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## Nutritional Composition, Physical Qualities and Sensory Evaluation of Wheat Bread Supplemented with Oyster Mushroom

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### ABSTRACT

The aim of this study was to evaluate nutritional, physical and sensory qualities of wheat-mushroom bread. Dried *Pleurotus ostreatus* mushrooms were processed into flour and mixed with wheat flour at 0, 5, 10 and 15% to develop bread. Moisture content, crude protein, crude fibre, fat, ash, minerals, amino acids and B-vitamins contents of wheat and wheat-mushroom breads were evaluated. Physical and sensory qualities of wheat and composite breads were also evaluated to determine consumer acceptability. Composite bread with 15% mushroom did not develop as the dough for this ratio did not form a visco-elastic dough. Moisture, total ash and protein contents of the composite breads increased with increasing mushroom content in the bread. Composite bread supplemented with 10% mushroom flour had highest moisture, protein and total ash contents. Carbohydrates content declined while fiber and fat contents did not change. Mineral composition of the composite breads increased with increasing mushroom supplementation except for magnesium, manganese and calcium contents. The contents of all amino acids and B-vitamins analyzed increased with addition of mushroom in bread. Sensory and physical qualities of bread declined with increasing amount of mushroom flour in composite bread. In conclusion, supplementing mushrooms in wheat bread increased protein, minerals, B-vitamins, amino acids contents of wheat-mushroom bread compared to wheat bread. Supplementing wheat flour with up to 10% mushroom flour produced baked products with high nutritional quality for improved health.

**Key words:** Wheat-mushroom bread, nutritional quality, sensory evaluation

### INTRODUCTION

Mushrooms are saprophytes and are cultivated for food or for their medicinal value. They include members of the *Basidiomycota* and some members of *Ascomycota*. Mushrooms thrive well on wood and agro waste products e.g., straws, corn, corn cobs, sugarcane bagasse and coffee residues (Petre and Petre, 2013). Oyster mushrooms are more popular because they are easiest and least expensive to cultivate besides their nutritional and medicinal value (Stamets, 2008).

Native mushrooms have been a food supplement among various cultures in Africa and around the world (Manjunathan *et al.*, 2011). Mushrooms are noted for improving human as well as environmental health and have been used as a valuable food and a source of traditional medicine in many communities in the world (Patel *et al.*, 2012).

In the recent years, efforts have been made to promote the use of composite flours whereby high protein crops are used to replace a portion of wheat flour to make bread, thereby decreasing the

demand for imported wheat and producing protein enriched bread (Giarni *et al.*, 2004). Wheat flour is the most common flour used in baking due to the presence of gluten proteins which help to increase dough strength and also give bread products a good structure and shape (Ali *et al.*, 2012).

Though rich in carbohydrates, wheat has lower protein content of 8-15 g/100 g (Shewry, 2009), compared to *Pleurotus ostreatus* mushroom which is 23.5 g/100 g (Khan *et al.*, 2008). Mushrooms also contain negligible fat (1.6 g/100 g dwb), salt (2.3 g/100 g dwb) and sugar contents but are a valuable source of crude fibre (8.7 g/100 g dwb) (Miles and Chang, 2004), thus offering a perfect diet for people trying to lose weight. Life style and sedentary diseases such as obesity, diabetes and cardiovascular diseases have raised an interest in consumption of functional food including medicinal or nutritional foods to manage such illnesses (WHO. and CDC., 2008). Exotic cultivated mushrooms are rich in non-starch polysaccharides; chitin and  $\beta$ -glucan (Cheung, 2013). Dietary fibres can help reduce blood cholesterol and protect against hypertension (Ching *et al.*, 2011). Some  $\beta$ -glucans isolated from the mushroom fruit bodies have also been shown to stimulate the non-specific immune system inhibiting cancer cell proliferation (Lemieszek and Rzeski, 2012).

