



# Evaluation of Nutritional, Microbial and Sensory Attributes of Rice Tuwo Flour Fortified with Soy and Plantain Flour Blends

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## Authors' contributions

This work was carried out in collaboration between the authors. Author NAA designed the study performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Author OSE managed the analyses of the study and the literature searches. Author NAA supervised the research and interpreted the data and prepared the final manuscript draft. Both authors read and approved the final manuscript.

## Article Information

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## ABSTRACT

**Aims:** The aim of the work is to investigate the effect of soybean and Plantain flour fortification on the nutritional, microbial and sensory qualities of rice flour paste (Tuwo) fortified with soy and plantain flour blends.

**Methodology:** White rice was cleansed, sorted and soaked in water for 12hrs and dried at 60°C for 12hrs. White rice was fortified with soybean and plantain flour at 10, 15, 20, 25% respectively while 100% white rice flour serve as the control. Nutrient, microbial and sensory qualities of the samples were determined using standard methods.

**Results:** There were significant differences ( $p \leq 0.05$ ) and increase in values of all the nutritional properties with increase in substitution of soy-plantain flour. The protein content ranges from (2.19 – 21.46%), Fat content (1.67 – 18.51%), Fiber (0.68 – 6.78%), Ash content (1.37 - 2.26%), Moisture content (10.16 – 12.47%) of the blends respectively, while the carbohydrate contents of the blends was significantly lower to that of the control sample. The mineral content increased where the abundant mineral was potassium (29.22 – 45.57 mg/100g) and zinc (2.66 – 3.34 mg/100g) been the least mineral element. The microbial analysis shows a lower microbial counts of prepared tuwo

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samples, which makes it safe for consumption. Mean total viable count range from 1.10 to 3.50 x10<sup>2</sup> cfu/g, Staphylococcus count range from 0.00 to 1.03 x10<sup>2</sup> cfu/g. fungi count range from 0.00 to 0.60 10<sup>2</sup> cfu/g with no growth of *salmonella* from all the samples respectively. The sensory evaluation result shows that the sample from whole rice was highly rated but sample B with 80% rice flour, 10% soy flour and 10% plantain flour has the highest preference in terms of taste, colour, aroma, texture, smoothness and overall acceptability.

**Conclusion:** This fortification highly improve its nutrient contents and slightly improves microbial and organoleptic properties of rice tuwo, which can serve as alternative protein supplement.

*Keywords:* Rice tuwo; nutritional; microbial; soy flour; plantain flour.

## 1. INTRODUCTION

Protein energy malnutrition is a major public health problem in developing world, diets in these parts are predominantly starchy [1]. Rice (*Oryza sativa*) is a dietary staple foods and one of the most important cereal crop especially for people in Asia but the consumption outside Asia has increased recently [2]. It provides the bulk of daily calories for many companion animals and humans [3]. The glycemic index is one of the popular issues of the world and people are re-thinking whether to consume rice or not. Some study showed that rice consumption is related to the highest risk of diabetes mellitus [4].

The nutrient content of rice was varied depending on the variety of rice soil, and the condition they grow. Rice contributes to the major dietary energy for body. Pre-germinated brown rice has twice as much protein as white rice i.e, 14.6g/100g(brown rice) vs 7.3g/100g(white rice).On the other hand the fat content is so high namely 24.8g/100g for pre-germinated brown rice and 1.5g/100g for white rice [5]. The amino acid profile of rice shows that glutamic and aspartic acids are the major amino acids [6]. A new method has been developed to achieve high lysine content in rice, using over accumulation of lysine rich BiP (Binding protein) in the endosperm [7]. Inadequate intake of protein in developing countries has led to various forms of malnutrition in both children and adults WHO, 2005 [8]. The need to find inexpensive sources of protein of good quality as dependency on plant proteins is however very high and it is pertinent to combine these plant proteins in proportions that will improve the protein intake of the consumers [9]. Other good alternative like rice, plantain and soybean which possesses interesting food potentials and large production ratio have not been fully exploited.

