Food Quality: A Comparison of the Proximate Content & Sensory Properties of Some Composite Flour Meals

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Authors’ contributions

This work was carried out in collaboration among all authors. Author EOO designed the study, performed the survey, wrote the protocol and wrote the first draft of the manuscript. Author PAE co-designed the study, made financial contributions and participated in the survey. Author WAF participated and edited the draft of the article. All the authors read and approved the final manuscript.

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ABSTRACT

Aims: To compare the proximate composition and sensory properties of some composite flour mix meals. This is to show which combination has higher nutritional value and is more palatable for consumption.

Study Design: Experimental and observational.

Place and Duration of Study: University of Calabar, Calabar - Nigeria. July to September, 2019.

Methodology: The samples were purchased from the market, washed, dried, and milled under proper sanitary conditions. The flours were then formulated by weight (1:1) and thoroughly milled together giving 3 composite flour mixes of guinea corn-millet, unripe plantain-cabbage and corn-cassava flour. These were made into meals (pastes) by boiling in hot water using standard procedures. Proximate analysis was carried using standard AOAC methods while the sensory evaluation was done by 20 semi-trained panelists using a 9-point hedonic scale. Statistical analyses of results were carried out using Statistical Package for Social Sciences and significance was accepted at p< 0.05.

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**Results:** Unripe plantain-cabbage flour mix had significantly higher content of protein, fat, ash, carbohydrate and consequently calories, while maize-cassava flour mix had the lowest content of fat and calories. The carbohydrate content of the 3 composite flours ranged from 24.23 to 27.45 KCal/100 g with guinea corn-millet flour mix having the least value. All 3 composite flour mixes were observed to be of good nutritional value.

**Conclusion:** Unripe plantain-cabbage flour mix and guinea corn-millet flour mix is recommended as a healthier alternative to excessively starchy swallows of low nutrient quality. Also, maize-cassava flour mix may be useful in the management of diabetes and obesity as it had lower caloric value and fat with good protein content and moderate carbohydrate. Generally, the 3 mixes had good acceptability, hence composite flour formulations made of indigenous foods should be encouraged since the combinations are not only palatable but of better nutrient quality than single flours.

**Keywords:** Composite; flours; proximate; cereals; meals; quality; sensory.

1. INTRODUCTION

Healthy foods/diets are essential for maintaining good health and preventing diseases. Recently, the increase in the incidence of many diet-related diseases such as diabetes, cancers, obesity and hypertension, worldwide has brought about a lot of research on the effect of various foods on the nutritional and health status of people. Excess consumption of high-carbohydrate and high-fat foods have been reported to be responsible for the increase in the incidence and prevalence of some of these diseases [1].

Some foods are considered healthy depending on their nutrient content while others are considered unhealthy [2]. Healthy diets (including adequate physical activity) are essential for maintaining good health and preventing diseases. Global industrialization has led to an increase in the consumption of excessively processed (unnatural) foods which are not so nutritious and can cause diseases when consumed frequently. This is due to the fact that people now spend a lot of time at work and many do not have enough time to search out and prepare nutritious foods at home, so they just grab whatever foods they can find in the course of the day. These excessively processed foods are usually high in sugar, fat and cholesterol content, hence when consumed in excess can cause hypercholesterolemia, a predisposing factor for cardiovascular diseases [3].

It is important that people, particularly adults, become aware of the health consequences of their food choices. This will make them better informed and enable them choose healthier diet alternatives that will at the same time boost their immunity to disease while supplying them with the necessary energy to do work. It is also important to inform people of healthier alternatives to certain foods and how to prepare them for maximum food quality. Dietary adjustments/modifications have also become quite popular and effective in the treatment and management of non-communicable diseases [1]. Proper nutrition education is also needed especially in rural or semi-urban areas in order to enlighten the people on how to maximise healthy foods available in their locality that will prevent disease and maintain health.

Food quality represents the sum of all properties and assessable attributes of a food item. Usually this is done by the three accepted categories of quality: sensoric value, suitability value and health value. All three deal with assessments, that is, judgments with a subjective component [4]. Several factors can affect food quality such as: microorganisms or spoilage from enzymatic and non-enzymatic activities, rancidity, browning and loss of nutrients. Food composition data (macronutrients, micronutrients and non-nutrient constituents) are essential as they are used in assessing the nutritional value of the food consumed and its effect on health and development [5]. Such data are also used for devising diets with specific (desirable) nutrient composition, in the formulation of ration scales and in the production of emergency food supplies.

