# Physicochemical, Nutritional and Sensory Properties of Bread from Wheat, Acha and Mung Bean Composite Flours

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**Abstract**
Wheat flour, acha flour and mung bean flours were blended into different ratios and used to produce bread. The flours were blended into six different ratios of wheat : acha : mung beans as follows: 100:0:0 (sample A) for the control, 80:10:10 (B), 70:15:15 (C), 60:20:20 (D), 50:30:20 (E) and 50:20:30 (F). Proximate composition of the flour blends and bread were determined. Selected minerals and vitamins were also determined. The physical evaluation of the bread samples was carried out and the bread samples were then subjected to sensory evaluation. The protein, ash, fibre and fat contents of all the samples increased significantly with increasing substitution of wheat flour with acha and mung bean flours. Moisture and carbohydrate contents decreased with increased substitution of the wheat flour with acha and mung beans. Protein and ash increased from 12.40% to 17.48% and from 0.88% to 2.36% respectively, showing significant difference between the different flour blends. The minerals and vitamins (calcium, iron, zinc, vitamins A and C) all increased with corresponding increase in the level of substitution of wheat flour with acha and mung beans. There was significant difference between the control and the blended samples. Bread loaf weight decreased with increased substitution of wheat with acha and mung beans from 271g to 234g. The specific volume of the control bread and those made from the flour blends were significantly different as bread made from the blends had lower specific volumes (1.55 to 1.45cm$^3$/g). Sample B bread was not significantly different from the control. There was significant difference in the oven spring of the control bread and the other composite bread. Sensory evaluation scores showed that all the bread samples were generally accepted on a nine point hedonic scale and there was no significance difference between 100% wheat bread and bread produced from 10% acha, 10% mung beans and 80% wheat flour blends.
**Keywords:** Bread, Composite flour, Acha, Mung beans, wheat

## 1. Introduction

Bread is an important staple food in both developing and developed countries and constitutes one of the most important sources of nutrients such as carbohydrate, protein, fibre, vitamins and minerals in the diets of many people worldwide (Igbabul *et al*, 2014a). Bread can also be described as a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of processes involving mixing, kneading, proofing, shaping and baking (Igbabul *et al*, 2014b). Bread is convenient as a food because it is ready to eat, easy to carry and is not messy.

Acha (*Digitaria Exilis)* is a cereal, traditionally consumed whole *as tuwo, couscous, gwate, acha jollof and kunun acha* (Jideani, 1990). Acha is reported to have a high pentosan (3.3%), hence, a high water absorption capacity that could be utilized in baking (Lasekan, 1994). Acha is rich in micronutrients like iron and iodine (28.5mg/100ml and 22.9mg/100ml respectively) and has about 73% carbohydrates (Oburuoga and Anyika, 2012). Acha is considered as health grain in a sense that it is often consumed whole and is gluten-free. (Jideani and Jideani, 2011). Acha is uniquely rich in methionine and cystine and evokes low sugar on consumption; an advantage to diabetics. (NRC, 1996 and Ayo and Nkama, 2006)

Mung beans (*Vigna radiata)* are legumes that are small, ovoid in shape and green in colour. They are also known as green gram or golden gram (Chavalvut and Somchai, 1990). The protein content of mung bean is about 24% (Masood *et al,* 2010).. Mung bean is rich in vitamin A, $B_1$, $B_2$, niacin vitamin C, potassium, phosphorus and calcium (Prabhavat, 1990). Mung bean could be incorporated with cereals which contain high concentration of methonine and cysteine to enhance nutrients in foods.

Wheat is used predominantly for baking due to its elastic gluten protein which helps in producing a relatively large loaf volume with a regular, finely vesiculated crumb structure.

