# SUPPLEMENTATION OF BISCUIT USING RICE BRAN AND SOYBEAN FLOUR

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## ABSTRACT

The cost of animal protein is increasing every day, thus making it unavailable for most people in developing countries. This unavailability has resulted into looking for other alternatives protein sources. Gradual shift away from fiber in diets calls for development of recipes, formulae and products that would restore the levels of dietary fiber. Snack foods such as biscuits and crackers offer several important advantages including; wide consumption, relatively long shelf life, good eating quality, highly palatable and acceptable in most countries. These characteristics make protein rich biscuits attractive for the research work. Wheat, soybean and rice bran flour blends were used for the formulation of biscuits in these ratios; (100% wheat flour), (70% wheat, 20% soybean, 10% rice bran flours), (50% wheat, 30% soybean, 20% rice bran flours), (30% wheat, 40% soybean, 30% rice bran flours), (10% wheat, 50% soybean, 40% rice bran flours). Width, thickness, spread ratio, sensory attributes (colour, texture, taste, odour and general acceptance), and proximate compositions (protein, fiber content, fat, ash and moisture content) of the formulations were analysed using AOAC standard methods. Widths of the biscuit samples ranged between 36.75 – 43.3 mm. Increase in width were noticed with increase in level of substitution. Similar trend was recorded on spread ratio. However, biscuit thickness decreased with increase in level of substitution. At $p \leq 0.05$, most preferred composite sample (wheat 70%, soybean 20%, rice bran 10%) showed no significance difference with control (100% wheat) in general preference of sensory ratings. Sample E (10 % wheat, 50% soybean, 40 % rice bran) was the least generally preferred sample. Proximate compositions of best-rated composite flour biscuit were protein ($16.28 \pm 0.41\%$), fiber ($1.90 \pm 0.17\%$), fat ($12.13 \pm 0.67\%$) and moisture ($4.37 \pm 0.18\%$). It is possible to produce biscuit from composite of wheat, full fat soybean and stabilized rice bran from parboiled rice flours. Adoption of this technology of biscuit manufacture will result in production of better protein and fiber enriched biscuit to the ever-increasing number of consumers.

**Key words**: Biscuit, Supplementation, Rice-bran, Soybean, Protein

## INTRODUCTION

Protein in human diets is obtained from several sources that include cereals, vegetables, root crops, legumes, meat, egg, milk and fish.  Of all these, sources from animals are regarded as the best because of its amino acid content [1].  However, the cost of animal protein is increasing every day, thus making it unavailable for most people in developing countries. This unavailability has resulted into looking for other alternatives protein sources. New technologies have helped to segregate the readily digestible fractions of foods from the non-digestible fractions such as fiber. This has changed the eating habits of many communities that only the digestible fractions are consumed. This gradual shift away from fiber in diets calls for development of recipes, formulae and products that would restore the levels of dietary fiber [2].

Enrichment of cereal-based foods with oil seed protein has received considerable attention. There has been a trend to incorporate bran from various sources into cereal products such as high protein- fiber source [3]. Intake of high dietary fiber is associated with lower risk of coronary heart disease, colon cancers and bowel disorders [4]. Supplementation of biscuits with rice bran, which has been noted for its high dietary fiber, is advantageous [5].

Snack foods such as biscuits and crackers receive less attention than bread; however they offer several important advantages including: wide consumption, relatively long shelf life, good eating quality, highly palatable and acceptable in most countries and can be modified to suit specific nutritional needs of any target population [6]. These characteristics make protein rich biscuits attractive for target areas especially School Feeding Programmes [7]. Biscuits have become a popular food source in many emergency-feeding programmes, for instance, between 1985 and 1986; over 6,000 tones of biscuits were distributed in Sudan and Ethiopia [8]. A good example of a school feeding programme in Nigeria is the Universal Basic Education (UBE) programme, where a meal will be offered to primary school pupils and junior secondary school students during school hours in the day according to education policy. Protein-rich biscuits will also be beneficial to the low-income groups and institutions. Therefore, this study was aimed at production of protein and fiber enriched biscuit form wheat-soybean-rice bran composite flour.