Diet is largely determined by availability, processing and palatability of foods. A healthy diet includes preparation of foods and sensory characteristics of food such as taste, texture, aroma, and appearance influences food acceptability distinctly [6]. Food product quality and consumers’ desirability depends on its interaction with the sensory organs of humans. According to the Institute of Food Technologists
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(IFT) in Chicago, sensory evaluation is one scientific ways adopted to measure, analyze and interpret consumers’ responses to products as perceived using the senses of sight, hearing, touch, smell and taste [7,8].

This is a food quality study which seeks to comparatively evaluate the nutrient content and sensory properties of three composite flour meals. This will assess the quality of these formulations as alternatives to starchy meals and will encourage the use of indigenous foods in promoting healthy diets.

2. METHODOLOGY

2.1 Sample Collection and Preparation

Mature guinea corn, millet, unripe plantain and maize (corn) were purchased from Watt market, Calabar, while cabbage and Samvita cassava flour (which was authenticated by its nutrition label) were purchased from Spar Calabar mall, Cross River State, Nigeria and conveyed to the laboratory in a polythene bag for processing. The plants were identified and authenticated at the Department of Botany, University of Calabar, Calabar, Nigeria. The samples were rinsed with distilled water and air dried. Cabbage and unripe plantain was cut into pieces, oven dried at 55°C, cooled, blended, milled and stored in an airtight container for the analysis. The other samples were milled into flour after proper drying, then stored in separate bottles and labeled. These mixtures were formulated by weighing out equal portions of each flour (50%/50%) and milled to homogenize.

The composite flours were grouped into three:

I. Sample A: comprises guinea corn and millet flour mix
II. Sample B: comprises unripe plantain and cabbage flour mix
III. Sample C: comprises maize and cassava flour mix

2.2 Proximate Analysis of Composite Flour ‘pastes’

2.2.1 Determination of moisture content

Moisture content was determined by the gravimetric method described by AOAC [7]. 5 grams of the flour was weighed into a weighed moisture can. The can and its content were dried in the oven at 105°C for 3 hours in the first instance. It was cooled in a desiccator and reweighed. The weight was recorded while the sample was retained in the oven for further drying. The drying, cooling and weighing was continued repeatedly until a constant weight was obtained. The moisture content was calculated as shown below,

\[
\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100
\]

Where,

\( W_1 = \text{Weight of empty moisture can} \)
\( W_2 = \text{Weight of can sample before drying} \)
\( W_3 = \text{Weight of can sample after drying to a constant weight} \)

2.2.2 Determination of total ash

This was done using the incineration gravimetric method [7]. A measured weight (5 g) of sample was put in a previous weighed porcelain crucible. The sample in crucible was put in a muffle furnace and set at 550°C and allowed to burn for 2 - 3 hours (until the sample become a grey ash). The sample in crucible was carefully removed from the furnace and cooled in a desiccator. It was reweighed by difference, the weight of ash was obtained and in percentage. It was given by the formula,

\[
\% \text{ Ash} = \frac{W_2 - W_1}{W_0} \times 100
\]

Where:

\( W_1 = \text{Weight of crucible} \)
\( W_2 = \text{Weight of empty crucible + Ash} \)
\( W_0 = \text{Weight of sample used} \)

2.2.3 Determination of protein

This was determined by Kjeldahl digestion method described by AOAC [9]. The total nitrogen was determined and multiplied with the factor 6.25 to obtain the protein. About 0.5 g of the sample was mixed with 10 mls of concentrated sulphuric acid, in a Kjeldahl digestion flask. A tablet of selenium catalyst was added to it and the mixture was digested under a fume cupboard until a clear solution was obtained. The acid and other reagent were digested but without sample to form the blank control. All the digests were carefully transferred to a 100 ml volume flask using distilled water and
made up to a mark in the flask. A 100 ml portion of each digest was mixed with equal volume of 45% NaOH solution in Kjeldahl distilling unit. The mixture was distilled and the distillate collected into 10 ml of 4% boric acid solution containing three (3 drops mixed indicator cresol green and methyl red). A total of 50 ml distillate was obtained and titrated against 0.02N H$_2$SO$_4$ solution. The end point is from the initial green colour to a deep red point. The nitrogen content was calculated as shown below:

$$\% \text{N} = \left(100 \times \frac{N \times 14 \times v_f}{W - \text{Titrant} \times V_a}\right)$$

Where:

$W$= weight of sample analyzed  
$N$= Concentration of H$_2$SO$_4$ titrant  
$v_f$= total volume of digest  
$V_a$= Volume of digest distilled  
$T$= Titre value – Blank.  
$\% \text{Crude Protein} = N \times 6.25\%$

### 2.2.4 Determination of fat content

Fat content of the sample was determined by the continuous solvent extraction method using a soxhlet apparatus. The method was described by Pearson [10]. 0.5 g of the sample was wrapped in a porous paper (Whatman No.1 filter paper). The wrapped sample was put in a soxhlet reflux flask containing 200 ml of petroleum ether. The upper end of the reflux flask was connected to a condenser. By heating the solvent in the flask through electro thermal heater, it vaporizes and condensed into the reflux flask. The wrapped sample was completely immersed in the solvent and remained in contact with it until the flask filled up and siphoned over thus carrying oil extract from the sample down to the boiling flask. This process was allowed on repeatedly, for about 4 hours before the defatted sample was removed and reserved for crude fibre analysis. The solvent was recovered and the extracting flask with its oil content was dried in the oven at 60°C for 3 minutes to remove any residual solvent. After cooling in desiccators, the flask was reweighed.

