

## Research Article

### Comparative Evaluation of the Nutritional and Sensory Quality of Major Commercial Whole-wheat Breads in Nigerian Market

<sup>1</sup>Joel Ndife, <sup>2</sup>James Obiegbunna and <sup>1</sup>Simeon Ajayi

<sup>1</sup>Department of Food Technology, Kaduna Polytechnic, Nigeria

<sup>2</sup>Department of Food Science and Tech., Nnamdi Azikiwe University of Tech. Awka, Nigeria

**Abstract:** The study examined the nutritional, microbial and sensory profile of regularly consumed commercial whole wheat breads in Nigeria in order to offer an insight into the overall quality of these foods. Four major local brands of commercial whole wheat breads (samples A, B, C and D) were evaluated. The normal white bread (sample E) served as control. Results of the physical properties obtained, showed that the white bread (sample E) had higher values for bread volume (2850 cm<sup>3</sup>), specific volume (4.38 cm<sup>3</sup>/g), hydration capacity (4.50%) and compressibility (45%) than the whole wheat breads. No trace of bromate was found in all the bread samples. The proximate analyses for the whole wheat bread showed the moisture content to range from (30.64-38.74%), fat (3.5-5.0%), Fibre (2.5-3.5%) higher than in white bread (26.40, 3.0 and 1.20% respectively). While the whole wheat breads had lower levels of protein (5.25-6.48%), carbohydrate (45.74-51.25%) and energy (249-258 Kcal) when compared to white bread of 9.00, 59.40% and 301 Kcal, respectively. The ash and mineral contents of the whole wheat breads were higher than that of white bread. While the viable microbial counts for the whole wheat breads ( $1.0 \times 10^2$ - $1.5 \times 10^2$ ) were lower than in the white bread ( $3.1 \times 10^2$ ). Generally, the bread samples were within the regulatory specifications and the whole wheat breads were nutritionally superior to the white bread while the white bread had better overall sensory preference than the whole wheat breads.

**Keywords:** Bread, chemical composition, mineral, sensory quality, whole wheat

## INTRODUCTION

Wheat is the most popular cereal grain that is consumed worldwide and is used for the production of numerous baked products such as bread, biscuits, cookies, doughnuts and cakes, of which bread is the most common.

Bread is a staple foodstuff and is eaten in most countries around the world. It may be described as a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of process involving mixing, kneading, proofing, shaping and baking (Dewettinck *et al.*, 2008).

Over the centuries master-bakers around the world have modified the traditional bread varieties using their accumulated knowledge to make best use of their available raw materials to achieve the desired bread quality. Therefore, in some countries the nature of bread making has retained its traditional form while in others it has changed dramatically. Thus, bread products have evolved into many forms, each based on different and very unique characteristics. The proliferation of bread varieties derives from the growing use of white flour and the unique properties of wheat proteins to form gluten (Mannay and Shadaksharaswany, 2005). Moreover, the use of white

flour derived from the processing of whole wheat grain by eliminating the outer bran and the components, which was aimed at improving the aesthetic value of white bread, has also led to the drastic reduction in the nutritional quality, when compared to bread made from whole grain cereals (Dewettinck *et al.*, 2008; Maneju *et al.*, 2011).

Whole wheat bread has been reported to possess better health-promoting benefits than white bread, because it is a rich source of functional ingredients such as fibre, phytochemicals, minerals, essential amino acids that are located in the bran and fat soluble vitamins contained in the germ of the whole wheat grain (Dewettinck *et al.*, 2008; Musaige *et al.*, 2007). Recently, consumers' awareness of the need to eat foods that have positive impact on health (functional foods) is increasing. Therefore, the trend is to produce specialty breads made from whole grain flour and other functional ingredients known as health breads or functional foods (Dewettinck *et al.*, 2008).

Ndife and Abbo (2009), reported that the development and consumption of such functional foods that contains whole grain, not only improves the nutritional status of the general population but also have been shown to have beneficial effects in the prevention

of several diseases, such as cardiovascular diseases, constipation, irritable colon, colon cancer, obesity and diabetes (Rodriguez *et al.*, 2006; Schatzkin *et al.*, 2007; Jideani and Onwubali, 2009).