Wheat, however has to be imported to tropical countries where climatic conditions are not conducive for growing it. This often leads to loss of huge foreign exchange of the importing countries like Nigeria. Wheat grains are also relatively low in protein and generally low in lysine and certain other amino acids, but these could be complemented with legumes such as mung beans. It is therefore imperative to use wheat and locally, cheap available crops for baking purposes. The most obvious result of such blending is that the mixture is higher in protein than the cereal component alone. The legumes also improve the quality of cereal protein by supplementing them with limiting amino acids such as lysine and sometimes tryptophan and threonine. On the other hand, legumes which are deficient in methionine can be supplemented by cereal grains which are not deficient in the amino acid (Potter *et al,* 1996). The existing problem of food insecurity and malnutrition and high cost of animal based food supplies have made it necessary to incorporate unconventional protein sources into bread and to enrich the traditional formulations (Masood *et al*, 2010). This work was therefore aimed at producing bread using wheat, acha and mung bean flour blends to enhance its nutrient contents as well as diversify the utilization of the underutilized crops.

## 2. Materials and methods

### 2.1. Source of Raw Materials

Mungbean (*Vigna radiata*) seeds were purchased from the Langtang market in Langtang North Local Government area of Plateau State. Acha (*Digitaria exilis*) and wheat grains were purchased from the Gindiri market in Mangu Local Government Area of Plateau State. The other ingredients like sugar, yeast and salt were bought at the North bank market in Makurdi, Benue State. All chemicals used were of analytical grade.

### 2.2. Preparation of raw materials

#### 2.2.1. Preparation of Mung bean Flour

Mung beans were manually cleaned by hand picking the chaff and the stones. The cleaned mung beans were washed with water in order to remove the adhering dirt. The mung beans were left to soak in water for about 10 minutes. The soaked seeds were pounded gently in a mortar to dehull them. The dehulled mung beans were air dried and milled using an attrition mill. The flour was sieved to pass through a 0.4mm mesh size and packaged in polyethylene bags and kept at room temperature for later use.

#### 2.2.2. Preparation of Acha Flour

Acha flour was produced using the method of Ayo *et al* (2007). Acha grains were winnowed to remove chaff and dust. Adhering dust and stones were removed by washing in water (sedimentation) using local calabashes. The washed and destoned grains were dried in a cabinet drier at $45^0$C to a moisture content of about 12%. The dried grains were milled using Attrition milling machine and the flour sieved to pass through a 0.4mm mesh sieve. The acha flour was packaged in air tight containers for later use.

### 2.3. Formulation of flour blends

Composite flour of acha, mung beans and wheat was prepared as shown in Table 1. One hundred percent wheat flour was the control and designated as sample A. Sample B consisted of 80% wheat, 20% acha and 20% mung beans. Sample C consisted of 70% wheat, 15% acha and 15% mung beans. Sample D was 60% wheat, 20% acha and 20% mung beans. Samples E and F consisted of 50% wheat, 30% acha, 20% mung beans and 50% wheat, 20% acha, 30% mung beans respectively. The blends were thoroughly mixed using a Kenwood blender to achieve uniform blending.

**Table 1: Formulation of Composite flours of wheat, acha and mung beans.**

| Sample | % wheat | %acha | % mung beans |
|---|---|---|---|
| A | 100 | 0 | 0 |
| B | 80 | 10 | 10 |
| C | 70 | 15 | 15 |
| D | 60 | 20 | 20 |
| E | 50 | 30 | 20 |
| F | 50 | 20 | 30 |

### 2.4. Production of bread and composite bread from wheat, acha and mung bean flour blends

Bread was produced using the straight dough method as reported by Ayo and Nkama, 2004 . All the ingredients (flour, salt, sugar, yeast, and water) were mixed together. The mixture was kneaded properly until soft to obtain the dough. The dough was cut and placed in greased baking pans, covered with muslin cloth for 2hrs for the dough to ferment and rise. It was baked at $230^o$C in an oven at for 30 minutes. The bread were removed from the pans and allowed to cool before packaging in polyethylene bags. The production process of bread and composite bread is shown in Figure 1.