By difference, the weight of fat (oil) extraction was determined and expressed as a percentage of the sample weight. It was calculated as:

$$\% \text{Fat} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where

$W_1$= weight of empty extraction flask  
$W_2$= weight of flask and oil extract

### 2.2.5 Determination of crude fibre

This was determined by the Wende method [11]. 5 g ($W_1$) of the sample was defatted (during fat analysis). After that, the sample was boiled in 200 ml of 1.25% H$_2$SO$_4$ solution under reflux for 30 minutes after that, the sample was washed with several portions of hot (boiling) water using a two – fold muslin cloth to trap the sample particle. The washed samples were carefully transferred quantitatively back to the flask and 20 ml of 1.25% NaOH solution was added to it again, the sample was boiled for 30 minutes and washed as before with hot water. Then they were very carefully transferred to a weighed porcelain crucible and dried in the oven at 105°C for 3 hours. After cooling in a desiccator, then reweighed ($W_2$) and then put in a muffle furnace and burn at 550°C for 2 hours until they become ash. Again, they were cooled in a desiccator and re-weighed. The crude fibre content was calculated gravimetrically as:

$$\% \text{Crude fibre} = \frac{W_2 - W_3}{W_1} \times 100$$

Where:

$W_1$= weight of crucible + sample  
$W_2$= weight of crucible + sample after washing and drying in oven  
$W_3$= weight of crucible + sample as ash

### 2.2.6 Determination of carbohydrate

The carbohydrate content was calculated by difference as the nitrogen free extractive (NFE), a method described by James [11]. The NFE was calculated by using the formula below:

$$\% \text{NFE} = 100 - (\% \text{MC} + \% \text{ASH} + \% \text{CF} + \% \text{EE} + \% \text{CP})$$

Where:

CF = Crude Fibre  
EE = Ether Extract  
CP = Crude protein  
MC=Moisture content

### 2.2.7 Energy/caloric value

The caloric value of the samples in kilocalories was obtained by multiplying the mean values of
protein, fat and carbohydrate by their respective Atwater factors (4, 9 and 4 respectively) and taking the sum of the product.

2.3 Sensory Evaluation

The method described by Iwe [12] was used for the sensory analysis after the flours has been stirred in boiling water to make ‘meals’ (pastes) that are usually swallowed along with indigenous soups. The organoleptic properties of the composite flour “meal” samples were tested by 20 semi-trained panelists, randomly selected from the staff and students of Michael Okpara University of Agriculture, Abia State, Nigeria.

All three composite flour meals/pastes were put on different coded dishes and served to the panelists. Water was provided for each panelist for mouth rinsing after testing each product to avoid carry over effect. Panel listing of attributes was carried out on three different days for each composite flour. Evaluation forms were designed with respect to some suitable attributes and presented to the panelists to record their sensory assessments for each evaluation session. Sensory quality attributes such as Appearance, Texture, Taste, Flavour, and General acceptability of the products were scored on a 9-point hedonic scale. The degree of likeness was expressed as follows: Like extremely 9, Like very much 8, Like moderately 7, Like slightly 6, Neither like nor dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike extremely 1.

2.4 Data Analysis

Each sample was analysed in triplicates and data expressed as Mean ± Standard error of mean. The data was analysed by one-way Analysis of Variance (ANOVA) with post hoc corrected two tailed t-tests using the SPSS statistic software version 22.0 (SPSS: Statistical Package for Social Sciences). Differences at P < 0.05 were considered significant.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate content of the three composite flour meals (pastes) namely: guinea corn and millet flour mix (GC-M flour mix), unripe plantain and cabbage flour mix (UP-C flour mix), maize and cassava flour mix (M-C flour mix) are shown in Table 1. The results show that the moisture content in the three food samples were significantly (p < 0.05) different, with M-C flour mix recorded the highest value (68.60 ± 0.09%), while UP-C flour mix recorded the lowest value (57.26 ± 0.01%). Of the 3 composite flours, UP-C flour mix had highest protein value (9.80 ± 0.03%), fat content (3.13 ± 0.01%), fibre (0.84 ± 0.03%) and total carbohydrate. Consequently, the UP-C flour mix also recorded significantly higher energy value (217.17 ± 0.41%) while M-C had the lowest caloric value (121.40 ± 0.51%). Generally, all the composite flours showed good content of all the essential nutrients with M-C flour mix having exceptionally lower content of fat (0.32 ± 0.02%).