Therefore, the food processors must arm themselves with the health awareness of the consumers and respond to this challenge by formulating food products that provide additional health benefits beyond the basic nutrition and overcome the technical problems associated with the sensory acceptance (Ndife and Abbo, 2009; Hiller *et al.*, 2011).

Very little work has been done on the quality of the various commercial-bread types available in the market. The purpose of this study, therefore, was to ascertain the physico-chemical, microbial and sensory quality of the regularly consumed whole wheat breads in Nigeria, in order to offer an insight into the nutritional profile of these foods which can help guide the un-informed consumer to make the right choice.

## MATERIALS AND METHODS

Four most popular brands of whole wheat breads including normal white bread were purchased off the shelf from different supermarket in Kaduna town, of Northern Nigeria. The different commercial whole wheat bread samples were labeled A, B, C, D and E for the white bread which served as control for the purpose of this study. All the bread samples were stored at ambient temperature in cellophane wraps, during the period of analytical investigation.

**Physico-chemical analysis:** The bread characteristics, such as: the dough expansion, bread volume and bread specific volume were measured by the method described by Maneju *et al.* (2011). While the pH, brix and bromate content of the composite bread samples were measured through methods described by Jacobs (1999).

**Proximate analysis:** The determination of the chemical composition of the bread samples viz: moisture content, ash content, protein content, fat content, crude fiber and content were determined by methods described by AOAC (1990). Carbohydrate was calculated by difference and energy was calculated using Atwater conversion factors. Total reducing sugars were determined by Lane Eyon method as described by Mehmood *et al.* (2008).

**Mineral assay:** Each bread sample was digested by the wet ashing method prior to mineral content determination using atomic absorption spectrophotometer for Ca, Mg and Fe and Corning 400 flame photometer for K and Na (Abulude, 2005). While the phosphorus content was determined colorimetrically with Jenway 6100 spectrophotometer using the method described by Nielsen (2003).

**Microbiological assay:** The determination of the microbial contamination (mesophilic aerobic bacteria, coliforms, yeast and mold counts) in the products was performed by the method outlined in compendium of methods for the microbiological examination of foods (AMPH, 1992) with some modifications.

**Sensory analysis:** Sensory evaluation of the composite bread samples were carried out by 20 panelists on a 9 point hedonic scale for different parameters such as colour, aroma, taste, texture and overall acceptability as described by Iwe (2010).

**Statistical analysis:** The sensory evaluation data was statistically analyzed using the analysis of variance (ANOVA) and the Duncan Multiple range test with significance level at  $p < 0.05$  (Ihekoronye and Ngoddy, 1985).

## RESULTS AND DISCUSSION

**Physico-chemical analysis:** Table 1 shows the result of the analysis of the physico-chemical properties of the bread samples.

The specific volume of the whole wheat breads (samples A, B, C and D) ranged from 2.55 to 3.14 ( $\text{cm}^3/\text{g}$ ) while the value for the normal white bread (sample E) was 4.38 ( $\text{cm}^3/\text{g}$ ). The whole wheat bread samples were affected by the whole grain flour used in the production. Dewettinck *et al.* (2008) and Elleuch *et al.* (2011) reported that, the main problem of using whole grain flour in baking is the important reduction of loaf volume due to the dilution of gluten network. The hydration capacity is an indication of the ability of the sample to absorb moisture especially during storage (Onwuka, 2006). The hydration capacity ranged from 3.50 to 4.20% in whole wheat bread samples. Sample E (white bread) had the highest value of 4.50%. The gluten network formed to trap air during swelling of the dough also created pores for moisture migration (Rosell *et al.*, 2009).

The pH of the bread samples ranged from 5.20 to 5.69. Sample B had the lowest pH value of 5.20. These values are within the standard pH limits (5.3-6.0) for whole wheat bread (SON, 2004). The pH will influence the microbial-ecology which will ultimately determine the shelf stability and of the bread products (Ezeama, 2007).