During wheat processing, milling removes important nutrients from the grains, notably iron, zinc, B-vitamins (thiamine, riboflavin, niacin, folate) and phyto-chemicals (Prasad, 2009). Populations who depend solely on refined cereals are therefore at increased risk of multiple micro-nutrients deficiencies. Mineral content in mushrooms is higher than that of meat and fish and may act as a suitable supplementary food especially to these populations that predominantly depend on cereal diet (Mallikarjuna *et al.*, 2013).

Okafor *et al.* (2012) established that adding over 15% of maitake mushroom flour to wheat flour negatively affected the physical quality characteristics of resulting composite bread. The loaf volume also decreased and the crumb texture became coarse with increasing supplementation of mushroom flour. Increase in supplementation of mushroom flour also affected sensory characteristics. This study therefore set out to establish the best ratio of *Pleurotus ostreatus* mushroom flour to wheat flour that could be used to make bread with good consumer acceptability as well as improved nutritional quality.

## **MATERIALS AND METHODS**

**Sample preparation:** Commercial baker's grade wheat flour was purchased from Unga Limited (Nairobi, Kenya). Oyster mushrooms (*Pleurotus ostreatus*) were grown for 3-4 weeks under controlled conditions in the mushroom pilot plant at Kenya Industrial Research and Development Institute. Harvested mushrooms were chopped into small pieces and then blanched in boiling tap at 100°C for 3 min according to the method proposed by Vullioud *et al.* (2011). The blanched mushrooms were dried in a cabinet drier at 40°C for 6 h after which they were milled into flour using the Bauermeister milling machine (Bauermeister-Hamburg, Altona, Germany) with sieve size of 500  $\mu$ m.

**Blends formulation:** Flour blends were prepared by mixing wheat flour to mushroom flour respectively at ratios of 100:0, 95:5, 90:10 and 85:15. These composite flours were then used to bake wheat-mushroom composite breads.

Wheat and mushroom flours were blended in the ratio of 100:0, 95:5, 90:10 and 85:15. The other ingredients weighed on the flour weight basis were: water (60%), sugar (6.3%), salt (2.1%), fat (2.5%), bread improver (1.5% g) and active dry yeast (3%). The ingredients were mixed using Kenwood mixer (Model 900, Watts KM264) for 6 min. The dough was covered with wet clean muslin

cloth and rested for 15 min. It was then weighed, rounded and rested further for 10 min. The dough pieces were then placed in baking tins. They were then proofed for 40 min at 85% relative humidity and then baked at 200°C for 20 min.

**Proximate analysis:** The moisture content, ash content, crude fat and protein (Nx 6.25), crude fibre were analyzed according to AOAC standard method 14.004 (AOAC., 1984) and Approved Method 46-12A; (AACC., 2000) for protein. Proximate analysis was carried out in triplicate and results expressed as g/100 g except for moisture content which was expressed as percentage.

Mineral profiling of the samples was done using AOAC Approved Method 942.05 (AOAC., 1984).

Amino acid profile of the mushroom was determined using AOAC Approved Method 994.12 (AOAC., 2006).

Vitamin C was analyzed using iodometric titration method using AOAC Approved Method 979.09 (AOAC., 1993). B-vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>5</sub>, B<sub>7</sub> and B<sub>12</sub>) were determined using AOAC Approved Method 925.10 (AOAC., 1993) using a variant HPLC with manual injection. Vitamin B<sub>9</sub> was determined using microbiological assay using *Enterococcus hirae* ATCC 8043, AOAC Approved Method 945.16 (AOAC., 1993).

**Sensory evaluation:** Sensory evaluation of wheat bread and wheat-mushroom composite breads was evaluated using Larmond (1977) method. Twenty semi-trained panelists were asked to evaluate the quality attributes of the composite breads (i.e., crumb color, crumb texture, aroma, taste and overall acceptability of the breads). The scores were based on a 9-point hedonic scale with 1 representing the least score (dislike extremely) and 9 highest score (like extremely). The scores of the panelists performance was averaged and the results subjected to one-way analysis of variance (ANOVA).

