Quality Characteristics of Bread Made from Wheat and Nigerian Oyster Mushroom (Pleurotus plumonarius) Powder

ARTICLE *in* PAKISTAN JOURNAL OF NUTRITION · JANUARY 2012

DOI: 10.3923/pjn.2012.5.10

4 AUTHORS, INCLUDING:

Gabriel Ifeanyi Okafor
University of Nigeria
36 PUBLICATIONS **27** CITATIONS

SEE PROFILE

Pakistan Journal of Nutrition 11 (1): 5-10, 2012
ISSN 1680-5194

Quality Characteristics of Bread Made from Wheat and Nigerian Oyster Mushroom (*Pleurotus plumonarius*) Powder

J.N.C. Okafor[1], G.I. Okafor[2], A.U. Ozumba[1] and G.N. Elemo[1]
[1]Food Technology Division, Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria
[2]Department of Food Science and Technology, University of Nigeria, Nsukka, Nigeria

Abstract: Bread containing graded levels of Mushroom Powder (MP) were produced by replacement of Wheat Flour (WF) with 0, 5, 10, 15, 20 and 25% MP. Effect of MP supplementation on the bread making properties, proximate composition and sensory qualities were evaluated. Water absorption was significantly ($p<0.05$) increased as MP level increased in all dough, however, loaf volume, specific volume, crumb grain and loaf quality decreased. Supplementation of WF with MP from 0-25% increased the crude protein content significantly from 7.96-14.62%, ash from 0.90-2.64% and crude fiber 0.51-2.48%. Sensory evaluation based on appearance, crust color, crumb color, crumb texture, taste, chew ability, flavor and overall acceptability showed there were no significant ($p>0.05$) difference between 5% MP fortified bread and 100% WF bread (control) in all the attributes evaluated. Equally, 10% MP fortified bread did not differ significantly in crust color, taste, chew ability and overall acceptability, it compared favorably well with control bread in these attributes. Bread with 15% MP though had significantly ($p<0.05$) lower rating compared to the control, was also acceptable to the panelist. Mushroom powder therefore could be added to wheat flour up to 10% without any observed detrimental effect on bread sensory properties. This could be used to improve the nutritional quality of bread especially in developing countries were malnutrition is prevalent.

Key words: Mushroom powder, bread, fortification, quality, acceptability

INTRODUCTION

Bread is one of the most widely consumed food product in the world and bread making technology is probably one of the oldest technology known (Selomulyo and Zhou, 2007). It is an important staple food for many countries. The product is basically made of hard wheat flour, yeast, fat, sugar, salt and water (Badifu *et al*., 2005). It is a cereal product that is naturally low in protein and nutritionally not a balanced diet because it is low in lysine, an essential amino acid (Giami *et al*., 2003, Agu *et al*., 2010).

However, evidence from food consumption survey in Nigeria indicated that there is a growing increase in the consumption of bread in Nigeria (Anyika and Uwaegbute, 2005). They reported an increased tendency among children and adults to move away from traditional eating pattern of three meals a day to eating snack foods such as, bread and biscuits. Kansas (2006) also reported that increase in consumption of bread, cookies and pasta is fastest in cities where they are now considered convenient foods. The preference for bread (apart from the taste and good eating quality) almost certainly reflects the convenience it offers to urban and probably some rural consumers, requiring no preparation (Anyika and Uwaegbute, 2005).

Since bread is an important food that is generally accepted, they could be an excellent and convenient food item for protein fortification to improve the nutritional well being/health of the people and in nutritional programs which will enhance reduction in protein malnutrition that is prevalent in Nigeria and other developing countries.

Fortification of wheat flour with high protein materials from plant sources to increase the protein and improve the essential amino acid balance of the resultant baked product such as bread has been recognized (Misra *et al*., 1991; Harinder and Sharma, 1999; Mubarak, 2001; Abdel-Kader, 2001; Giami *et al*., 2003; Rosales-Juarez *et al*., 2008; Mepba *et al*., 2009; Agu *et al*., 2010).