The brix is an indication of the sugar content of the bread samples. The brix value ranged from 1.50 to 1.80 in whole wheat breads and was 2.10 in white bread. Hence whole wheat bread samples with lesser sugar content would be suitable for diabetic diets (Ndife and Abbo, 2009).

There was no trace of bromate in any of the bread samples analyzed. The use of bromate as dough improver is prohibited by food regulators because of the carcinogenic implications (Mannay and Shadaksharaswany, 2005).

Table 1: Physico-chemical properties of bread samples

Parameters	Bread samples				
	A	B	C	D	E
Loaf weight	550.00±0.60	800.00±0.81	600.00±0.53	590.00±0.56	650.00±0.72
Loaf vol. (cm <sup>3</sup> )	1725±0.54	2450±0.61	1530±0.53	1710±0.54	2850±0.63
Specific vol. (cm <sup>3</sup> /g)	3.14±0.20	3.06±0.15	2.55±0.21	2.90±0.12	4.38±0.18
Hydration capacity (%)	4.00±0.80	3.50±0.65	3.52±0.74	4.20±0.85	4.50±0.70
Compressibility (%)	31.00±0.80	38.00±0.76	25.00±0.74	29.00±0.85	45.00±0.87
pH	5.60±0.15	5.69±0.13	5.68±0.17	5.20±0.13	5.35±0.14
Brix	1.50±0.32	1.60±0.35	1.80±0.32	1.60±0.32	2.10±0.37
Bromate (ppm)	Nil	Nil	Nil	Nil	Nil

<sup>a</sup>Data are mean values of duplicate determinations ± standard deviation

Table 2: Proximate analysis result for bread samples

Parameters	Bread samples (%)					*RDA
	A	B	C	D	E	
Moisture (%)	35.98±0.30	38.74±0.20	37.96±0.23	30.64±0.28	26.40±0.25	NA
Protein (%)	5.25±1.100	5.78±1.06	6.30±1.04	6.48±1.00	9.00±1.08	20-71
Fat (%)	3.50±1.080	4.00±1.11	5.00±1.06	4.50±1.1	3.00±1.08	25-30
Fiber (%)	2.50±0.80	2.60±0.65	3.00±0.74	3.50±0.86	1.20±0.93	19-38
Ash (%)	1.52±0.50	1.47±0.61	2.00±0.62	2.23±0.58	1.00±0.43	NA
Carbohydrate (%)	51.25±4.28	47.41±3.9	45.74±4.81	47.35±4.2	59.40±5.08	130-210
Reducing sugar %	12.38±3.25	13.11±3.51	10.94±4.00	11.81±3.83	10.05±3.95	NA
FEV (Kcal)/100g	258±6.14	249±5.90	253±6.32	256±6.8	301±6.70	NA

RDA: recommended dietary allowance (mg/day); \* Data are mean values of duplicate determinations ± standard deviation

Table 3: Mineral assay result for bread samples

Parameters	Bread samples (mg/100 g)					*RDA
	A	B	C	D	E	
Sodium	351.40±2.30	285.80±2.51	312.93±2.32	254.47±2.42	170.65±2.33	1000-1500
Potassium	170.43±2.65	151.10±2.34	155.48±2.64	140.68±2.75	120.14±2.48	4000-4700
Calcium	128.35±0.45	103.11±0.53	116.58±0.48	121.40±0.57	93.29±0.460	800-1100
Magnesium	60.23±0.28	44.63±0.31	47.58±0.24	50.81±0.27	35.74±0.29	110-300
Iron	5.21±0.18	88.49±0.20	5.15±0.190	4.38±0.11	3.72±0.14	8-22
Phosphorous	180.42±1.70	220.45±1.64	150.78±1.96	180.29±1.55	125±1.48	380-1055

\*RDA: Recommended dietary allowance (mg/day); <sup>a</sup>Data are mean values of duplicate determinations ± standard deviation

