacement of margarine with peanut decreased hardness. Changes in the internal structure of the cake product might have contributed to this observation. Mancebo et al. [26] observed a decreased in hardness when proteins were added to cookies consistent with results of Hadnadev et al. [27] who substituted rice flour with buckwheat flour with higher protein content. This study however observed that total replacement of margarine with peanut paste in gluten free products increased hardness whereas partial peanut paste replacement decreased hardness. However the crumb hardness of the cake product (B) with total replacement of margarine with peanut paste but partial wheat replacement with brown rice flour was not statistically different from the control.

Cohesiveness defines the internal resistance of food structure [1]. The cake product (B) total peanut substitute and partial brown rice flour substitute mimicked the control in terms of how well a cake product withstands a second deformation relative to its behaviour under the first deformation. The gluten free product (C) with partial replacement of margarine with peanut again recorded the least value for cohesiveness. Springiness quantifies how a product springs back after it has been deformed during the first compression. Again sample with partial wheat and total margarine replacements (B) was not statistically different (p>0.05) from the control. Cake formulations with total margarine replacement with peanut (B and D) recorded the highest scores for springiness and were not statistically different from the control. Results is consistent with Dhen et al. [7] who noted that incooperation of soy proteins in cake formulation caused an increase in springiness and cohesiveness. Aside the role of nourishing the cake product, peanut protein enrichment of the brown-rice cake products also functioned as a structure and texture forming agent [23]. The samples with partial margarine replacements with peanut had the least values for springiness.

Resilience measures how well a products regains its original position after the first penetration (instant springiness). As observed for springiness, cake formulations with total margarine replacement were generally higher in springiness than the formulations with partial replacement of margarine with peanut.

Table 3. Proximate characteristics of brown rice-peanut paste cake products

Treatment	Protein	Carbohydrate	Fat	Moisture	Fibre	Ash
A	15.68(±0.07)[a]	28.39(±0.05)[a]	34.67(±0.01)[a]	18.03(±0.02)[a]	1.62(±0.03)[b]	1.60(±0.14)[a]
C	16.33(±0.03)[b]	32.18(±0.11)[b]	33.71(±0.01)[b]	14.84(±0.01)[b]	1.58(±0.07)[b]	1.35(±0.05)[a]
E	6.57(±0.14)[c]	39.58(±0.50)[c]	26.27(±0.01)[c]	24.70(±0.41)[c]	1.34(±0.01)[a]	1.52(±0.07)[a]

C (Gluten free-Partial margarine replacement formulation); A (Partial wheat replacement-Partial margarine replacement formulation); E (100 % wheat-100 % margarine -Control sample). Means sharing the same letters in a column are non-significant (P>0.05).

Table 4. Texture characteristics of brown rice-peanut paste cake products

Treatment	Hardness	Springiness	Cohesiveness	Resilience
A	2288.71[b]	0.78[a]	0.53[b]	0.22[ab]
B	3412.44[c]	0.86[b]	0.64[c]	0.27[bd]
C	1506.33[a]	0.76[a]	0.46[a]	0.19[a]
D	8176.05[d]	0.86[b]	0.55[b]	0.23[bc]
E	3310.43[c]	0.84[b]	0.64[c]	0.28[d]

C and D - Total wheat replacement formulations (Gluten free formulations); A and B- Partial wheat replacement formulations; B and D – Total margarine replacement formulations; A and C – Partial margarine replacement formulations; E – 100 % wheat-100 % margarine (Control sample). Means sharing the same letters in a column are non-significant (P>0.05).

4. Conclusion

Total replacement of margarine with peanut paste greatly influenced both sensory and instrumental texture characteristics of the gluten free brown rice cake product. Total replacement of margarine with peanut paste in gluten free products increased hardness whereas partial peanut paste replacement decreased hardness. The crumb hardness, cohesiveness and springiness of the cake product (B) with total replacement of margarine with peanut paste but partial wheat replacement with brown rice flour was not statistically different from the control. High peanut proteins in gluten free cake formulation increased the mouth feel, crumb hardness, cohesiveness, springiness and resilience of the product. Cake products with partially replaced margarine rated better in taste and overall acceptability than formulations in which margarine was totally replaced with peanut paste. Inclusion of peanut and brown rice in cake formulations significantly improved the nutritional value of the cake products. Peanut and brown rice substituted cake formulations had higher protein, fat and fibre content than the control-100% wheat-100 % margarine product.

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References

[1] Gomez, M., Ronda, F., Caballero, P.A., Blanco, C. and Rosell, C.M. "Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes," *Food Hydrocolloids*, 21. 167-173. 2007.

[2] Wakim-Fleming, J., Pagadala, M.R., McCullough, A.J., Lopez, R., Bennett, A.E., Barnes, D.S. and Carey, W.D. "Prevalence of celiac disease in cirrhosis and outcome of cirrhosis on a gluten free diet: a prospective study," *Journal of Hepatology*, 61.558-563. 2014.

[3] Lionetti, E., Gatti, S., Pulvirenti, A. and Catassi, C. "Celiac disease from a global perspective," *Best Practice and Research Clinical Gastroenterology*, 29.365-379.2015.