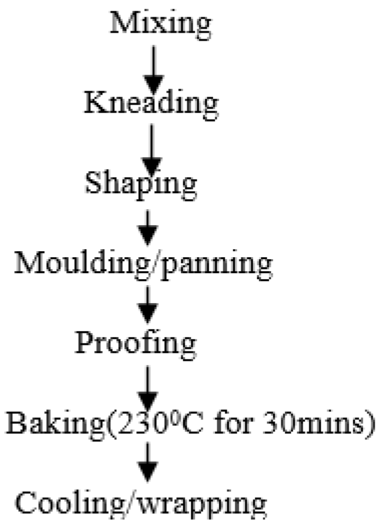


Figure 1: Flow chart for the production of bread.
Source: Ayo and Nkama, 2004.

## 2.5. Analysis

### 2.5.1. Proximate composition of bread

The moisture, ash, fat, crude fibre, protein contents of the bread were determined by the method of (AOAC,2005). The carbohydrate content was determined by difference, thus the total sum of the percentage of moisture, ash, fat, crude fibre and protein was subtracted from hundred, following the method of Egounlety (2001).

### 2.5.2. Determination of minerals and vitamin Contents of bread

The Atomic Absorption Spectrophotometric (AA800 Perkin-Elmer, Germany) was used to determine the iron, calcium and zinc contents of the products as described by Igbabul *et al*, (2014b). Vitamin A (β-Carotene) and vitamin C was determined by the method of (AOAC, 2005)

### 2.5.3. Determination of the physical properties of bread

The oven spring of bread was determined from the difference in height of the dough just before baking and height of loaf after baking. After baking, the bread loaves were allowed to cool for about one hour after which they were weighed on an electronic weighing balance.

Bread loaf volume was measured 50 minutes after the loaves were removed from the oven using the rapeseeds displacement method as modified by Giami *et al.* (2004), millet was used in place of rapeseeds. A box of known volume was filled till slightly overfilled. The box was shaken twice and a straight edged rule was used to press across the top of the box to give a level surface. The seeds were decanted and weighed. A weighed loaf was placed in the box and the decanted seeds used to fill the box and leveled off as before. The overspill was weighed and from the weight obtained, the weight of seeds around the loaf and volume of seeds displaced by the loaf was calculated. Loaf specific volume was obtained by dividing the loaf volume by its corresponding loaf weight.

### 2.5.4 Determination of sensory properties of bread

The samples were analyzed based on appearance, colour, flavour, taste, odour and general acceptability using a 9-point hedonic scale by fifteen member panel who are familiar with bread. The rating of the samples ranged from 1 (extremely dislike) to 9 (like extremely) (Ihekoronye and Ngoddy, 1985).

## 2.6. Statistical Analysis

The mean and standard deviation of duplicate samples of the bread were determined. The statistical significance of all the samples were evaluated by Analysis of Variance and least significant difference ($P<0.05$) as described by Ihekeronye and Ngoddy 1985.

## 3. Results and discussion

### 3.1. Proximate Composition of Bread

The proximate composition of bread made from the different flour blends are shown in Table 2. The moisture, and carbohydrate contents decreased with increased substitution of the wheat flour with acha and mung beans (14.35% to13.12% and 69.29% to 62.30% respectively). The protein, fibre and ash contents however increased with increased substitution with acha and mung beans. The protein content of the bread increased significantly from 12.40% (A) to 17.48% (F). This is in agreement with the work of Igbabul *et al,* (2014a) who reported increase in protein content of bread from wheat, defatted soy and banana flours. This increase in protein could be due to the increase in mungbean flour which is high in protein. Mung beans are excellent sources of protein (27%) as reported by Mubarak (2005). The products with high levels of protein and ash had lower levels of carbohydrates. The high protein, low carbohydrate samples has nutrition advantage over the 100% wheat bread especially for individuals with health problems that may require protein-rich and low-carbohydrate foods such as the diabetics. The increased ash content is an indication of increased mineral content capable of solving malnutrition problems (Chinma *et al.,* 2012).