Mushrooms are edible fungi that contain high quality digestible protein that varied between (10-40%), carbohydrate (3-21%) and dietary fiber (3-35%) on dry weight basis depending on species (Mallavadhani *et al*., 2006). Most species contain all the essential amino acids about the same proportion as in egg (Friedman, 1975; Quimio *et al*., 1990). Lysine which is deficient in most grain cereals like wheat is the abundant essential amino acid in Mushroom (Friedman, 1975), so mushroom will complement well with wheat flour to produce nutritionally balanced high quality bread. It is also a good source of B-vitamins (thiamin, riboflavin, niacin, biotin, pyridoxine, panthotenic acid) and vitamin C. It also contain significant amount of mineral elements like phosphorus, iron, potassium and calcium and (Friedman, 1975). Mushrooms are not only sources of

Corresponding Author: J.N.C. Okafor, Food Technology Division, Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria

nutrients but have also been reported as therapeutic foods, useful in preventing diabetic, cancer and heart diseases (Bobek and Galbavy, 1999). In Nigeria and other West African countries mushrooms grow in the wild and also cultivated, however, mushroom cultivation has increased tremendously recently because they are popular, well accepted and used as food, especially for soup preparation as substitute for meat (Fasidi and Ukwere, 1993; Okeke *et al*., 2003).

However, with the emphasis on utilization of Mushroom as a source of protein to enrich human diet especially in developing countries (Boras, 1996), appropriate processing technique was developed to preserve Nigerian oyster mushroom which was utilized in bread enrichment. The effect of this supplementation on the physical, nutritional and sensory properties/ acceptability of product was determined.

MATERIALS AND METHODS

Source of raw materials: The Wheat Flour (WF) used was commercial baker's grade wheat flour milled by Nigeria Flour Mills (Golden Penny, Nigeria), Blue Band Margarine (Lever Brothers Nigeria Plc), Baker's brand of yeast, table salt and colorless granulated sugar were purchased from a local market in Lagos, Nigeria. The fresh mushroom (*Pleurotus plumonarius*) was bought from a commercial mushroom grower in Festac Town, Lagos, Nigeria.

Preparation of mushroom powder: The mushroom powder was prepared in the laboratory from fresh mushroom using the method described by Okeke *et al*. (2003). The dried mushroom was milled using a hammer mill and sieved to pass through a 60 mesh sieve (British Standard Screen). The powder was packaged in a low density polyethylene bag, sealed, stored in the refrigerator (4°C) until required.

Production of Wheat Flour (WF) and Mushroom Powder (MP) bread: The preparation of the bread involves the replacement of part of the Wheat Flour (WF) with 0, 5, 10, 15, 20 and 25% Mushroom Powder (MP). The 0% MP bread served as control. Baking was carried out on the blends using standard bread baking procedures established for the straight dough (Pyke, 1976). The formula and baking conditions are given in Table 1. The amount of water needed to make the dough was estimated from the farinograph absorption and feel of the dough during mixing. The baking test was replicated at least twice.

Table 1: Baking formula* and conditions of WF-MP bread

Wheat flour** (%)	100
Dry yeast (%)	1
Salt (%)	2
Sugar (%)	6
Fat (%)	1
Water	Variable
Fermentation	1½ hrs at 30°-32°C
Proofing	1 hr at 30-35°C
Baking	25-30 min at 220-250°C
RH	85-90%

*Ingredients listed as percent of flour.
**The WF was replaced by 0, 5, 10, 15, 20 and 25% MP

Analysis

Physical properties of WF-MP bread: The loaf volume was determined immediately after baking by the rape seed displacement method (SON, 1976). Specific volume was determined from the weight and volume data, when cooled, the loaves were sliced using a bread slicer. Crust and crumb colosr, crumb grain and loaf shape were estimated using a numerical rating of 0-10 (optimum = 10, very poor = 0).

Sensory evaluation: The bread products were subjected to organoleptic analysis. A total of twenty semi-trained panelist drawn from the Staff of Federal Institute of Industrial Research, Oshodi-Lagos, Nigeria, who are familiar with bread, participated in the evaluation. The samples of coded sliced bread were served in clean white plates at room temperature (28±2°C) to the panelist in a sensory evaluation booth with fluorescent lights on. The panelist were to eat the bread and score each sample using a 9-point Hedonic scale (Larmond, 1977) where 1 = extremely unacceptable and 9 = extremely acceptable. Attributes evaluated include; bread appearance, crust color, crumb color, texture, taste, chew ability, flavor and overall acceptability. The resulting data were analyzed using Analysis of Variance (ANOVA), while the means were separated using Duncan multiple range test (Duncan, 1955), significance was accepted at 5% level of probability ($p<0.05$).