[4] Turabi, E., Gulum, S. and Sahin, S. "Quantitative analysis of macro and micro-structure of gluten-free rice cakes containing different types of gums bake d in different ovens," *Food Hydrocolloids*, 24.755-762.2010.

[5] Ugwuona, F.U. and Suwaba, S. "Effects of defatted jack bean flour and jack bean protein concentrate on physicochemical and sensory properties of bread" *Nigeria Food Journal*, 31. 25-32. 2013.

[6] Cheng, Y.F. and Bhat, R. "Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (Pithecellobium jiringa Jack.) legume flour," *Food Bioscience, 2016.*

[7] Dhen, N., Roman, L., Rejeb, I.B., Martinez, M.M., Garogouri, M. and Gomez, M. "Particle size distribution of soy fl our affecting the quality of enriched gluten-free cakes," *Food Science and Technology*, 66.179-185.2016.

[8] Mohammadi, M., Sadeghnia, N., Azizi, M., Neyestani, T., Mortazavian, A.M "De velopment of gluten-free flat bread using hydrocolloids: Xanthan and CMC," *Journal of Industrial and Engineering Chemistry*, 20.1812-1818.2014.

[9] Demirkesen, I., Mert, B., Sumnu, G. and Sahin, S. "Utilization of chestnut flour in gluten-free bread formulations," *Journal of Food Engineering*, 101.329-336.2010.

[10] Lamberts, L., De Bie, E., Vandeputte, E.G., Veraverbeke, W.S., Derycke, V., De Man, W., Delcour, J.A. "Effect of milling on colour and nutritional properties of rice," *Food Chemistry*, 100.1496-1503. 2007.

[11] Renzetti, S. and Arendt, E.K. "Effect of protease treatment on the baking quality of brown rice bread: From textural and rheolog ical properties to biochemistry and microstructure," *Journal of Cereal Science*. 50.22-28.2009.

[12] Cornejo, F., Caceres, P.J., Martinez-Villaluenga, C., Rosell, C.M. and Frias, J. "IEffects of germination on the nutritive value and bioactive compounds of brown rice breads," *Food Chemistry.* 173: 298-304. 2015.

[13] Bose, L.K., Nagaraju, M. and Singh, O.N. "Genotype x environment interaction and stability analysis of lowland rice genotypes" *Journal of Agricultural Sciences*, 57.1-8. 2012.

[14] MoFA. 2009. Statistics, Research and Information Directorate (SRID). Ministry of Food and Agriculture.

[15] Kameswara R. K., Payton, P., Rakwal, R., Agrawal, G.K., Shibato, J., Burow, M. and Puppala, N. "Proteomics analysis of mature seed of four peanut cultivars using two-dimensional gel electrophoresis reveals distinct differential expression of storage, anti-nutritional and allergenic proteins," *Plant Science*, 175. 321-329. 2008.

[16] Farzana, W., and Khalil, I. A. "Protein quality of tropical food legumes," *Journal of Science and Technology,* 23.13-19. 1999.

[17] Minarro, B., Albanell, E., Aguilar, N., Guamis, B. and Capellas, M. "Effect of legume flours on baking characteristics of gluten-free bread," *Journal of Cereal Science*, 56. 476-481. 2012.

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

[19] Grosso, N.R. and Guznam, C.A. "Lipid, protein, and ash contents, and fatty acid and sterol composition of peanut (*Arachis hypogaea* L.) seeds from Equador," *Peanut Science*, 22.84-89. 1993.

[20] Nepote, V., Olmedo, M.G., Mestrallet and Grosso, N.R. “A study of the relationships among consumer acceptance, oxidation chemical indicators and sensory attributes in high-oleic and normal peanuts,” *Journal of Food Science: Sensory and Food Quality*,74. 1-8. 2008.

[21] AOAC. (2000). Official Methods of Analysis, 17th ed. Washington, DC: Association of Official Analytical Chemists.

[22] Gularte, M.A., Hera, E., Gomez, M. and Rosell, C.M. “Effect of different fi bers on batter and gluten-free layer cake properties,” *LWT - Food Science and Technology*, 48.209-214.2012.

[23] Ziobro, R., Witczak, T., Juszczak, L. and Korus, J. “Supplementat ion of gluten-free bread with non-gluten proteins. Effect on dough rheological properties and bread characteristic,” *Food Hydrocolloids*, 32.213-220.2013.

[24] Idowu, A. O. “Development, nutrient composition and sensory properties of biscuits produced from composite flour of wheat and African yam bean,” *British Journal of Applied Science and Technology*, 4.1925-1933.2014.

[25] Hallen, E., Ibanoglu, S., and Ainsworth, P. “Effect of fermented/germinated cowpea flour addition on the rheological and baking properties of wheat flour,” *Journal of Food Engineering*, 63. 177-184.2004.

[26] Mancebo, C.M., Rodriguez, P. and Gomez, M. “Assessing rice flour-starch- protein mixtures to produce gluten free sugar-snap cookies,” *LWT - Food Science and Technology*, 67.127-132.2016.

[27] Hadnadev, T.D., Torbica, A. and Hadnadev, M. “Rheological properties of wheat flour substitutes/alternative crops assessed by Mixolab,” *Procedia Food Science*, 1.328-334.2011.