**TABLE 2: Proximate Composition of Bread From Wheat, Acha and Mungbean Flour blends**

| Sample | Moisture (%) | Crude protein (%) | Crude fibre (%) | Crude fat (%) | Ash (%) | CHO (%) |
|---|---|---|---|---|---|---|
| A | 14.35±0.37$^{a}$ | 12.40±0.24$^{e}$ | 2.55±0.42$^{a}$ | 0.53±0.03 $^{c}$ | 0.88±0.01$^{d}$ | 69.29±0.76$^{a}$ |
| B | 14.26±0.35$^{a}$ | 13.69±0.47$^{d}$ | 3.00±0.01$^{b}$ | 0.55±0.01$^{c}$ | 0.91±0.03$^{d}$ | 67.159±0.10$^{b}$ |
| C | 14.02±0.02$^{a}$ | 15.20±0.30$^{c}$ | 3.06±0.06$^{b}$ | 0.63±0.03$^{b}$ | 1.12±0.12$^{c}$ | 65.97±0.10$^{c}$ |
| D | 13.91±0.01$^{a}$ | 16.20±0.26$^{b}$ | 3.12±0.01$^{b}$ | 0.65±0.06$^{b}$ | 1.53±0.01$^{b}$ | 64.59±0.13$^{d}$ |
| E | 13.06±0.06$^{b}$ | 16.41.±0.06$^{b}$ | 3.46±0.01$^{b}$ | 0.71±0.01$^{a}$ | 1.54±0.01$^{b}$ | 64.82±0.78$^{cd}$ |
| F | 13.12±0.02$^{b}$ | 17.48±0.01$^{a}$ | 3.99±0.16$^{a}$ | 0.75±0.02$^{a}$ | 2.36±0.08$^{a}$ | 62.30±0.31$^{e}$ |
| LSD | 0.499 | 0.757 | 0.469 | 0.072 | 0.149 | 1.302 |

Values followed by the same superscript(s) within the same column are not Significantly different at 5% probability level. Values are mean ± standard deviation of duplicate determinations.

### 3.2. Minerals and Vitamins Content of Bread

Table 3 shows the minerals (Calcium, Iron, Zinc )and vitamins (vitamin A and C) content of the bread. The nutrients increased with corresponding increase in the levels of substitution of wheat flour with acha and mung beans. Calcium ranged from 33.93 mg/100g (A) to 50.01mg/100g (F), Iron ranged from 7.27mg/100g to 26.58 mg/100g for (samples A-F), values of 2.27mg/100g to 6.52mg/100g were recoded for Zinc (samples A-F).

Vitamins A and C were not detected in 100% wheat bread but in the composite bread, the vitamins increased as the levels of substitution with acha and mung beans increased. All the minerals and vitamins generally increased with increased substitution of wheat flour with acha and mung beans. Mung beans are rich in nutrients and dehulling also decreases anti-nutrients content such as phytate, tannins, oxalate and thereby increases micro-nutrient content of zinc, copper and iron (Oburuoga and Anyika*,* 2012). Calcium is necessary for teeth and bone health, whereas iron is crucial for the formation of heamoglobin, and plays an important role in the various metabolic processes. Zinc aids in the growth and repair of tissues, boosts the immune system, and plays an important role in sperm survival (Gamonski, 2014).

**TABLE 3: Minerals and Vitamins Content of Bread from Wheat, Acha and Mungbean Flour Blends**

| Sample | Calcium (mg/ 100g) | Iron (mg/ 100g) | Zinc (mg/ 100g) | vitamin A (mg/ 100g) | Vitamin C (mg/ 100g) |
|---|---|---|---|---|---|
| A | 33.93±0.10$^{e}$ | 7.27±0.49$^{e}$ | 2.27±0.49$^{e}$ | None | None |
| B | 39.15±0.09$^{d}$ | 11.06±0.03$^{d}$ | 3.55±0.17$^{c}$ | 0.41±0.06$^{e}$ | 1.95±0.13$^{d}$ |
| C | 47.37±0.08$^{c}$ | 16.88±0.17$^{c}$ | 4.08±0.33$^{c}$ | 1.88±o.03$^{d}$ | 3.91±0.01$^{c}$ |
| D | 47.23±0.01$^{c}$ | 20.83±0.95$^{b}$ | 5.44±0.47$^{ab}$ | 2.10±0.06$^{c}$ | 5.25±0.11$^{b}$ |
| E | 49.05±0.06$^{b}$ | 21.64±0.17$^{b}$ | 6.19±0.22$^{a}$ | 2.84±0.06$^{b}$ | 5.37±0.01$^{ab}$ |
| F | 50.01±0.01$^{a}$ | 26.58±0.77$^{a}$ | 6.52±0.39$^{a}$ | 3.08±0.11$^{a}$ | 5.54±0.01$^{a}$ |
| LSD | 0.194 | 1.531 | 0.860 | 0.213 | 0.181 |