**Experimental design and statistical analysis:** The experimental design was a single factor completely randomized design experiment with three replicates.

The data obtained was analyzed statistically using SPSS software (IBM Inc, New York, USA). The results were subjected to one-way analysis of variance (ANOVA) and differences in treatment means identified at  $p < 0.05$  by Duncan's multiple range test using PASW Statistics Edition 18 software.

## RESULTS

**Proximate composition:** Composite bread at ratio 85:15 did not develop as the dough for this ratio did not form a visco-elastic dough. Moisture content declined significantly ( $p < 0.05$ ) with increasing mushroom content in all composite breads. Wheat bread had the highest moisture content of  $26.89 \pm 0.15\%$ . Protein content increased significantly ( $p < 0.05$ ) with increasing mushroom content in composite breads (Table 1). Composite bread prepared at ratio 90:10 had the highest protein content of  $45.58 \pm 3.09$  g/100 g, dry-matter basis. Total ash content was least in wheat flour ( $2.18 \pm 0.04$  g/100 g) but increased significantly ( $p < 0.05$ ) with increasing mushroom content in the composite breads. Carbohydrates content ranged between 43.58 and 70.59 g/100 g, dry-matter basis.

**Mineral composition:** Phosphorous content increased significantly with increasing mushroom content in composite breads. Potassium and iron contents also increased significantly ( $p < 0.05$ ) with

Table 1: Proximate composition of wheat-mushroom composite breads

| Wheat:Mushroom bread | Moisture content (%)    | Total ash              | Fat                    | Fiber                  | Protein                 | Carbohydrates           |
|----------------------|-------------------------|------------------------|------------------------|------------------------|-------------------------|-------------------------|
| 100:0                | 26.89±0.15 <sup>a</sup> | 2.18±0.04 <sup>b</sup> | 2.57±0.85 <sup>a</sup> | 2.92±0.13 <sup>a</sup> | 21.73±4.92 <sup>a</sup> | 70.59±4.64 <sup>c</sup> |
| 95:5                 | 31.27±0.44 <sup>b</sup> | 2.52±0.12 <sup>b</sup> | 2.41±0.13 <sup>a</sup> | 3.88±0.25 <sup>a</sup> | 32.35±1.46 <sup>b</sup> | 58.85±1.29 <sup>c</sup> |
| 90:10                | 31.35±0.51 <sup>b</sup> | 2.88±0.11 <sup>a</sup> | 2.32±0.38 <sup>a</sup> | 5.66±2.45 <sup>a</sup> | 45.58±3.09 <sup>c</sup> | 43.58±2.91 <sup>a</sup> |

Values are given on dry-matter basis (g/100 g) except for moisture content, values are means of three replicates, means in the same column with different superscript are significantly different (p<0.05)

Table 2: Mineral composition of wheat-mushroom composite bread

| Wheat:Mushroom bread | P                       | Mg                      | K                       | Fe                      | Mn                     | Zn                     | Na                      | Ca                     | Cu                     |
|----------------------|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|-------------------------|------------------------|------------------------|
| 100:0                | 31.41±2.25 <sup>a</sup> | 28.74±0.35 <sup>a</sup> | 15.28±0.49 <sup>a</sup> | 8.09±1.32 <sup>a</sup>  | 9.17±1.78 <sup>a</sup> | 4.61±0.20 <sup>a</sup> | 2.21±0.12 <sup>a</sup>  | 1.50±0.23 <sup>a</sup> | 0.57±0.08 <sup>a</sup> |
| 95:5                 | 37.86±2.60 <sup>b</sup> | 28.29±0.46 <sup>a</sup> | 18.38±1.31 <sup>b</sup> | 11.14±0.47 <sup>b</sup> | 8.16±0.68 <sup>a</sup> | 7.09±0.33 <sup>b</sup> | 2.41±0.03 <sup>b</sup>  | 1.77±0.70 <sup>a</sup> | 0.92±0.04 <sup>a</sup> |
| 90:10                | 45.38±2.96 <sup>c</sup> | 28.27±0.35 <sup>a</sup> | 22.05±2.04 <sup>c</sup> | 16.10±0.39 <sup>c</sup> | 8.21±1.05 <sup>a</sup> | 9.58±0.45 <sup>c</sup> | 2.33±0.04 <sup>ab</sup> | 1.16±0.39 <sup>a</sup> | 1.71±0.36 <sup>b</sup> |