Chemical composition: The proximate composition (moisture, crude protein, total fat, ash and crude fiber) of the wheat flour, mushroom powder, the blends and bread were determined by standard method of AACC (1990).

Moisture content of the of the samples were determined according to method 44-19 and expressed as dry basis. Crude protein was determined by an automated Kjedahl method, using Kjedahl 2006 digester. Crude fat content was determined using soxhlet apparatus, with petroleum ether to extract the lipid according to method 20-26. Method 48-06 was used to determine crude fiber content. The carbohydrate was obtained by difference (100-moisture, crude protein, total fat and crude ash) while the caloric value (energy) was obtained by multiplying the values of crude protein, total fat and carbohydrate by their physiological fuel values of 4, 9 and 4 respectively and taking the sum of the products.

All the experiment was carried out in triplicates.

Statistical analysis: Data were reported as mean±SD. Statistical significance was established using One-Way Analysis of Variance (ANOVA) at 5% level of probability and differences between means were compared using Duncan Multiple range test. Statistical analysis were carried out using SPSS for Windows, version 14.0 (SPSS Inc. Chicago, IL USA).

RESULTS

The chemical composition of the wheat flour, mushroom powder and their blends is shown in Table 2. Mushroom powder had relatively high content of protein (36.0%), ash content (7.60%) but low content of carbohydrate (38.0%) and crude fiber (7.90%) while wheat flour was observed to have lower contents of protein (9.7%), ash (0.76%) and crude fiber (0.30%). The high protein content of mushroom powder used in the fortification of the wheat flour reflected in the high content of protein in the blends. It was observed that wheat flour with 25% mushroom inclusion had relatively high protein content (16.95%), 20% mushroom inclusion (15.68%), 15% inclusion (14.91%), 10% mushroom inclusion, (13.14%) while 5% mushroom inclusion had the lowest value for protein (11.87%).

Table 3 shows the effect of supplementation of mushroom powder on bread making characteristics. Bread with 25% mushroom powder had highest value for water absorption (57.3%) and 100% wheat bread had the lowest water absorption (43.3%). A very low loaf volume was observed in the bread with 25% mushroom addition (375 cc/g) while the bread without mushroom addition (0%) had the highest loaf volume (675 cc/g). Specific volume of bread without mushroom was (3.73 cc/g), 5% (3.20 cc/g), 10% (2.85 cc/g), 15% (2.7 kcc/g), 20% (2.46 cc/g), 25% (2.10 cc/g). Bread without mushroom had the highest value for crumb grain (8.2) while 25% mushroom bread had the lowest value (4.5). Bread without mushroom had the highest loaf quality (8.0), bread with 5% mushroom (7.0), 10% (6.0), 15% mushroom bread (5.8), 25% mushroom bread had the lowest loaf quality (4.2).

The chemical composition of bread supplemented with *Pleurotus plumonarius* mushroom powder is presented in Table 4. There were no significant difference ($p>0.05$) between the 100% wheat bread and those fortified with mushroom in moisture and crude fat. The moisture content of all the bread samples did not differ significantly ($p>0.05$) and were in the range (31.80-32.60%). The fat content of the bread samples did not differ significantly as well and ranged between 1.68-1.89%. However, there were significant differences ($p<0.05$) among the bread samples in crude protein content, the bread with 25% mushroom inclusion was observed to have the highest crude protein content (14.6%), this was followed by 20% mushroom bread (13.24%), while the bread without mushroom inclusion had the lowest crude protein content (7.96%). Equally, there were significant differences ($p<0.05$) among the bread in carbohydrate content. Bread without mushroom inclusion had the highest content of carbohydrate (56.42%) followed by the one with 5% mushroom (54.3%), while the bread with 25% mushroom had the lowest carbohydrate content (46.47%).