Soybean (*Glycine max*) is a significant and cheap source of protein for animal feeds and mainly packaged in meals e.g., Soybean

products such as textured vegetable protein (TVP) are ingredients in many meat and dairy substitutes [10]. The seed is unique for its possession of substantial oil as well as high quality protein content (18-20% oil and 35-40% protein). It is a leguminous vegetable of the pea family that grows in tropical, sub-tropical and temperature climate) [11].

Plantain (*Musa Parasidiacal*) are used as an expensive source of calorie [12], it is an important staple food in central and west Africa which along with bananas provide 60 million people with 25% of the calories [13]. Nigeria produces about 2.11 million metric tonnes annually [6]. Plantain is diety staple due to its versatility and good nutritional value [14]. When processed into flour it is used traditionally for the preparation of gruel which is made by mixing the flour with appropriate quantities of boiling water to form a thick paste [15].

Tuwo rice or Tuwo shinkafa is a type of Nigerian and Niger dish from Niger and the northern part of Nigeria [1]. It is a thick pudding prepared from a local rice or Maize or millet that is soft and sticky, and is usually served with different types of soups like Miyan kuka, Miyan kubewa, Miyan taushe. However, the utilization of Tuwo and maize generally is limited by its extremely low protein content and so the consumption of its products has been implicated in malnutrition [16]. There is little or no information on nutrient and fortification of tuwo shinkafa from soy and plantain flour. The objectives of this study is to produce a rice tuwo fortified with soy and plantain flour blends and to evaluate the nutritional, microbial and sensory attributes of the samples.

## 2. MATERIALS AND METHODS

### 2.1 Materials

Freshly harvested soya bean and plantain were purchased from a local market in Yewa south

Ilaro Ogun state and was used to produce the soy flour. White local rice was obtained from a market in Ilaro Ogun state. The rice was used to produce the rice flour used in the production of Tuwo.

## 2.2 Production of Rice Flour

Rice flour was produced by the method described by [8]. The white rice was thoroughly cleansed, this was then washed twice in portable water and soaked for 12hrs. The rice was then washed and dried in an oven for 12hrs at 60°C and allowed to cool. It was then dried again at 70% for 15mins. After cooling, it was then milled in a disc attrition mill (Hunt No. 2A premier mill, Hunt and Co, UK) and then packaged in a plastic container.

## 2.3 Production of Soybean Flour

Soybean flour was prepared by the method described by [17]. Soybeans were sorted to remove particles, washed in clean portable water. The seeds were boiled for 30mins and drained so as to inactivate the trypsin inhibitors followed by dehulling using manual method. The soybean seeds were dried in a hot air oven at 70°C for 10hours. After drying, the soybean hulls were removed by winnowing, the dried samples were milled to fine powder and sieved through a standard sieve of 400µm particle size. The flour was packaged in a polythene bag.

## 2.4 Production of Plantain Flour

The method of Ogazi [18] was used to prepare the plantain flour. Green matured plantain fruits were washed to remove adhering soil particles, peeled and sliced into thin thickness, blanching was carried out on the sliced samples in hot water. The product was dried in the cabinet dryer at 60°C for 24 h. The dried plantain slices were milled into flour using a milling machine and then sieved. The flour was packaged in a polythene bag.

## 2.5 Preparation of the Flour Blends

White Rice flour and soy flour and plantain flour were mixed in various proportions ranging from 10 to 25% (w/w) substitution level. Sample A 100% white rice as the control B (80%Riceflour; 10%soy; 10%plantainflour) C(70%Rice; 15%soy; 15%plantainflour) D(60%Rice; 20%soy; 20%plantainflour) and E (50% Rice; 25%soy;

25%plantainflour) The various mixes obtained were thoroughly blended using a vortex mixer, packed and sealed in polythene bags.