P: Phosphorous, Mg: Magnesium, K: Potassium, Fe: Iron, Mn: Manganese, Zn: Zinc, Na: Sodium, Ca: Calcium, Cu: Copper, Values are given on dry-matter basis (mg/100 g), values are means of three replicates, means in the same column with different superscript are significantly different (p<0.05)

increasing mushroom content in the composite breads. Bread prepared from wheat flour only had the least amount of potassium and iron at 15.28±0.49 and 8.09±1.32 g/100 g, respectively. Zinc content also increased with increasing mushroom content (Table 2).

**Amino acids composition:** Glutamic acid content was highest in wheat-mushroom composite breads. Composite bread at 90:10 ratio had the highest level of glutamic acid at 7.23±0.05 mg/100 g. Aspartic acid and leucine contents increased significantly (p<0.05) with increasing mushroom content in composite breads. Composite bread prepared at ratio 90:10 had the highest amounts of phenylalanine and arginine at 1.42±0.01 and 1.41±0.01, respectively. The contents of these amino acids increased significantly (p<0.05) with addition of mushroom flour in the composite breads (Table 3).

**Vitamin composition:** Vitamin A, ascorbic acid and cobalamin were not detected in the composite breads. Niacin was the most abundant B-vitamin in the composite breads. Its content increased significantly (p<0.05) with increasing mushroom content in the breads. Composite bread prepared at ratio 90:10 had the highest amount of niacin (29.60±0.00 mg/100). Riboflavin content increased significantly (p<0.05) with increasing mushroom content in composite breads. Wheat bread (100:0) had the highest content of thiamin at 0.64±0.00 mg/100 g whereas composite bread prepared at ratio 95:5 had the highest content of riboflavin (1.15±0.01 mg/100 g). Pantothenic, pyridoxine and biotin content also increased significantly (p<0.05) with increasing mushroom content in composite bread (Table 4).

**Sensory evaluation:** Specific volume and bread shape did not change significantly (p>0.05) with increasing mushroom content in the composite flours (Table 5). However, the corresponding pictures in Fig. 1, show that the general appearance and shape of the breads tended to decline with increasing mushroom content in the composite flours.

## DISCUSSION

**Proximate composition:** It was not possible to develop viscoelastic dough and consequently bread from composite flour comprising 85 parts wheat flour and 15 parts mushroom flour. The reduction of moisture content of wheat-mushroom composite flours with addition of mushroom flour as a non-wheat flour was similar to an observation by Eddy *et al.* (2007). Increase in protein content

Table 3: Amino acids in wheat-mushroom composite breads

| Wheat:Mushroom bread | Glutamic acid          | Aspartic acid          | Leucine                | Phenylalanine          | Arginine               | Isoleucine             | Threonine              | Tryptophan             | Valine                 | Lysine                 | Methionine             |
|----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| 100:0                | 4.91±0.02 <sup>a</sup> | 1.16±0.00 <sup>a</sup> | 1.30±0.00 <sup>a</sup> | 0.98±0.00 <sup>a</sup> | 0.79±0.00 <sup>a</sup> | 0.59±0.00 <sup>a</sup> | 0.47±0.00 <sup>a</sup> | 0.15±0.00 <sup>a</sup> | 0.77±0.00 <sup>a</sup> | 0.55±0.00 <sup>a</sup> | 0.33±0.00 <sup>a</sup> |
| 95:5                 | 6.68±0.04 <sup>b</sup> | 2.90±0.01 <sup>b</sup> | 2.03±0.02 <sup>b</sup> | 1.28±0.01 <sup>b</sup> | 1.40±0.01 <sup>b</sup> | 0.96±0.01 <sup>b</sup> | 0.79±0.00 <sup>b</sup> | 0.79±0.01 <sup>b</sup> | 0.87±0.01 <sup>b</sup> | 0.68±0.04 <sup>b</sup> | 0.66±0.00 <sup>b</sup> |
| 90:10                | 7.23±0.05 <sup>c</sup> | 3.92±0.03 <sup>c</sup> | 2.43±0.02 <sup>c</sup> | 1.42±0.01 <sup>c</sup> | 1.41±0.01 <sup>c</sup> | 0.96±0.08 <sup>b</sup> | 0.96±0.01 <sup>c</sup> | 0.96±0.01 <sup>c</sup> | 0.88±0.01 <sup>b</sup> | 0.83±0.01 <sup>b</sup> | 0.72±0.01 <sup>c</sup> |