## MATERIALS AND METHODS

### Biscuit production
Wheat flour, sucrose, margarine, sodium bicarbonate, vanilla flavour, milk flavour, and soybean seeds were purchased from Bodija market in Ibadan, Nigeria. Rice bran flour from parboiled rice was obtained from Agro Millers (OLAM), a rice-milling factory in Makurdi, Nigeria. Soybean was milled to flour using hammer mill (model FE 326B, FOBA Engineering, Nigeria). The flours were substituted in ratio 10:0:0, 7:2:1, 5:3:2, 3:4:3 and 1:5:4 of wheat, soybean and rice bran respectively. A known weight of sugar and margarine were mixed at medium speed until fluffy, then composite flour, baking powder; milk flavour and vanilla flavour were slowly added

into the mixture and mixed until a uniform smooth paste was obtained. The dough was uniformly spread over the board to a thickness of about 4 mm using a rolling pin. Circular biscuits of about 4 cm in diameter were cut using a circular cutter. The biscuits were placed on a baking mesh and baked at 180°C for 15 minutes in an oven. The baked biscuits were cooled to room temperature and stored in sealed polyethylene sachets of appropriate thickness and permeability using an impulse sealing machine model WO – 200H. The procedures were repeated thrice. About fifty units of each composite biscuits formulation were produced from each experimental procedure. Analysed samples were randomly picked.

## Physical analysis

Biscuit width (W) and thickness (T) were determined by arranging four units in a row and taking their average diameter and thickness using digital venier caliper with 0.01 mm accuracy (Cappera precision, China). The spread ratio (SR) was calculated using the relationship between SR, W, T and correction factor CF as shown in equation 1.
$$SR = W/T \times CF \times 10 \ldots\ldots\ldots\ldots 1$$

## Sensory evaluation of the biscuits

Sensory evaluation of the samples was carried out for consumer acceptance and preference using 10 untrained panelists selected at random from the University of Ibadan campus. Colour, texture, taste, odour and general acceptance of the products were rated using a 9-point hedonic scale where 9 and 1 represent extremely like and extremely dislike respectively. The mean scores were analysed using analysis of variance (ANOVA) method and difference separated using Turkey test. SPSS 16.0 software package was employed to run the analysis.

## Proximate analysis

Protein, fiber, fat, ash and moisture contents of the best-rated composite biscuit were determined using AOAC standard methods [9].

Protein was determined by Kjedahl procedure using a protein factor of 6.25. About 1.2g of sample was weighed into a digestion tube and $H_2SO_4$ 98% added using a dispenser. The tube was placed in a preheated digester at 420°C for about 30 minutes until a clear solution was obtained. The tube was removed from the digester, cooled and diluted with water and placed in the distillation unit. A conical flask containing 25 ml of boric acid (with indicator) was placed under the condenser outlet. About 25 ml of 40% Sodium hydroxide (Na0H) was dispensed in the digestion tube and distillation carried out for 5 min. The ammonium borate solution formed was titrated with 0.1M tetraoxosulphate (VI) acid to purplish-grey end point. Percentage nitrogen ($\%N_2$) was calculated.

Fiber content of the biscuits was measured using the enzyme-modified, neutral detergent fiber (NDF) method. Dried samples of biscuits whose fat content was extracted using Soxhlet extraction approach were treated with standard NDF procedures up to the point that fiber containing residues were filtered and washed with water. The filtered residues were incubated with a porcine – amylase solution

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at 37°C overnight. The residues were filtered after incubation, washed very well and dried. The NDF was calculated as filtered residual.

Fat analysis was carried out using Soxhlet extraction method. About 25 g from each powdered samples were mixed with about 100 ml of n-hexane. The mixture was vigorously shaken with the separation flask knob opened at intervals to release the accumulated air pressure, which may burst the flask if left there. The fat in spirit was evaporated to dryness over a Soxhlet extraction, which extracts n-hexane from its solution of fat. The fat left behind in the flask was placed in the oven to dry at 105°C for 1½ hours. The round bottom flask was cooled in desiccators and weighed. Percentage of fat in the sample was calculated.

Moisture content was determined by weighing 5 g of the samples separately into labeled cans of known weights ($W_1$). The samples in cans ($W_2$) were placed in an oven for 6 hours at 105°C and then cooled in desiccators and reweighed ($W_3$). Difference in weight was assumed to be moisture loss.

Ash content of the samples were determined by putting about 5g in a dish of known weight ($W_4$) and dried in an oven for 4 hours at 105°C. The sample in dish was ash in a muffle furnace at 550°C until white or grey ash resulted. It was cooled and reweighed ($W_6$). The percentage ash content was calculated.

## RESULTS

### Physical analysis
The result of the physical analysis of biscuit produced from wheat, soybean and rice bran flour blends was shown in Table 1. Widths of the biscuit samples ranged between 36.75 – 43.3 mm. Increase in width were noticed with increasing levels of substitution. Similar trend was recorded on spread ratio. However, biscuit thickness decreased with increasing level of substitution (Table 1).