## 2.6 Production of Tuwo

Tuwo was prepared from flour of rice, soya beans and plantain using a method as described by (Bolade et al, 2002) [19]. Water was added to the flour formulation to make a slurry this was followed by boiling some water. The cold slurry initially prepared was added to the boiling water coupled with vigorous stirring, using a wooden flat spoon, to form a pap like consistency. The remaining quantity of flour was then added gradually to the boiling pap like paste with continuous stirring so as to facilitate non formation of lumps and to ensure a homogeneous gel formulation. Water was finally added to the formed gel, covered properly without stirring and allowed to cook for about 5-8 minutes after which it was stirred vigorously to ensure smoothness of the gel, so the final product obtained is called TUWO.

## 2.7 Proximate Analysis

Each flour sample was analyzed for moisture content using the method described by AOAC. Crude protein was determined using the Kjeldahl method. Crude fat extracted in a Soxhlet extractor with hexane and quantified gravimetrically; Ash and Crude fibre were determined using the method described by AOAC while Carbohydrate was calculated by difference [20].

## 2.8 Mineral Analysis

The ash was prepared by adding about 5ml of concentrated HCl to the crucible containing the previously ashed samples. The mixture was boiled for 5min on a hot plate in a fume cupboard and more acid added to maintain the volume. The contents of the crucible after boiling was transferred and washed in a beaker, adjusted to about 40ml and boiled for 10min. It was latter cooled, filtered through a glass wool into 100ml volumetric and the beaker rinsed with distilled water into the volumetric flask. The ash solution was cooled and made up to volume. The solution was used for determination of calcium, potassium and magnesium using atomic absorption spectrophotometer [21].

## 2.9 Microbiological Analysis

### 2.9.1 Isolation and identification of microorganisms

Ten (10) grams of each Tuwo samples was diluted in 90 ml of sterile distilled water in a conical flask to get the aliquot, a tenfold serial dilution was carried out. An aliquot of 1 ml from selected dilutions of each sample was inoculated aseptically into labelled triplicate agar plates (NA, for total viable count, BPA for *Staphylococcus* count, BSA for *Salmonella* count) using standard pour plate method and incubated at 37°C ±2°C for 24 to 48 hours. Potato Dextrose Agar was incubated at (28°C±2°C) for 3 to 5 days for isolation of fungi. Colonies were enumerated at the end of incubation period using digital colony counter (Gallenkamp England) [22, 23].

### 2.10 Sensory Evaluation

Sensory characteristics of products were assessed by a trained and conversant panel of judges from the polytechnic. Samples were assessed for the following Taste, Colour, Aroma, Texture and overall acceptability. The panelists were instructed to sip water before and after assessment of each product. The judges recorded sensory characteristics of each sample using an 8 – point hedonic scale as described by Ihekoronye and Ngoddy [9].

### 2.11 Statistical Analysis

Means of duplicate data were subjected to a one-way analysis of variance (ANOVA) using SPSS statistical package version 20.0 (SPSS Inc, Chicago, USA) to determine significant differences between the quality attribute of samples with Duncan's Multiple Range Test (DMRT) at  $p < 0.05$ .

## 3. RESULTS AND DISCUSSION

Table 1. shows the result for the proximate analysis of the samples. The moisture content ranged from 10.16 to 12.47%. The lowest moisture content of 10.16% was recorded in sample A while the highest moisture content of 12.47% was recorded in sample E. Considering different food temperatures have different capacity for absorbing/retaining moisture which may exist as absorbed water. The protein content ranges from 2.19 to 21.46%. This result depicts a rise in protein content with increase in