Organoleptic properties of the mushroom supplemented bread are present in Table 5. Significant difference ($p<0.05$) was observed between the 0% mushroom bread and those fortified with 15-25% mushroom powder in all the quality attributes analyzed. Bread with

Table 2: Chemical composition of wheat flour, mushroom powder and their blends (% dry basis)

			Wheat flour: Mushroom powder				
Constituent (%)	Wheat flour (%)	Mushroom powder (%)	(95:5)	(90:10)	(85:15)	(80:20)	(75:25)
Moisture	12.30^{c}±0.21	8.60^{a}±0.93	11.92^{b}±0.45	11.75^{b}±0.49	11.57^{b}±0.55	11.40^{b}±0.80	11.20^{b}±0.14
Crude protein	9.70^{a}±0.69	36.00^{g}±0.73	11.87^{b}±0.63	13.14^{c}±0.55	14.91^{d}±0.09	15.68^{e}±0.58	16.95^{f}±0.49
Fat	1.30^{a}±1.41	1.90^{a}±0.98	1.52^{a}±0.77	1.54^{a}±0.72	1.58^{a}±1.21	1.59^{a}±0.63	1.63^{a}±0.99
Ash	0.76^{a}±0.64	7.60^{d}±0.75	1.11^{ab}±0.92	1.44^{b}±0.85	1.79^{bc}±0.69	2.13^{c}±0.18	2.47^{c}±0.51
Crude fiber	0.30^{a}±1.19	7.90^{e}±1.54	0.69^{ab}±0.91	1.06^{b}±2.31	1.45^{bc}±0.89	1.82^{cd}±1.02	2.21^{d}±0.98
Carbohydrate	75.94^{g}±0.22	38.00^{a}±0.01	72.89^{f}±0.16	71.07^{e}±0.62	68.71^{d}±0.25	67.38^{c}±0.09	65.53^{b}±0.34
Energy (kcal/100 g)	341.66	313.10	352.72	350.70	348.70	347.91	344.67

Means in the same row with different letters as superscript are significantly different ($p<0.05$)

Table 3: Effect of mushroom supplementation on bread making characteristics

Supplementation level (%)		Water absorption	Loaf Vol.	Sp. Vol.	Crumb grain	Loaf quality
WF	MP	(%)	cc	cc/g	0-10	0-10
100	0	43.3^{a}	675^{a}	3.73^{d}	8.2^{a}	8.0^{d}
95	5	48.3^{b}	525^{b}	3.20^{dc}	7.5^{ad}	7.0^{cd}
90	10	51.0^{c}	500^{c}	2.85^{bc}	6.8^{bc}	6.0^{cb}
85	15	52.0^{c}	475^{d}	2.71^{ab}	6.2^{c}	5.8^{b}
80	20	55.0^{d}	425^{e}	2.46^{ab}	5.0^{d}	4.7^{a}
75	25	57.3^{e}	375^{f}	2.18^{a}	4.5^{d}	4.2^{a}

Means in the same column with different letters as superscript are significantly different ($p<0.05$)

Table 4: Chemical composition of bread supplemented with mushroom powder

WF:MP	Moisture	Protein	Fat	Ash	Crude fibre	Carbohydrate	Energy (kcal/100 g)
		---------- (%) ----------					
100:0	32.60^{a}±0.53	7.96^{a}±0.16	1.69^{a}±0.33	0.90^{a}±0.22	0.51^{a}±0.38	56.42^{a}±0.84	272.73
95:5	32.04^{a}±0.74	9.68^{b}±0.83	1.70^{a}±0.80	1.32^{b}±0.99	0.89^{a}±0.20	54.37^{b}±0.64	271.50
90:10	31.92^{a}±1.01	11.07^{c}±0.26	1.68^{a}±0.78	1.56^{b}±1.08	1.20^{ab}±0.81	52.63^{c}±0.44	269.92
85:15	32.26^{a}±0.92	12.75^{d}±0.96	1.80^{a}±1.20	1.93^{bc}±0.57	1.54^{b}±0.74	49.67^{d}±0.59	266.78
80:20	31.80^{a}±0.85	13.24^{e}±1.58	1.89^{a}±0.66	2.11^{c}±0.63	1.98^{bc}±0.23	48.89^{e}±0.90	265.53
75:25	32.17^{a}±0.49	14.62^{f}±0.76	1.72^{a}±0.54	2.64^{c}±0.48	2.48^{c}±0.11	46.47^{f}±0.13	259.84

Means in the same column with different letter as superscript are significant different (p<0.05)