Values are given on dry-matter basis (mg/100 g). Values are means of three replicates. Means in the same column with different superscript are significantly different (p<0.05)

Table 4: Vitamins in wheat-mushroom composite breads

| Wheat: mushroom bread | Retinol (Vit A) | Ascorbic acid (Vit C) | Thiamin (Vit B <sub>1</sub> ) | Riboflavin (Vit B <sub>2</sub> ) | Niacin (Vit B <sub>3</sub> ) | Pantothenic acid (Vit B <sub>5</sub> ) | Pyridoxine (Vit B <sub>6</sub> ) | Biotin (Vit B <sub>7</sub> ) | Folic acid (Vit B <sub>9</sub> ) | Cobalamin (Vit B <sub>12</sub> ) |
|-----------------------|-----------------|-----------------------|-------------------------------|----------------------------------|------------------------------|--|----------------------------------|------------------------------|----------------------------------|----------------------------------|
| 100:0                 | ND              | ND                    | 0.64±0.00 <sup>c</sup>        | 0.36±0.00 <sup>a</sup>           | 9.66±0.02 <sup>a</sup>       | 2.76±0.01 <sup>a</sup>                 | 0.14±0.00 <sup>a</sup>           | 11.07±0.02 <sup>a</sup>      | 61.76±0.13 <sup>a</sup>          | ND                               |
| 95:5                  | ND              | ND                    | 0.63±0.01 <sup>b</sup>        | 0.97±0.01 <sup>b</sup>           | 20.03±0.13 <sup>b</sup>      | 6.03±0.04 <sup>b</sup>                 | 0.56±0.00 <sup>b</sup>           | 15.25±1.00 <sup>b</sup>      | 86.66±0.55 <sup>b</sup>          | ND                               |
| 90:10                 | ND              | ND                    | 0.55±0.01 <sup>a</sup>        | 1.15±0.01 <sup>c</sup>           | 29.60±0.00 <sup>c</sup>      | 8.89±0.07 <sup>c</sup>                 | 0.60±0.01 <sup>c</sup>           | 20.56±0.15 <sup>c</sup>      | 99.63±0.74 <sup>c</sup>          | ND                               |

Values are given on dry-matter basis (mg/100 g), values are means of three replicates. means in the same column with different superscript are significantly different (p<0.05), ND: Not detected