the fortification of soybean plantain flour and significant difference ( $p < 0.05$ ) existing across the two samples. The highest value was recorded in sample E while the lowest value was in sample A. Soyabeans have been reported to contain high content of 25.78% protein (thus the rise in protein content might have been due to soybean and plantain fortification. Similar results were observed when soybean was used to fortify Ofada rice by [8] and when soybean and plantain was used to fortified maize in weaning food formulation by [24]. Protein helps in building and maintaining all tissues in the body. It increases with increase in the addition of soy and plantain flour. The fat content ranges from 1.67 to 18.52%. The data obtained indicate a significant difference ( $p < 0.05$ ) between the two samples. The lowest fat content of 1.67% was recorded in sample A and the highest fat content of 18.52% was recorded in sample E. The ash content ranges from 1.37 to 2.26%. Significant difference ( $p < 0.05$ ) exist between the two samples. A high fat content is undesirable in food products. The ash content of samples E with a value of 2.26% and sample D was 1.77% higher than the remaining samples while sample B was the lowest with 1.37%. High ash content is due to the presence of minerals. The ash content of a food sample is an index of the mineral element of such food [25]. The result obtained gave an indication that the Tuwo produced from the composite flour are good source of minerals.

The crude fibre in Table 1 ranges from 0.68 to 6.78%. The lowest fiber content was obtained in sample A and the highest fiber content was in sample E. Crude fiber plays a vital role in controlling disease by exerting certain physiological functions. Dietary fibre has been shown to have a great impact on health of consumers. The presence of high dietary fibre in food products is essential owing to its ability to facilitate bowel movement and prevention of constipation thereby contributing to the health of gastro-intestinal and metabolic system in man [26]. Carbohydrate contents in samples ranges from 38.53 to 83.95%. The highest value was recorded in sample A while the lowest value was recorded in sample E. Because rice contains very high percentage of carbohydrates, this implies that the Soy and plantain flour blends are good supplements to cereal grains as source of energy. The results obtained for the mineral content analysis of the Tuwo rice fortified with soybeans and plantain flour are shown in Fig. 1. The results showed that the concentration of K, Ca, Mineral element concentrations showed that

Sample E recorded significantly difference ( $p < 0.05$ ) higher with comparable values for some of the mineral elements especially Phosphorus, Calcium, magnesium, zinc and Thiamine. This shows that addition of soybeans and plantain flour did significantly increase the mineral, so as the level of substitution increase with soybean and plantain flour, level of minerals increase in the formulated sample proportions, The result is in agreement with the findings of [16] who fortified Tuwo maize with cirina-forda flour blends.

The calcium ranges from 18.81 to 35.46mg/100g. The calcium level of sample E was higher with 35.46% and sample A was the lowest with 18.81% due to increase in the proportions of the blends. The blends show a higher content of calcium due to substitution at different levels. Calcium helps muscle relaxation and contract also important in nerve functioning [16]. The level of zinc ranges from 2.66 to 3.34 mg/100g. The zinc level in sample E and sample D were higher than sample A. The increase in zinc level, function in taste perception, wound healing and normal fetal development. The potassium ranges from 29.22 to 45.57mg/100g. There is an increase in the value with increase in fortification of Soy plantain flour. The values were higher than the values recorded from Morakinyo and Adegoke [27] who evaluated the mineral content of local foods in Nigeria like tuwo shinkafa was among the food samples. Potassium is needed for proper fluid balance, nerve transmission and muscle contraction. For Thiamine, it ranges from 0.95 to 1.21 mg/100g, the Thiamine content of sample E higher than the remaining samples while sample B was the lowest. Thiamine helps to form and maintain soft tissue, mucus membrane and skin. Magnesium ranges from 2.95 to 3.4mg/100g. The highest is in sample E with 3.4 mg/100g and the lowest is sample A 2.95 mg/100g. Magnesium is required for making protein, immune system health and muscle transmission [28].