**Proximate analysis:** The results obtained from the proximate analysis of the bread samples are shown in Table 2.

The whole wheat breads had on the average, higher values for fat (4.25%), fibre (2.9%), ash (1.81%) and total reducing sugars (12.06%) than the values in white bread (3.00, 1.20, 1.00 and 10.05%, respectively). In comparison to the Nigerian regulatory standards for proximate values of whole wheat breads: The moisture, fat, fibre, carbohydrate and energy contents of the bread samples were within regulatory specifications of moisture 40% maximum; fat 10% maximum; fibre 6% maximum; carbohydrate 37% minimum and energy (1000 KJ/100 g) minimum (SON, 2004). It is recommended that the maximal intake of added sugars be limited to providing no more than 25% of energy (SON, 2004). The higher presence of fat in the whole wheat breads, derived from the bran and germ inclusion, would help to increase the sources of fat soluble vitamins and precursors such as vitamin A and pro-vitamin A carotenoids as well as the total energy content (Shubhangini, 2002). However the average protein content for the whole wheat breads (5.95%) did not meet the standard specification of 10% minimum

requirement (SON, 2004). The inclusion of the whole grain components had a dilution effect on the protein content of the bread samples (Seyer and Gelinas, 2009; Kamaljit *et al.*, 2011). The nutritional significance of each element is related to the contribution it makes to the Recommended Dietary Allowance (RDA) (Wardlaw, 2004).

When compared to the recommended dietary allowances (RDA), the whole wheat bread samples contribute on the average 8.5, 14.2, 7.6 and 22.8%, respectively to daily dietary allowances for protein, fat, fibre and carbohydrates respectively. The crude fibre contents of the whole wheat breads were also within the recommended range of not more than 6 g dietary fibre and other non-absorbable carbohydrates per 100 g dry matter (Shubhangini, 2002). High dietary fibre diets from whole grains are associated with the prevention, reduction and treatment of some diseases such as; cardiovascular diseases, diverticulosis, constipation, irritable colon, cancer and diabetes (Slavin, 2005; Elleuch *et al.*, 2011; Maneju *et al.*, 2011).

**Mineral analysis:** Table 3 shows the result of the analysis of the mineral content of the bread samples.

Table 4: Microbial analysis result for bread samples

Parameters	Bread samples (cfu/g)					*SON
	A	B	C	D	E	
TVC	1.2±0.10×10 <sup>2</sup>	1.5±0.20×10 <sup>2</sup>	1.3±0.13×10 <sup>2</sup>	1.0±0.11×10 <sup>2</sup>	3.1±0.21×10 <sup>2</sup>	<100
TCC	Nil	Nil	Nil	Nil	Nil	Nil
TYMC	<1.0±0.02×10 <sup>1</sup>	1.5±0.25×10 <sup>1</sup>	1.3±0.16×10 <sup>1</sup>	<1.0±0.02×10 <sup>1</sup>	2.5±0.28×10 <sup>1</sup>	<10

TVC-Total Aerobic Counts; TCC-Total Coliform Counts; TYMC-Total Yeast and Mould Counts; \*SON-Standards Organization of Nigeria maximum allowable counts; <sup>a</sup>Data are mean values of duplicate determinations ± standard deviation

The mineral contents of the whole wheat breads (samples A, B, C and D) were higher than in white bread (sample E). These correspond to the results obtained for the ash values. The ash content is an indication of the mineral contents of foods (Abulude, 2005; Cubadda *et al.*, 2009). The average sodium (275 mg) and potassium (147 mg) levels in the bread samples were higher when compared to the other minerals analyzed. The high sodium and potassium contents are characteristic of plant foods (Cubadda *et al.*, 2009).

Inadequate intakes of micronutrients (minerals) have been associated with severe malnutrition, increased disease conditions and mental impairment (Shubhangini, 2002; Abulude, 2005). In comparison to the minimum RDA (Wardlaw, 2004), the whole wheat bread samples contribute on the average: 30, 9, 15, 46, 81 and 48% for Na, K, Ca, Mg, Fe and P, respectively. The result shows the Na/K ratio to be 2:1. To protect against the adverse effect of high sodium intake the Na/K ratio of 1:1 is recommended (Guthrie and Picciano, 1995). Sodium in combination with potassium is involved in maintaining proper homeostasis (acid-balance) of body fluids and in nerves transmission (Guthrie and Picciano, 1995; Shubhangini, 2002). The sodium-Potassium balance is of particular importance in hypertension patients (Shubhangini, 2002).