### Sensory attributes
Results of sensory evaluation are as shown in Table 2. Sensory rating of biscuit for colour at 5% levels of significance and 9 degree of freedom showed that colour of sample B (70 % wheat, 20% soybean and 10 % rice bran) was most preferred. Only sample D (30 % wheat, 40 % soybean, 30 % rice bran) showed a significant difference in colour with the control (100 % wheat flour) at $p \leq 0.05$. It was also observed that as the level of substitution increased from (30 – 90) %, the crust colour changed from light brown to darker shades of brown.

Preference for odour of biscuits treatments decreased with increasing level of substitution (Table 2). Sample A (100% wheat) rating was highest. Except for sample B, all other treatments indicated significant differences with the control at 5% level of significance.

Sensory evaluation for taste at 5% level of significance and 9 degree of freedom of biscuit treatments ranged between 7.1 and 4.3. Sample B (70 % wheat, 20% soybean, 10 rice bran) was not significantly difference in taste with the control while all other samples showed significant difference. Decreases in preference for taste of the biscuits were observed from the control to the least preferred treatment sample E (10 % wheat, 50% soybean, 40 % rice bran). Some panelists remarked that samples D (30 % wheat, 40% soybean, 30 % rice bran) and E (10 % wheat, 50% soybean, 40 % rice bran) had a bitter after-taste.

Texture of the biscuit samples decreased for preference evaluation at 5% level of significance with increasing levels of substitution of soybean and rice bran flours from 7.0 – 4.9 as shown in Table 2. Out of the composite flour biscuits, sample B (70 % wheat, 20% soybean, 10 % rice bran) was the most preferred for texture and showed no significant difference ($p > 0.05$) in texture to the control. The other treatments indicated significant difference at $p \leq 0.05$. Some of the panelists remarked of feeling grits in biscuits treatments D and E.

Generally, sample B (70% wheat, 20% soybean, 10% rice bran) showed no significant difference with control (whole wheat) while rest of the treatments indicated significant differences at p 0.05. Sample E (10% wheat, 50% soybean, 40% rice bran) was the least preferred sample.

**Proximate composition**

The result of proximate composition of 100 % wheat and preferred sample (70 % wheat, 20% soybean, 10 % rice bran) was illustrated in Figure 1. The protein content of the most preferred composite biscuit has higher protein content ($16.28 \pm 0.41\%$) than the control ($9.43 \pm 0.44$). Fiber content of sample B (70 % wheat, 20% soybean, 10 % rice bran) was $1.90 \pm 0.17\%$ while the control has $0.18 \pm 0.02\%$ as shown in Fig.1.

Fat content in the preferred sample of biscuit is higher ($12.13 \pm 0.67\%$) than in the control ($10.50 \pm 0.60\%$). Sample (B) has higher mineral content ($1.70 \pm 0.18\%$) compared to the control ($0.91 \pm 0.11\%$). The moisture level in sample B was slightly higher than the control (Fig. 1).
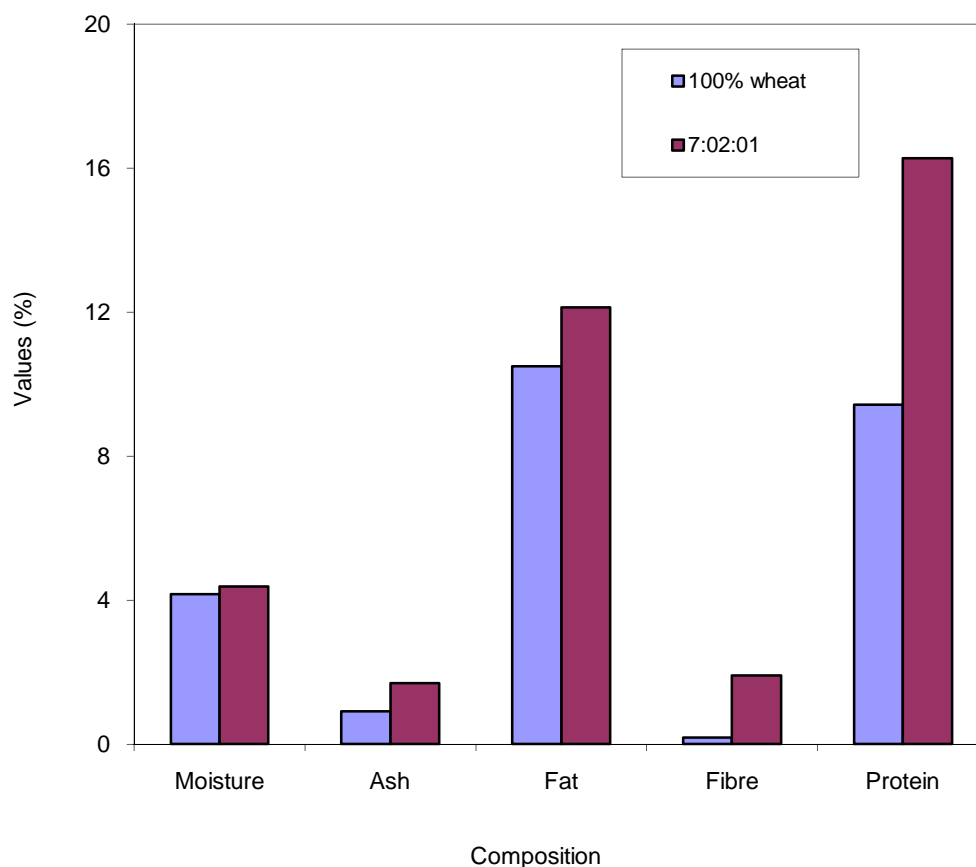
Figure 1: Comparison of proximate analysis of prefered composite with whole wheat flour biscuit