The microbiological analysis of Tuwo rice fortified with soybean and plantain flour is presented in Fig 2. The number and types of microbes present in the food in order of examination reflect the quality of the food and extent of risk posed to the consumers. In this study, microbial counts increase from sample A to E, with increase in soy-plantain flour fortification. This might be due to the incorporation of soybean flour which is in

high in protein content and nutrient for the proliferation of the few microbes. Although the counts were low and does not exceed the acceptable limit of ready to eat of  $10^5$  cfu/g, This is in agreement with the findings of Falolu et al., 2013 [8] who fortified Ofada rice with soybean flour while Bolade et al [19] who evaluated the microbial loads of tuwo also found the bacterial content to be higher. Fig. 2. result revealed that the analysis of the Tuwo samples. The total viable count ranged from  $1.01 \times 10^2$  cfu/g to  $3.50 \times 10^2$  cfu/g. *Staphylococcus* count ranges from  $0.00 \times 10^2$  to  $1.03 \times 10^2$  cfu/g respectively, Fungi count of prepared tuwo indicated the least from  $0.00 \times 10^2$  to  $0.60 \times 10^2$  cfu/g respectively while there was no growth of Salmonella counts in all the samples, this confer the Tuwo samples does not contain food infection organisms. The microbes seen in the flour blends might be from the raw materials and during the processing. However, the high temperature at which the rice paste (Tuwo) will be subjected to during preparation is expected to destroy all microorganisms present. The sensory evaluation of the rice tuwo samples are presented in Fig. 3. In terms of the colour, sample B (70:15:15) had the highest mean score of 15.60% while the least mean score was recorded in sample D (60:20:20) with 10.0%. The result implies that sample C with mean value of 15.6% is the most preferred in colour by the judges. The taste analysis shows that Sample A (100% Rice Tuwo) had the highest mean score of 14.4% while the least was recorded in sample D (60:20:20) with 9.2%. The sense of taste provide to its ingestion and uptake into the body. The aroma of the prepared Tuwo shows that Sample A had the highest mean score of 14.40%. while the least mean score was recorded in sample D with 10.8%. The result indicates that Tuwo sample A is the most preferred in terms of aroma. Flavour is the main criteria that makes the product to be liked or disliked [29]. Also the Texture of samples A and sample B was higher while sample D was the lowest. The smoothness in the Table shows that the sample A and sample B were higher than the remaining samples while sample D was the lowest. The overall acceptability of the samples shows that sample samples A and B had the highest mean score. Among the fortified Tuwo samples, sample B (80:10:10) was the most acceptable sample. The result of the sensory evaluation of the cookies are similar to the finding of Falola et al. [8].

**Table 1. Proximate analysis of rice tuwo flour fortified with soy and plantain flour blends**

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
A	10.16 ± .07 <sup>a</sup>	1.37 ± 0.02 <sup>b</sup>	1.67 ± 0.01 <sup>a</sup>	2.19 ± 0.01 <sup>a</sup>	0.68 ± 0.02 <sup>a</sup>	83.95 ± 0.09 <sup>e</sup>
B	10.71 ± 0.07 <sup>b</sup>	0.92 ± 0.02 <sup>a</sup>	4.4 ± 0.01 <sup>b</sup>	9.7 ± 0.01 <sup>b</sup>	0.73 ± 0.02 <sup>a</sup>	73.56 ± 0.09 <sup>d</sup>
C	11.22 ± 0.01 <sup>c</sup>	1.62 ± 0.02 <sup>c</sup>	9.82 ± 0.01 <sup>c</sup>	15.06 ± 0.05 <sup>c</sup>	1.9 ± 0.04 <sup>b</sup>	60.39 ± 0.02 <sup>c</sup>
D	11.70 ± 0.04 <sup>d</sup>	1.77 ± 0.04 <sup>e</sup>	14.42 ± 0.13 <sup>d</sup>	17.95 ± 0.02 <sup>d</sup>	3.48 ± 0.02 <sup>c</sup>	50.72 ± 0.23 <sup>b</sup>
E	12.47 ± 0.08 <sup>e</sup>	2.26 ± 0.02 <sup>f</sup>	18.52 ± 0.13 <sup>e</sup>	21.46 ± 0.13 <sup>e</sup>	6.78 ± 0.16 <sup>d</sup>	38.53 ± 0.5 <sup>a</sup>

Values are mean, standard deviation of duplicate determination. Mean on the same column with different superscript are significantly different at  $p < 0.05$