The availability of calcium in the body depends on the calcium to phosphorus ratio and the presence of anti-nutritional substances, such as phytic acid that is associated with fibre in the food. For good calcium intestinal absorption, Ca/P ratio must be 1:1 (Guthrie and Picciano, 1995). In this study the Ca/P ratio is 1:2, which is not bad. Phosphorus is associated with calcium for bones, teeth and muscles growth and blood maintenance (Shubhangini, 2002; Ologunde *et al.*, 2011). The results from this study show that the bread samples would need to be supplemented with other mineral sources in the diet to meet up with the RDA requirements for a healthy nutrition.

**Microbial analysis:** The results of microbial analysis of the bread samples are presented in Table 4. The results obtained for total aerobic counts were low in all the bread samples (<3.1×10<sup>2</sup> cfu/g). They were also below the maximum limit in the SON (2004) specification for commercial breads (<3.1×10<sup>3</sup> cfu/g). However, the aerobic plate counts were found to be higher in the white bread (3.1×10<sup>2</sup> cfu/g) than in the

Table 5: Sensory evaluation result for bread samples

Parameters	Bread sample				
	A	B	C	D	E
Appearance	7.85 <sup>b</sup>	7.44 <sup>b</sup>	6.73 <sup>c</sup>	6.62 <sup>c</sup>	8.35 <sup>a</sup>
Taste	6.45 <sup>b</sup>	6.23 <sup>b</sup>	5.86 <sup>c</sup>	5.54 <sup>c</sup>	7.26 <sup>a</sup>
Texture	6.35 <sup>b</sup>	6.28 <sup>b</sup>	5.37 <sup>c</sup>	5.13 <sup>c</sup>	7.34 <sup>a</sup>
Chew ability	6.15 <sup>b</sup>	6.24 <sup>b</sup>	4.32 <sup>c</sup>	4.18 <sup>c</sup>	7.83 <sup>a</sup>
Overall acceptability	7.15 <sup>b</sup>	7.10 <sup>b</sup>	6.98 <sup>b</sup>	6.04 <sup>c</sup>	8.55 <sup>a</sup>

Means within a row with different letters are significantly different at p<0.05

whole wheat breads (1.2×10<sup>2</sup> to 1.5×10<sup>2</sup> cfu/g).The moisture content and pH are critical to the survival of microbes and will ultimately affect the shelf stability and sensory quality of the breads (Jay, 2000; Ezeama, 2007).

There were no observable coliform growths in all the bread samples. This eliminates the possibility of faecal contamination in the breads, which is due to good manufacturing and handling practice (Ezeama, 2007), this conforms with the regulatory specification of zero tolerance for coliform counts in breads (SON, 2004). The total mould and yeasts counts in the bread samples range from <1.0×10<sup>1</sup> to 1.5×10<sup>1</sup> cfu/g. While the highest mould and yeasts counts (2.5×10<sup>1</sup> cfu/g) were observed in the white bread sample E. This is higher than the standard specification of 1.0×10<sup>1</sup>cfu/g for whole wheat breads (SON, 2004). The low microbial counts in whole wheat breads could be due to increased mineral content, which has been shown to inhibit to some extent microbial growth. Most minerals are hygroscopic in properties, which could make moisture unavailable to microbial cells for growth (Akhtar *et al.*, 2008).

**Sensory analysis:** Table 5 summarizes the results for the sensory evaluation and overall acceptability of the whole wheat bread samples as compared to white bread (control E).