## DISCUSSION

### Physical analysis

The results obtained agreed with literature report on acha-wheat biscuit supplemented with full fat soybean flour [10]. Spread ratio was affected by the competition of ingredients for the available water [11]. Other functional properties of proteins and fat might have also affected the spread ratio [10]. It can therefore be deduced that both protein and fat content in the full-fat soy and parboiled rice bran flours had effect on the spread ratio of the biscuit treatments. The spread here seems not to be due to competition over available water by ingredients as both soy and rice bran flours absorb water during dough mixing. The observed noticeable differences may be traced to the protein and fat content of the supplements and thus affected the rise in the biscuit samples during the baking process. The poor effect of substitution of wheat flour as shown in thickness could be due to the higher levels of supplementation. Rate

of substitution for semi hard biscuits should be 20% to produce acceptable quality products [12]. The biscuits prepared had a substitution of (30 – 90) %.

## Sensory attributes

This result agreed with the literature report that baked goods provide one of the most attractive possibilities of using rice bran as ingredient in that, it increased dough yield and contributed to attractive crumb and crust [13]. Sugar content of the rice bran (3 – 8%) contributed to oven browning which is an accepted quality index in baked products [13]. It has also been reported that soy flour is added to baked products to improve the crumb quality [14]. All these have been indicated by the reaction of panelist in the evaluation of the colour of biscuit treatments. Noticeable change in colour from light brown to darker shades of brown with increase in level of substitution could be associated to non-enzymatic browning reactions (Maillard reactions) between reducing sugar molecules and lysine. Soybeans and rice bran are reported to be rich in lysine which produces darker shades of brown colours [15].

Fresh rice bran is associated with volatile compounds and its odour is composed of alcohols and carbonyls, which could be a hindering factor in its use as an ingredient in human foods [16]. The recorded results may be associated with these reasons.

Beany flavour of soybean flour at the substitution level in biscuits of greater than 20% lowers the odour rating of biscuits [10]. Rice bran has a characteristic bland flavour that is neither bitter nor sweet. The flavour is described as insipid rancid, musty and sour due to its ready deterioration in commercial lots. Maillard reaction is an important source of unusual flavours by the thermal breakdown of sugars and decarboxylation of amino acids to produce specific flavours. After taste bitterness remark on samples D and E were subjective to age, since adult panelists seemed to prefer these samples. It can be deduced that, even though sample A was most preferred for flavour, other samples with higher levels of soybean and rice bran flour substitutions could be developed for matured adults.

Similar observations on the texture characteristics was reported, sensory evaluation for texture decreased with increasing levels of substitution of soybean flour in wheat–acha biscuits [10]. The low rating of higher substitution could also be due to the difference in particle size of the composite flours, as was earlier reported [12]. The report revealed that first important characteristic of composite flour is the particle size which should be almost the same as that of the wheat flour, preferably be smaller than 130μm. The remarked of feeling grits in biscuits treatments D and E could be associated to particle size. These grits could probably be from rice bran fraction of the composite flour. Also rice bran flour high tendency to absorb water, make samples with higher proportion of the bran to be damp and not crispy.