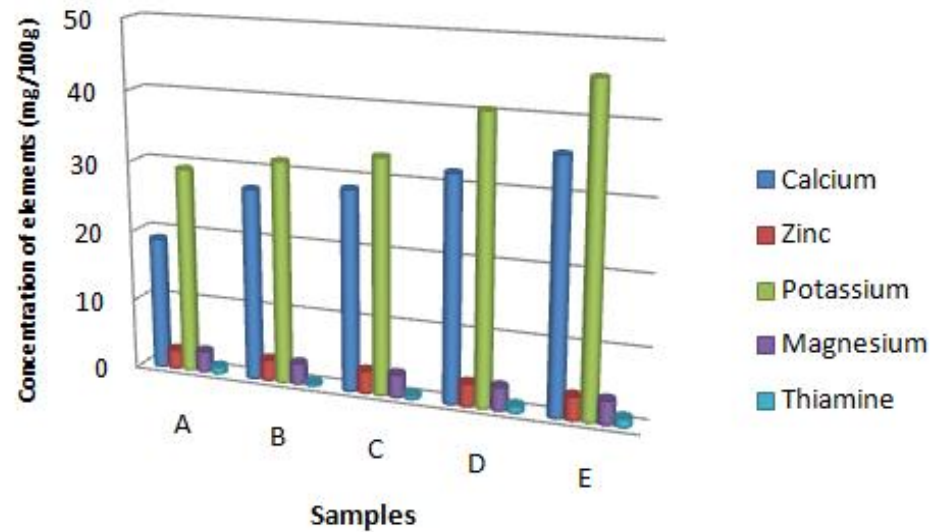
Key:

Sample A contains 100%rice flour, 0%soyflour and 0% plantain flour.

Sample B contains 80%rice flour, 10%soyflour and 10% plantain flour.

Sample C contains 70%rice flour, 15%soyflour and 15% plantain flour.

Sample D contains 60%rice flour, 20%soyflour and 20% plantain flour Sample E contains 50%rice flour, 25%soyflour and 25% plantain flour



**Fig. 1. Mineral analysis of rice tuwo flour fortified with soy and plantain flour blends**

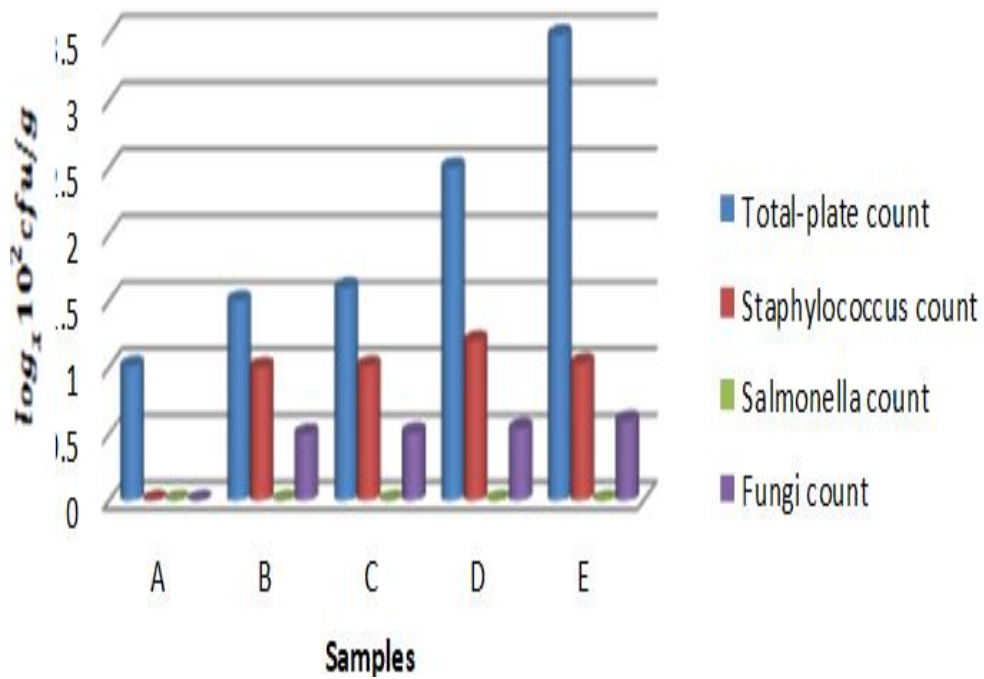


Fig. 2. Microbial count of rice tuwo flour fortified with soy and plantain flour blends