Table 5: Sensory means scores of bread supplemented with mushroom powder

Attributes	Level of supplementation (%) 0	5	10	15	20	25
Crust color	8.0^{a}±0.68	7.7^{a}±0.36	7.0^{ab}±0.99	6.1^{bc}±0.99	5.3^{c}±0.80	4.0^{d}±0.56
Crumb color	8.1^{a}±0.51	7.6^{a}±1.12	6.2^{b}±0.90	6.0^{b}±0.85	5.6^{c}±1.54	5.1^{c}±1.60
Taste	8.1^{a}±1.02	7.6^{a}±0.93	7.0^{ab}±0.65	6.4^{b}±1.49	5.2^{c}±0.86	4.9^{c}±0.91
Texture	7.9^{a}±1.04	7.2^{ab}±0.89	6.4^{b}±1.23	5.8^{cd}±0.71	5.0^{de}±0.65	4.4^{e}±0.87
Chew ability	8.0^{a}±0.93	7.6^{a}±1.25	7.0^{ab}±0.77	6.4^{bc}±0.52	5.9^{cd}±0.89	5.2^{d}±1.04
Flavor	8.0^{a}±0.43	7.3^{ab}±0.78	6.9^{b}±0.39	5.8^{c}±0.56	5.2^{c}±0.27	4.9^{c}±0.65
Loaf shape/appearance	8.2^{a}±0.77	7.6^{ab}±0.82	7.1^{bc}±1.03	6.5^{cd}±0.91	6.0^{d}±0.78	5.1^{e}±0.24
Overall acceptability	8.0^{a}±1.03	7.5^{a}±0.90	7.0^{ab}±0.68	6.1^{b}±0.84	5.2^{bc}±1.07	4.4^{cd}±0.96

Mean in the same raw with different letters as superscripts are significantly different (p<0.05)

0% mushroom had the highest sensory mean score in crust color (8.0), crumb color (8.1), taste (8.1), texture (7.9), chew ability (8.0), flavor (8.0), loaf shape/appearance (8.2) and overall acceptability (8.0). However, very low sensory mean scores was observed in the bread samples with 25% mushroom powder, with crust color (4.0), crumb color (5.1), taste (4.9), texture (4.4), chew ability (5.2) flavor (4.9), loaf shape/appearance (5.1) and overall acceptability (4.4).

DISCUSSION

The chemical composition of Wheat Flour (WF) and Mushroom Powder (MP) and their blends showed that there were significant (p<0.05) differences between the wheat flour, mushroom powder and their blends in crude protein, crude ash, crude fiber and carbohydrate contents. However, no significant (p>0.05) difference was observed in fat content of the WF, MP and their blends. Both the MP and their blends had significantly (p<0.05) higher protein, ash and crude fiber than the WF. Consequently, addition of mushroom powder to wheat flour would increase the crude protein, total ash and crude fiber of the resultant bread. The crude protein, total ash, crude fiber and carbohydrate contents of mushroom powder is similar to those reported (Friedman, 1975; Bano and Rajarathnian, 1988; Oei, 1996).

Data in Table 3 shows the effect of MP addition on bread making properties. Water absorption was significantly (p<0.05) increased due to the addition of MP at all levels of enrichment and this increased with increase in quantity of MP added. Water absorption increased from 43.3% in formulation with 0%MP to 57.3% in blend with 25% MP. The higher water absorption of WF-MP blends may be due to the increase in hydration capacity of the MP. This result agrees with those reported (Misra *et al*., 1991; Mubarak, 2001; Mepba *et al*., 2009) that indicated substantial increase in water absorption on addition of 3-15% soybean flour, lupin seed products and cowpea flour respectively to wheat flour. This result is however, in contrast to those of Harinder and Sharma (1999) that reported decrease in water absorption with increase in addition of pigeon pea to wheat flour.

Loaf volume decreased significantly (p<0.05) with increase in MP supplementation. There were significant (p<0.05) difference between the loaf volume of the 100% bread and those with MP, with 25% supplemented bread having the lowest loaf volume. This result is similar to the report of Harinder and Sharma, 1999; Mubarak, 2001; Badifu *et al*., 2005; Mepba *et al*., 2009, for pigeon pea, lupin seed. Mango and cowpea flour supplemented bread. Decrease in loaf volume of bread with fluted pumpkin flour has also been reported (Agu *et al*., 2010). Furthermore, increase in supplementation level with MP also resulted in decrease in specific volume, crumb grain and loaf quality. There were significant differences (p<0.05) between 100% WF bread and those with 10, 15, 20 and 25% MP in the attributes mentioned. Increasing level of MP resulted in a coarse crumb grain and gave hard texture to the crumb and this affected the bread overall quality significantly. This result is similar to the findings of Ranhotra and Loewe (1974) for bread fortified with flour concentrate from different plant proteins. Bread with 5% MP did not differ significantly from the control in these parameters.