Values followed by the same superscript(s) within the same column are not significantly different at 5% probability level. Values are mean ± standard deviation of duplicate determinations.

### 3.3. Physical properties of Bread

The result of the physical properties of bread are shown in Table 4. The loaf weight decreased significantly (271.0 – 234.0 g) with increasing substitution of wheat with acha and mung beans. The decrease in loaf weight could be attributed to decrease in moisture content and increase in fat content as acha and mung beans were increased. Bread specific volume decreased with increase in the level of substitution of wheat flour with acha and mung beans (1.55cm$^{3}$/g to 1.35cm$^{3}$/g). The volumes of the bread made from the composite flours were lower than those made from 100% wheat flour. The highest bread specific volume was 1.55cm$^{3}$/g obtained with bread made from 100% wheat (A) while the sample with the lowest specific volume is the one made from 50% wheat, 20% acha and 30% mung beans (F). This is in agreement with the results of Aluko and Olugbemi (1989) and Igbabul *et al,* (2014a) where they found lower bread volumes associated with composite flour as opposed to 100% wheat flour. The lower loaf volumes can be attributed to lower levels of gluten network in the dough because of decrease in structure forming proteins in the composite flour and consequently less ability of the dough to rise due to the weak cell structure (Igbabul *et al,* 2014b). However, the specific volumes of 100%

wheat flour and 80% wheat, 10% acha and 10% mung bean (B), were not significantly different from each other. The oven spring also decreased significantly as the level of substitution of wheat flour with acha and mungbeans increased. This could also be due to poor gluten framework in the composite flours.

**TABLE 4: Physical Properties of Bread from Wheat, Acha and Mungbean Flour Blends**

| Sample | Weight (g) | Ovenspring (cm) | Volume ($cm^3$) | Specific volume ($cm^3/g$) |
|---|---|---|---|---|
| A | $271.0\pm4.24^{a}$ | $2.35\pm0.07^{a}$ | $419.0\pm1.41^{a}$ | $1.55\pm0.021^{a}$ |
| B | $259.5\pm0.71^{b}$ | $2.05\pm0.05^{b}$ | $388.0\pm2.83^{b}$ | $1.50\pm0.021^{b}$ |
| C | $258.5\pm0.71^{b}$ | $1.60\pm0.00^{c}$ | $381.5\pm2.12^{c}$ | $1.47\pm0.000^{b}$ |
| D | $250.5\pm4.24^{c}$ | $1.45\pm0.07^{c}$ | $358.0\pm2.83^{d}$ | $1.43\pm0.014^{b}$ |
| E | $246.5\pm4.95^{d}$ | $0.65\pm0.07^{d}$ | $341.5\pm2.12^{e}$ | $1.39\pm0.035^{b}$ |
| F | $250.0\pm4.24^{e}$ | $0.35\pm0.07^{e}$ | $338.0\pm2.83^{f}$ | $1.35\pm0.007^{b}$ |
| LSD | 2.452 | 0.179 | 2.481 | 0.128 |

Values followed by the same superscript(s) within the same column are not significantly different at 5% probability level. Values are mean ± standard deviation of duplicate determinations.