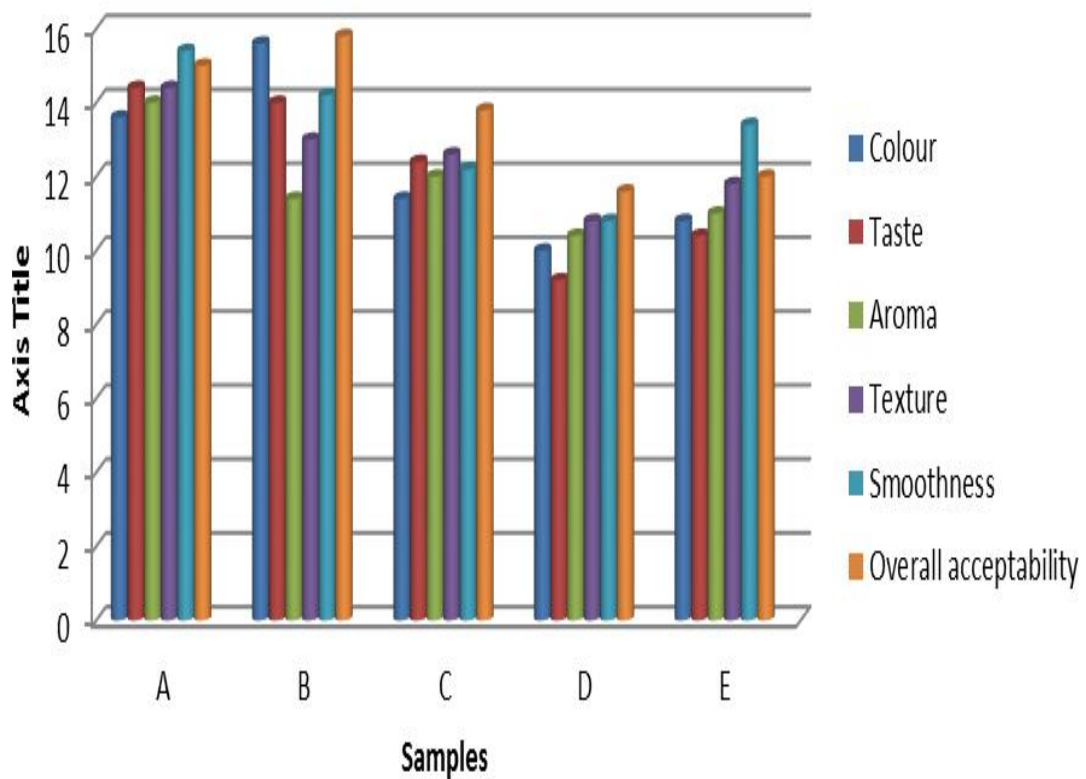


Fig. 3. Sensory evaluation of rice tuwo flour fortified with soy and plantain flour blends

#### 4. CONCLUSION

This study has shown that increasing the percentage of soy and plantain flour blends for production of rice tuwo improved the nutritional value but acceptability decreased when the blends increased above 10% substitution. The microbial analysis shows that the microbial count of the tuwo meal were lower and do not exceed the standard therefore it is safe for consumption. Hence incorporation of soy and plantain flour at 10% substitution in production of Tuwo should be encourage. The development of the composite flour can be incorporated into the diet to prevent protein energy malnutrition in the community.

#### DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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