Changes in proximate composition of bread supplemented with graded levels of MP indicated that addition of MP to WF increased the crude protein content significantly (p<0.05) with about 83.65% increase in

bread with 25% MP addition. Similarly, crude ash and crude fiber contents increased significantly too in the MP supplemented bread. The increase in these proximate parameters could be probably due to their high quantities in mushroom power. According to Okaka (2005) cereals such as wheat flour are lower in protein and lysine deficient but rich in sulphur containing amino acid, mushroom on the other hand is very rich in lysine with about 36% crude protein and good balance of other essential amino acids, hence the consumption of MP supplemented bread will mean eating bread with higher protein content and improved protein quality, invariably, a more balanced diet with enhanced nutritional value that would help reduce protein-energy malnutrition.

No significant ($p<0.05$) difference in total fat content was observed between the 100% WF bread and 5-25% MP supplemented samples. On the other hand, carbohydrate content was reduced as a result of MP addition. These results were in agreement with the report of Abdel-Kader (2001), Mubarak (2001) and Agu *et al*. (2010).

The result of the sensory evaluation indicated significant ($p<0.05$) difference between 100% WF bread (control) and those fortified with 15, 20 and 25% MP in all the quality attributes analyzed. Bread with 5% MP did not differ significantly from 100% WF bread in appearance, crust and crumb color, taste, texture, chew ability, flavor and overall acceptability; it compared favorably well with the control (100%) bread in all these qualities. Similarly, there were no significant ($p>0.05$) difference between the 10% MP supplemented bread and the control in crust color, taste, chew ability and overall acceptability. Bread with 25% MP addition had significantly poor loaf size, dark color and pronounced mushroom taste and flavor.

Although, the 15 and 20% MP fortified bread had low rating in most of the quality attributes, they were however, acceptable to the panelist. Generally, the mushroom powder gave the bread a unique taste and texture that make them taste and feel like cake-bread particularly the 20 and 25% MP formulation.

Conclusion: The investigation shows that there was significant improvement in the bread protein content and nutritional quality on addition of mushroom powder. This was evident in the significant increase of 21.60-83.66% in the crude protein content of fortified bread sample. Also over 50% increase in the ash and crude fiber content was achieved. Acceptable bread that compared favorably well with whole wheat bread were produced with 5 and 10% supplementation with mushroom powder. However, the acceptability decreased with increase in inclusion of mushroom power. Bread with 25% mushroom powder was the least acceptable.

Since mushroom powder addition at the optimum level of 5-10% significantly increased protein content between (21.66-39.00%), and over 50% increase in the ash and crude fiber, mushroom could be used to improve the nutritional quality of bread which could help in reduction of protein-energy malnutrition prevalent in Nigeria and other developing Countries.

ACKNOWLEDGEMENTS

The authors wish to express their sincere gratitude to the DG and Management of the Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria, for providing the fund and facilities for this research work.

REFERENCES

American Association of Cereal Chemists (AACC), 1990. Approved methods of the American Society of Cereal Chemists (8th Edition Vol. 2). St Paul, MN: The American Association of Cereal Chemists.

Abdel-Kader, Z.M., 2001. Enrichment of Egyptian Balady bread part 2: Nutritional values and biological evaluation of enrichment with decorticated cracked broad bean flour (*Vicia faba* L). Nahrung/Food, 45: 31-34.

Agu, H.O., J.A. Ukonze and K.A. Paul, 2010. Quality characteristics of bread made from wheat and fluted pumpkin seed flour. Nig. Food J., 28: 188-198.

Anyika, J.U. and A.C. Uwaegbute, 2005. Frequency of consumption and nutrient content of some snacks eaten by adolescent secondary and University student in Abia State. Nig. J. Nutr., Sci., 26: 10-15.

Badifu, S.O., C.E. Chima, Y.I. Ajayi and A.F. Ogori, 2005. Influence of Mango Mesocarp flour supplement to Micronutrient; physical and organoleptic qualities of wheat-based bread. Nig. Food J., 23: 59-68.