## Proximate composition

Increase in protein content was obtained from supplementation of cereal meals with soybean [17]. This was similar to the result of this experiment. Also cowpea (V*igna unguiculata*) and Jackbean (*canvalia nsiformis*) respectively were used for biscuit to

obtained similar increases in protein levels [5]. This increase in the protein level of wheat, soybean and rice bran flour blend biscuits could possibly come from soybean fraction of the blended flour. Rice bran is also rich in protein. The increase in protein value of the biscuit indicated high nutritional value. Consumption of 17-25g of soy protein per day reduces serum cholesterol to 9.3% on the average. Also, low-density lipoprotein cholesterol (LDL) reduces to about 13% [17].

The higher fiber content could have come from the rice bran fraction of the flour since soybean used was de-hulled. The increase in fiber of the biscuit as a result of supplementation agreed with literature report [2]. Only pomace was used for the enrichment of biscuits for fiber, vitamin C and antioxidant and obtained a five fold higher value of dietary fiber in the biscuits than the control. The fiber-enriched biscuits may be helpful in curing the constipation and other aliments related to fast food habits [18].

The increase in fat content of the 30% substituted soy-rice bran flour for wheat biscuit could be the contribution of both soybean flour and rice bran. Both of these ingredients are rich in oil, (15-19.7%) and (18-20%) respectively. Ash content indicated an estimate of the total mineral content in a given quantity of food substance. Rice bran is rich in mineral content [19].

It was known that rice bran and soy flour absorb moisture in baked products when used; increasing freshness and reducing the recrystalization of amylopectin during storage which could play a role in modulating the staling mechanism of baked products [20]. Thus the recorded higher moisture content in the composite flour biscuit could be traced to these characteristics. Moisture content determination was necessary for further studies concerning shelf life determinations. A high level of moisture indicates high water activity ($a_w$) and higher risk of deterioration due to mould growth.

## CONCLUSION

It is possible to produce biscuit from composite of wheat, full fat soybean and stabilized rice bran from parboiled rice flours. The formulated biscuit had 70%, 20% and 10% wheat, soy and rice bran flours respectively. It contained high proportion of protein (16.28%), fiber (1.90%) and fat (12.13%), and thus could be used as a nutritious food for children and adolescent in developing countries. Adoption of this technology of biscuit manufacture will result in production of better protein and fiber enriched biscuit to the ever-increasing number of consumers. Since rice bran and soybean flour are relatively cheaper in Nigeria market than wheat flour, substitution of up to 30% wheat flour in the biscuit formulation will reduce the cost of production.

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**Table 1: Physical characteristics of biscuit produced from wheat, soybean and rice bran flour blends**

| Treatment | Parameters | | |
|---|---|---|---|
| | Width(w) (mm) | Thickness(T) (mm) | Spread Ratio (SR) |
| A (10:0:0) | 36.75±0.57 | 7.25±0.21 | 48.45±1.58 |
| B (7:2:1) | 41.75±0.76 | 6.80±0.20 | 57.77±0.63 |
| C (5:3:2) | 41.33±1.32 | 6.67±0.31 | 59.36±4.44 |
| D (3:4:3) | 42.25±0.72 | 5.75±0.24 | 70.28±3.65 |
| E (1:5:4) | 43:30±0.50 | 5.30±0.18 | 78.10±3.02 |

**Key**

A: 100% wheat flour

B: 70% wheat, 20% soybean, 10% rice bran flours.

C: 50% wheat, 30% soybean, 20% rice bran flours

D: 30% wheat, 40% soybean, 30% rice bran flours

E: 10% wheat, 50% soybean, 40% rice bran flours

**Table 2: Sensory evaluation of biscuit produced from wheat soybean and rice bran flour blends**

| Treatments | Sensory attributes | | | | |
|---|---|---|---|---|---|
| | Co lour | Odours | Taste | Texture | General preference |
| A (10:0:0) | 7.2±1.400[a] | 7.8± 0.748[a] | 7.1± 0.700[a] | 7.0± 1.483[a] | 7.5±0.806[a] |
| B (7:2:1) | 7.4±0.136[a b] | 7.2± 0.422[a] | 6.3±0.344[a b] | 6.2± 0.466[a b] | 6.7±0.410[a] |
| C (5:3:2) | 5.5± 0.604[c] | 5.5± 0.630[b] | 5.3± 0.625[bc] | 5.0± 0.609[bc] | 5.1± 0.652[b] |
| D (3:4:3) | 5.8± 0.549[bc] | 5.8± 0.609[b] | 4.4± 0.610[c] | 4.9± 0.728[c] | 5.0± 0.758[b] |
| E (1:5:4) | 6.1± 0.656[bc] | 5.5± 0.610[c] | 4.3± 0.813[c] | 4.9± 0.833[c] | 4.2± 0.728[c] |

LSD = 1.36

Means having a common superscript in the same column are not significantly different at 5% level of significance.

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