### 3.4. Sensory properties of bread from acha, mung beans and wheat composite flours

The mean sensory scores for each of the quality attributes (taste, flavour, color, texture and general acceptability) of cookies are shown in Table 5. As the levels of substitution of wheat flour with acha and mung beans increased, the scores decreased. The mean scores for the taste of the bread decreased with increasing acha and mung beans (8.4 – 5.0). 100% wheat bread (A) and 80% wheat, 10% acha and 10% mung beans bread (B) were rated highly and were not significantly different from each other. This shows that bread made with 80% wheat, 10% acha and 10% mung beans (B), can favourably compare to that made from 100% wheat flour. The least scores for taste and flavour of bread were seen in the product with 50% wheat, 20% acha and 30% mung bean (F). That product (F) had a strong beany flavor which may be the reason the panelist rated them low (4.8) and were poorly accepted (Grewal, 1992, Rastogi and Singh, 1989).

The mean scores for color of bread decreased from 8.1 – 5.8 as acha and mung beans levels increased. Bread made from 100% wheat (A) and t 80% wheat, 10% acha and 10% mung beans (B) were rated highly and were not significantly different from each other. There was significant difference however, between the first two products (A and B) and the next two (C and D). The colour of products with 50% wheat, 30% acha 20% mung beans (E) and the ones with 50%wheat, 20% acha, 30% mung beans (F), were rated far lower than the control sample. The colour of the crust of the bread became darker, from creamy to dark brown, as the substitution of wheat flour with acha and mung beans increased. No significant difference was observed in the colour up to blending with 10% acha and 10% mung beans (B). The darker colour of the products may be due to maillard reaction between reducing sugars and protein (Raidi and Klein, 1983; Dingra and Jood, 2005).

The texture scores decreased with increasing acha and mung beans (8.1-4.5). Bread with 20% acha, 30% mung beans (F) and that with 30% acha and 20% mung bean (E) were rated poorest (4.5 and 5.1). From the general acceptance, bread could be baked from the composite flours of wheat, acha and mung beans but most especially 10% acha, 10% mung beans and 80% wheat flour blends.

**TABLE 5 : Sensory properties of bread from different flour blends.**

| Sample | Taste | Flavour | Colour | Texture | General acceptability |
|---|---|---|---|---|---|
| A | $8.4\pm0.50^{a}$ | $8.2\pm0.83^{a}$ | $8.1\pm0.91^{a}$ | $8.1\pm0.91^{a}$ | $8.4\pm0.50^{a}$ |
| B | $8.0\pm1.36^{a}$ | $7.6\pm1.31^{a}$ | $7.7\pm1.09^{a}$ | $7.6\pm1.14^{a}$ | $8.3\pm0.64^{a}$ |
| C | $6.4\pm1.95^{b}$ | $6.5\pm1.73^{b}$ | $6.6\pm1.40^{b}$ | $6.0\pm1.67^{b}$ | $7.0\pm1.96^{b}$ |
| D | $6.1\pm2.09^{b}$ | $6.2\pm1.39^{b}$ | $6.2\pm1.73^{b}$ | $5.5\pm2.09^{b}$ | $6.4\pm1.57^{b}$ |
| E | $6.1\pm2.17^{b}$ | $5.9\pm1.94^{b}$ | $6.1\pm1.93^{b}$ | $5.1\pm1.86^{b}$ | $5.7\pm2.06^{b}$ |
| F | $5.0\pm2.01^{c}$ | $4.8\pm1.80^{c}$ | $5.8\pm1.77^{b}$ | $4.5\pm1.82^{b}$ | $5.2\pm2.26^{b}$ |
| LSD | 0.987 | 0.937 | 0.804 | 0.856 | 0.917 |

Values followed by the same superscript(s) within the same column are not significantly different at 5% probability level. Values are mean ± standard deviation of duplicate determinations.

## 4. Conclusion

The study has produced bread of acceptable quality from composite flours of wheat, acha and mung beans. The bread produced from 10% acha, 10% mung beans and 80% wheat flour blends compared favourably with 100% wheat flour bread with no significance difference. All the other bread products were all of acceptable quality on a 9-point hedonic scale. The bread had increased nutrient contents which are all desirable for good health and wellbeing.

The use of acha and mung beans in bread production would diversify its use, enhance nutrition, health and wellbeing of the consumers and reduce the dependence on wheat flour,thereby huge foreign exchange used in importing wheat would be saved for other developmental projects. Food security would also be enhanced in Nigeria and Africa.

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