The statistical analysis revealed that there were significant difference (p<0.05) among all the bread samples in the sensory characteristics observed. Sample D had the lowest score (6.62), while sample A had the highest score (7.85) for appearance, among the whole wheat breads. Panelists observed smaller loaf volume and dark colour in whole wheat breads when compared to the white bread (8.35). The inclusion of wheat bran in the whole wheat flour has been reported as responsible for reduced volume and brown color of the whole wheat loaves (Gomez *et al.*, 2003; Bakke and

Vickers, 2007; Eiman *et al.*, 2008). Similar trends were observed for the sensory ratings of texture and chew ability in the breads. Sample D had the lowest scores (5.13 and 4.18) followed by sample C (5.37 and 4.32) and sample B (6.28 and 6.24), respectively. Hard Crumb texture and poor chewability, caused by increased fiber from wheat bran substitution was reported by Eiman *et al.* (2008).

The white bread sample E, had better scores for taste (7.26) and overall acceptability (8.55) as compared to the whole wheat breads. Bakke and Vickers (2007) reported that the soft texture and sweet taste of white bread is much more appreciated than the hard texture and low sugar of whole-grain bread. More so, a strong negative correlation between consumer acceptability, crumb compressibility, firmness and moisture content has been documented (Bakke and Vickers, 2007; Seyer and Gelinias, 2009).

### CONCLUSION

The high proximate values recorded confirm that the whole wheat breads are capable of meeting most nutritional provisions as a staple food. Highly refined products show a strong association towards consumer liking, thus white bread was preferred in contrast to whole-grain bread.

Whole grain breads are considered as functional foods with additional health benefits, based on their contents of fibre and phytochemicals which have antioxidant potential (Vitali *et al.*, 2009). Therefore there is the need to investigate the phytochemical content and the antioxidant activity of the whole wheat breads.

### REFERENCES

- Abulude, F.O., 2005. Distribution of selected minerals in some Nigerian white bread. *Nig. Food J.*, 23: 139-147.
- Akhtar, S., F. Anjum, S. Rehman, M. Sheikh and K. Farzana, 2008. Effect of fortification on the physico-chemical and microbiological stability of whole wheat flour. *Food Chem.*, 110: 113-119.
- AOAC, 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC.
- Bakke, A. and Z. Vickers, 2007. Consumer liking of refined and whole wheat breads. *J. Food Sci.*, 72: 473-480.
- Cubadda, F., F. Aureli, A. Raggi and M. Carcea, 2009. Effect of milling, pasta making and cooking on minerals in durum wheat. *J. Cereal Sci.*, 52: 4992-4997.
- Dewettinck, K., F. Van-Bockstaele, B. Kühne, D. Van-De Walle, T.M. Courtens and X. Gellynck, 2008. Nutritional value of bread: Influence of processing, food interaction and consumer perception. *J. Cereal Sci.*, 48: 243-257.
- Eimam, H., M. Amir and A. Mustafa, 2008. Effect of Fermentation and particle size of wheat bran on the antinutritional factors and bread quality. *Pak. J. Nutr.*, 7(4): 521-526.
- Elleuch, M., D. Bedigian, O. Roiseux, S. Besbes, C. Blecker and H. Attia, 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. *Food Chem.*, 124: 411-421.
- Ezeama, C.F., 2007. Food Microbiology: Fundamentals and Applications. Natural Prints Ltd., Lagos.
- Gomez, M., Ronda, F., C.A. Blanco, P.A. Caballero and A. Apesteguía, 2003. Effect of dietary fibre on dough rheology and bread quality. *Eur. Food Res. Technol.*, 216: 51-56.
- Guthrie, H. and M. Picciano, 1995. Human Nutrition. WCB/McGraw-Hill Publishing Co., New York, USA.
- Hiller, B., W. Schlormann, M. Gleis and M. Lindhauer, 2011. Comparative study of colorectal health related compounds in different types of bread: Analysis of bread samples pre and post digestion in a batch fermentation model of the human intestine. *Food Chem.*, 125: 1202-1212.
- Ihekoronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics. 2nd Edn., Macmillan Publishers Ltd., London.
- Iwe, M.O., 2010. Handbook of Sensory Methods and Analysis. Rojoint Communication Services Ltd., Enugu, pp: 75-78.
- Jacobs, B.M., 1999. The Chemical Analysis of Foods and Food Products. 3rd Edn., CBS Publishers and Distributors. New Delhi, India.
- Jay, M.J., 2000. Modern Food Microbiology. 6th Edn., Aspen Publishers Inc., Gaithersburg, Maryland.
- Jideani, V. and F. Onwubali, 2009. Optimisation of wheat-sprouted soybean flour bread using response surface methodology. *Afr. J. Biotechnol.*, 8(22): 6364-6373.
- Kamaljit, K., K. Amarjeet and S. Tarvinder-Pal, 2011. Analysis of ingredients, functionality, formulation, optimization and shelf life evaluation of high fibre bread. *Am. J. Food Technol.*, 6(4): 306-313.
- Maneju, H., C.E. Udobi and J. Ndife, 2011. Effect of added brewers dry grain on the physico-chemical, microbial and sensory quality of wheat bread. *Am. J. Food Nutr.*, 1(1): 39-43.
- Mannay, S. and C.M. Shadaksharaswamy, 2005. Foods: Facts and Principles. 2nd Edn., New Age International Ltd. Publishers, New Delhi, India.
- Mehmood, Z., A. Zeb, M. Ayub, A. Bibi, A. Badshah and A. Ihsanullah, 2008. Effect of pasteurization and chemical preservatives on the quality and shelf stability of apple juice. *Am. J. Food Technol.*, 3(2): 147-153.

