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

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**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 where 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

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.

## 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

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

data, when cooled, the loaves were sliced using a bread slicer. Crust and crumb colour, 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 Kjeldahl method, using Kjeldahl 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)

Constituent (%)	Wheat flour (%)	Mushroom powder (%)	Wheat flour: Mushroom powder				
			(95:5)	(90:10)	(85:15)	(80:20)	(75:25)
Moisture	12.30±0.21	8.60±0.93	11.92 <sup>b</sup> ±0.45	11.75 <sup>b</sup> ±0.49	11.57 <sup>b</sup> ±0.55	11.40 <sup>b</sup> ±0.80	11.20 <sup>b</sup> ±0.14
Crude protein	9.70 <sup>a</sup> ±0.69	36.00 <sup>d</sup> ±0.73	11.87 <sup>b</sup> ±0.63	13.14 <sup>c</sup> ±0.55	14.91 <sup>d</sup> ±0.09	15.68 <sup>e</sup> ±0.58	16.95 <sup>f</sup> ±0.49
Fat	1.30 <sup>a</sup> ±1.41	1.90 <sup>a</sup> ±0.98	1.52 <sup>a</sup> ±0.77	1.54 <sup>a</sup> ±0.72	1.58 <sup>a</sup> ±1.21	1.59 <sup>a</sup> ±0.63	1.63 <sup>a</sup> ±0.99
Ash	0.76±0.64	7.60 <sup>d</sup> ±0.75	1.11 <sup>ab</sup> ±0.92	1.44 <sup>b</sup> ±0.85	1.79 <sup>bc</sup> ±0.69	2.13 <sup>c</sup> ±0.18	2.47 <sup>c</sup> ±0.51
Crude fiber	0.30±1.19	7.90 <sup>d</sup> ±1.54	0.69 <sup>ab</sup> ±0.91	1.06 <sup>b</sup> ±2.31	1.45 <sup>bc</sup> ±0.89	1.82 <sup>d</sup> ±1.02	2.21 <sup>d</sup> ±0.98
Carbohydrate	75.94 <sup>a</sup> ±0.22	38.00 <sup>a</sup> ±0.01	72.89 <sup>a</sup> ±0.16	71.07 <sup>a</sup> ±0.62	68.71 <sup>d</sup> ±0.25	67.38 <sup>e</sup> ±0.09	65.53 <sup>b</sup> ±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. cc	Sp. Vol. cc/g	Crumb grain 0-10	Loaf quality 0-10
WF	MP					
100	0	43.3 <sup>a</sup>	675 <sup>a</sup>	3.73 <sup>d</sup>	8.2 <sup>a</sup>	8.0 <sup>d</sup>
95	5	48.3 <sup>b</sup>	525 <sup>b</sup>	3.20 <sup>dc</sup>	7.5 <sup>ad</sup>	7.0 <sup>cd</sup>
90	10	51.0 <sup>c</sup>	500 <sup>c</sup>	2.85 <sup>bc</sup>	6.8 <sup>bc</sup>	6.0 <sup>cb</sup>
85	15	52.0 <sup>c</sup>	475 <sup>d</sup>	2.71 <sup>ab</sup>	6.2 <sup>c</sup>	5.8 <sup>b</sup>
80	20	55.0 <sup>d</sup>	425 <sup>e</sup>	2.46 <sup>ab</sup>	5.0 <sup>d</sup>	4.7 <sup>a</sup>
75	25	57.3 <sup>e</sup>	375 <sup>f</sup>	2.18 <sup>a</sup>	4.5 <sup>d</sup>	4.2 <sup>a</sup>

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



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 powder. 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 powder. 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.

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