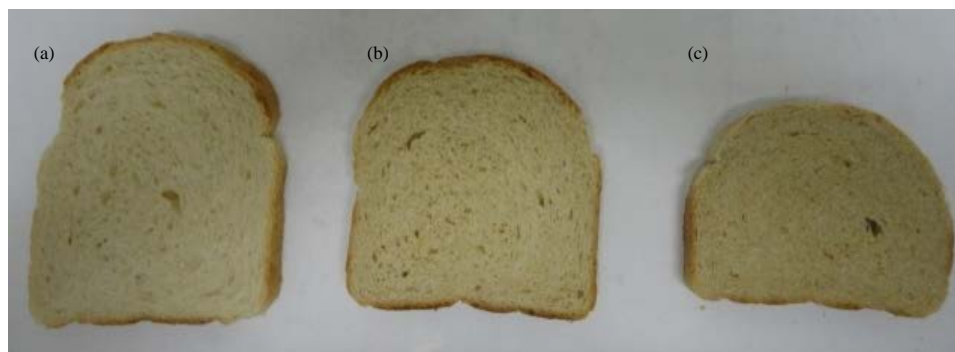


Fig. 1(a-c): General shape of the wheat bread and wheat-mushroom composite breads. Wheat mushroom bread prepared from: (a) 100 parts wheat flour, (b) 95 parts wheat flour and 5 parts mushroom flour and (c) 90 parts wheat flour and 10 parts mushroom flour

Table 5: Sensory evaluation of wheat bread and wheat-mushroom composite breads

| Wheat:Mushroom bread | Color                  | Texture                | Aroma                  | Taste                  | Overall acceptability  |
|----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| 100:0                | 6.95±1.32 <sup>b</sup> | 7.15±1.04 <sup>b</sup> | 7.05±1.00 <sup>b</sup> | 7.20±1.24 <sup>b</sup> | 7.00±1.92 <sup>b</sup> |
| 95:5                 | 6.45±1.15 <sup>b</sup> | 6.80±1.01 <sup>b</sup> | 6.85±0.88 <sup>b</sup> | 6.60±1.05 <sup>b</sup> | 6.65±1.00 <sup>b</sup> |
| 90:10                | 4.00±1.95 <sup>a</sup> | 3.80±1.77 <sup>a</sup> | 3.10±1.89 <sup>a</sup> | 2.95±1.82 <sup>a</sup> | 2.70±1.75 <sup>a</sup> |

Values followed by the same superscript letter in the same column are not significantly different at  $p > 0.05$

in wheat-mushroom bread with increase in mushroom content indicated that supplementing mushroom flour in wheat flour improves the protein quality of composite bread. Fruiting bodies of *Pleurotus* spp. contain about 26.6-34.1 g/100 g crude protein (Khan *et al.*, 2008).

Fat content in the wheat-mushroom breads ranged between 1.55 g/100 g and 1.90 g/100 g. Fat fraction in mushrooms is mainly composed of unsaturated fatty acids like palmitic, oleic, stearic and linoleic acid (Khan *et al.*, 2008). These essential fatty acids have been shown to be effective in prevention of coronary heart disease, hypertension, type 2 diabetes and renal disease (Khan *et al.*, 2008).

The increased fibre content with increasing supplementation with mushroom flour would ensure sufficient intake of dietary fiber which is beneficial in health maintenance and disease prevention including cardiovascular disease, diabetes, weight regulation and cancer (Theuwissen and Mensink, 2008). Soluble and insoluble fibers in mushrooms offer both anti-tumor properties and also promote digestion and good bowel health.

**Mineral composition:** Increased ash content in the composite breads translated to increased minerals content. Effects of mineral deficiencies include both functional and health outcomes involving growth, development, mental and neuro-motor performance, immune-competence, physical working capacity, morbidity, mortality, overall reproductive performance and risk of maternal death (Viteri and Gonzalez, 2002). Potassium was the most abundant mineral in the composite breads followed by iron and magnesium. Wheat bread had the lowest quantity of potassium possibly due to stripping during milling and processing. Potassium is an essential nutrient needed for maintenance of total body fluid volume, acid and electrolyte balance and normal cell function (Young, 2001). Magnesium helps to keep blood pressure normal, aids in muscle contraction, strengthen bones and also keep the heart rhythm steady (Manjunathan *et al.*, 2011).



Iron on the other hand is a cofactor in enzymes and a major component of hemoglobin and myoglobin. Its deficiency results in anaemia, cognitive impairment, poor physical work performance, poor pregnancy outcomes and delayed growth (WHO. and CDC., 2008). Zinc was also higher in wheat-mushroom breads than wheat bread and increased with increasing mushroom flour supplementation. Zinc helps to correct functions of enzymes and promotes a healthy immune system in the body. Copper and sodium contents were lowest in all wheat-mushroom blends. Mushrooms have low levels of sodium therefore making them ideal foods for patients with hypertension (Manjunathan *et al.*, 2011).