- Musaige, R.O.A., J. Al-Jedah and R. D'Souza, 2007. Nutritional profile of bakery products consumed in Bahrain Pakistan. *J. Nutr.*, 6(3): 228-233.
- Ndife, J. and E. Abbo, 2009. Functional foods: Prospects and challenges in Nigeria. *J. Sci. Technol.*, 1(5): 1-6.
- Nielsen, S.S., 2003. *Food Analysis Laboratory Manual*. 3rd Edn., Kluwer Academic Plenum Publishers, New York.
- Ologunde, M.O., M.O. Omosebi, O. Ariyo, B.A. Olunlade and R.A. Abolaji, 2011. Preliminary nutritional evaluation of cashew nuts from different locations in Nigeria. *Cont. J. Food Sci. Technol.*, 5(2): 32-36.
- Onwuka, G.I., 2006. *Food Analysis and Instrumentation: Theory and Practice*. Naphthali Prints Lagos, Nigeria.
- Rodriguez, E., A. Jimenz, J. Fernandex-Bolanos, R. Guiltlen and A. Heredia, 2006. Dietary fiber from vegetable products as source of functional ingredients. *Trends Food Sci. Technol.*, 17: 3-5.
- Rosell, C.M., J.A. Royas and D.B. Benedito, 2009. Influence of hydrocolloids on dough rheology and bread quality. *Food Hydrocolloid.*, 15: 75-81.
- Schatzkin, A., T. Mouw, Y. Park, A.F. Subar, V. Kipnis and A. Hollenbeck, 2007. Dietary fibre and whole-grain consumption in relation to colorectal cancer in the NIH-AARP diet and health study. *Am. J. Clin. Nutr.*, 85: 1353-1360.
- Seyer, M.E. and P. Gelinas, 2009. Bran characteristics and wheat performance in whole wheat bread. *Int. J. Food Sci. Technol.*, 44: 688-693.
- Shubhangini, A.J., 2002. *Nutrition and Dietetics*. 2nd Edn., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.
- Slavin, J.L., 2005. Dietary fiber and body weight. *Nutr.*, 21: 411-418.
- SON, 2004. *Standard on Whole Wheat Bread*. Standards Organization of Nigeria, ICS67.060, NIS 470.
- Vitali, D., V. Dragojevic and B. Sebecic, 2009. Effects of incorporation of integral raw materials and dietary fibre on the selected nutritional and functional properties of biscuits. *Food Chem.*, 114: 1462-1469.
- Wardlaw, G.M., 2004. *Perspectives in Nutrition*. 6th Edn., McGraw Hill Co., New York, U.S.A.