Bano, Z. and S. Rajarathnian, 1988. Pleurotus mushrooms part II: Chemical composition, nutritive value postharvest physiology, preservation and role as human food. CRC Crit. Rev. Food Sci. Nutr., 27: 87-157.

Bobek, P. and S. Galbavy, 1999. Hypocholesterolemic and anti-atherogenic effect of oyster mushroom (*Pleurotus ostreatus*) in rabbits. Nahrung, 39: 98-99.

Boras, M., 1996. Mushroom as a stew source for food and its role in food security. Agric. Dev., 15: 40-48.

Duncan, D.B., 1955. Multiple range and multiple F-text. Biometrics, 11: 1-42.

Fasidi, I.O. and E. Ukwere, 1993. Studies on *Pleurotus tuber-regium* (Friar) Singer: Cultivation, proximate composition and mineral content of scelotia. Food Chem., 48: 253-258.

Friedman, M.I., 1975. Protein nutritional quality of foods and feeds. Marcel Dekker Inc. NY, pp: 308-318.

Giami, S., Y. Mepha, D.B. Kin-Kabari and S.C. Achienewhu, 2003. Evaluation of the nutritional quality of breads prepared from wheat-fluted pumpkin (*Telferia occidentlis Hook*) seed flour blends. Plant Food Hum. Nutr., 58: 1-8.

Harinder, K.B. and S. Sharma, 1999. Studies on the baking properties of wheat and pigeon pea flour blends. Plant Food Human Nutr., 54: 217-226.

Kansas, 2006. Wheat letter, May 18, 2006. Seminar on what importation in Nigeria by Kansas Wheat Commission, Kansas Association of Wheat Growers, Manhattan, Kansas.

Larmond, E., 1977. Laboratory Methods for Sensory Evaluation of Foods. Publication No. 1637 Canada Department of Agriculture Ottawa.

Mallavadhani, U.V., A.V.S. Sudharkar, K.V.S. Satyanarayana, A. Mahapatra, W. Li and R.B. Van Breemen, 2006. Chemical and analytical screening of some edible mushrooms. Food Chem., 95: 58-64.

Mepba, H.D., L. Eboh, A. Aron and U.J. Ukpabi, 2009. Rheological, baking and sensory characteristics of fermented cassava starch what cowpea blends. Nig. Food J., 27: 172-186.

Misra, P., M.S. Usha and S. Sing, 1991. Soy-wheat flour blends. Chemical, rheological and baking characteristics. J. Food Sci. Technol., 28: 89-91.

Mubarak, A.E., 2001. Chemical, nutritional and sensory properties of bread supplemented with Lupin seed (*Lupinus albus*) products. Nahrung/Food, 45: 241-245.

Oei, P., 1996. Mushroom cultivation with special emphasis on appropriate techniques for developing countries. Tool Publication, Leiden, the Netherlands, pp: 234-236.

Okaka, J.C., 2005. Handling; Storage and Processing of Plants Foods. OCJANCO Academic Publisher, Enugu, Nigeria, pp: 250-270.

Okeke, J.N.C., A.U. Ozumba, O.O. Olatunji and S.A. Odunfa, 2003. Effect of drying methods on some qualities of Nigerian *Pleurotus pulmonarius* mushroom powder. Nig. Food J., 21: 137-143.

Pyke, M., 1976. Food Science and Technology (3rd Edn., John Murray Publishers Ltd.) London, pp: 42-51.

Quimio, T.H., T. Changs and D.T. Royse, 1990. Technical Guidelines for Mushroom growing in the Tropics, FAO, Italy.

Ranhotra, G.S. and R.J. Loewe, 1974. Bread making characteristics of wheat flours fortified with various commercial soy protein products. Cereal Chem., 51: 631-634.

Rosales-Juarez, M., B. Gonzalez-Mendoza, E.C. Lopez-Guel, F. Lozano-Bautista, J. Chanonaperez, G. Gutierrez-Lopez and G. Calderon-Dominguez, 2008. Changes on dough rheological characteristics and bread quality as a result of the addition of germinated and non-germinated soybean flour. Food Bioprocess Technol., 1: 152-160.

Selomulyo, V.O. and W. Zhou, 2007. Frozen bread dough: Effects of freezing storage and dough improvers. J. Cereal Sci., 45: 1-17.

SON, 1976. Standard Organization of Nigeria. Standard for White Bread Federal Ministry of Industries, Lagos NIS 75: 10-13.