**Amino acid composition:** *Pleurotus ostreatus* mushrooms contain all the essential amino (Zakia and Singh, 1972). Non-essential amino acids like arginine, aspartic acid and glutamic acid were present in composite bread supplemented with mushroom flour. Glutamic acid was the most abundant amino acid in all the composite breads, followed by aspartic acid. High concentration of glutamic acid may be due to their function as precursors in the formation of other amino acids in the body (Oyetayo *et al.*, 2007).

**B-vitamins:** Thiamin was found to decrease with increase in mushroom supplementation in the composite breads. This B-vitamin is an essential nutrient which the body requires for normal functioning of the brain and nervous system and proper functioning of enzymes that are required for metabolism of carbohydrate required by tissues in the body (Martin *et al.*, 2003).

Levels of riboflavin in composite breads increased with increasing mushroom content. Riboflavin is important in maintaining healthy red blood cells and also promotes healthy skin and vision. *Pleurotus ostreatus* mushroom contains 0.9 and 2.5 mg/100 g thiamin and riboflavin, respectively (Mattila *et al.*, 2001).

In this study, the amount of niacin in the wheat-mushroom breads increased with increasing mushroom content. Niacin prevents pellagra and it helps in controlling blood cholesterol and in release of energy from protein, fat and carbohydrate, which keeps the body's digestive and nervous systems in good health (Kurtzman, 2005).

Mushrooms are also a rich source of folate which is essential in formation of red and white blood cells in bone marrow, building of new body cells and in making of DNA (Duthie *et al.*, 2002). Folate lowers the risk of giving birth to infants with neural tube defects and possibly other birth defects. It is also recognized in lowering the risk of cardiovascular diseases, cancer and impaired cognitive function in adults (WHO. and CDC., 2008). In this study, increasing mushroom content in composite bread boosted the level of folate. Ingesting folic acid through wheat-mushroom bread may therefore contribute significantly to total daily requirements of folic acid for a healthy individual.

**Sensory evaluation:** The results on sensory attributes indicated that wheat flour could be replaced with up to 10% mushroom flour without adversely affecting sensory acceptance. The rating on the color attribute decreased with increasing mushroom content. Composite bread supplemented with highest mushroom content at ratio 90:10 had the lowest rating. All composite breads had developed unattractive dull appearance due to the presence of dark colored mushroom flour. Color is an important quality and it often influences the acceptance of the food to the consumer.



All the composite breads had a characteristic odor and this may have been responsible for the poor rating in aroma. This characteristic odor may be due to octenol, a major volatile compound found in cultivated mushrooms (Hanson, 2008). The control bread had the highest rating in aroma. Comments from some panelists described a 'Meaty' taste in wheat-mushroom breads. Hallock (2007) attributed this meaty taste to amino acids found in mushrooms namely glutamic acid and aspartic acid. Wheat bread had the highest score in overall acceptability. It was followed by composite bread at ratio 95:5. Composite bread prepared at ratio 90:10 had the least score in overall acceptability. Based on overall acceptability score, these results demonstrated that wheat flour supplemented with 5% mushroom flour could be used to make bread.

## **CONCLUSION AND RECOMMENDATIONS**

Adding mushroom flour to wheat flour to make composite bread decreased dough strength which had a negative effect on bread volume and height. Blanching mushrooms before milling reduced this effect by inactivating proteases hence making it possible to bake wheat-mushroom composite bread. However, composite bread with 15% mushrooms did not form due to decreased dough strength despite the blanching process. Further studies should be carried out to determine a feasible method to pre-treat mushrooms hence improve the final product without compromising the nutrient profile.

Supplementing mushroom flour in wheat bread has the potential to deliver these nutrients to large segments of the population without radically changing their food consumption patterns. Increasing the diversity of mushroom based food products may help in improving the nutritional status of a population.

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