All the three composite meals (pastes) were observed to have better nutritional value than the popularly consumed cassava meal (eba) which has a high starch content and less concentration of the essential nutrients as reported by Oko [13]. This suggests that these composite formulations could be good alternatives for ‘eba’ especially when managing certain diet-related diseases like diabetes and obesity. Considering the rich protein and carbohydrate content of especially the GC-M and UP-C mixes, these meals when incorporated into the diet could be useful in managing protein-energy malnutrition (PEM) in children, and could also improve the nutritional status of adults especially in many developing countries where there is a high incidence of PEM. Generally, the high moisture content of these flour mixes was due to the fact that they were analysed in their ‘pasty’ forms (i.e. constituted with hot water in the forms they are consumed). Moisture content analysis is one of most widely used measurements which determine the way the food will be processed and its shelf-life [14] and also had been used as a measure of stability and susceptibility to microbial contamination. High moisture content favours the development of contaminating microorganisms, whose growth and activities cause spoilage in foods [15]. This means that these composite meals have a very short shelf life before microbial spoilage sets in.

In the case of fibre content, a similar study by Awuchi [16] on grain flour composites reports slightly higher content of fibre in rice-wheat and soybean-wheat flour mixes than those of the mixes studied in this research. This could be due to difference in methodology as theirs was analysed as dry powdered flours not constituted pastes. However, the crude fibre values of the three composites mixes studied here are still
Table 1. Proximate composition of the composite flour meals (paste form)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture (%)</th>
<th>Dry matter (%)</th>
<th>Ash (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Fibre (%)</th>
<th>Carbohydrate (%)</th>
<th>Energy (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample A</td>
<td>65.80 ±0.01</td>
<td>34.20 ± 0.01</td>
<td>1.76 ±0.01</td>
<td>6.26 ±0.02</td>
<td>1.95 ±0.01</td>
<td>0.65 ±0.02</td>
<td>24.23 ±0.02</td>
<td>139.43± 0.25</td>
</tr>
<tr>
<td>Sample B</td>
<td>57.26 ±0.01*</td>
<td>42.74 ±0.01*</td>
<td>2.36 ±0.00*</td>
<td>9.80 ±0.03*</td>
<td>3.13 ±0.01*</td>
<td>0.84 ±0.03*</td>
<td>27.45 ±0.05*</td>
<td>217.17± 0.41*</td>
</tr>
<tr>
<td>Sample C</td>
<td>68.60 ± 0.09*</td>
<td>31.40 ±0.09*</td>
<td>1.45 ±0.00*</td>
<td>3.86 ±0.02*</td>
<td>0.32 ±0.02*</td>
<td>0.45 ±0.01*</td>
<td>25.77 ±0.13*</td>
<td>121.40 ±0.51*</td>
</tr>
</tbody>
</table>

Data were mean of three determinations (n=3) and reported as Mean ± SEM

* = significantly different from sample A at p<0.05
a = significantly different from sample B at p<0.05, Sample A = Guinea Corn-Millet flour mix (GC-M), Sample B= Unripe Plantain-Cabbage flour mix (UP-C), Sample C= Maize-Cassava flour mix (M-C)
Table 2. Sensory evaluation of the composite flour meals

<table>
<thead>
<tr>
<th>Samples</th>
<th>Colour</th>
<th>Texture</th>
<th>Taste</th>
<th>Aroma</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC-M flour mix</td>
<td>6.85 ± 0.08a</td>
<td>7.90 ± 0.07a</td>
<td>7.70 ± 0.05a</td>
<td>7.70 ± 0.06a</td>
<td>7.65 ± 0.07a</td>
</tr>
<tr>
<td>UP-C flour mix</td>
<td>6.40 ± 0.07a</td>
<td>8.00 ± 0.04a</td>
<td>7.80 ± 0.06a</td>
<td>7.20 ± 0.08b</td>
<td>7.80 ± 0.08a</td>
</tr>
<tr>
<td>M-C flour mix</td>
<td>6.50 ± 0.05a</td>
<td>8.10 ± 0.03a</td>
<td>7.80 ± 0.10a</td>
<td>7.85± 0.09a</td>
<td>7.85 ± 0.09a</td>
</tr>
</tbody>
</table>

Means having the same letter within column are not significantly different at p<0.05
Data were means of three determinations (n=3)

Fig. 1. Most frequently consumed snack by respondents

higher than the average value of 0.51% reported for refined wheat flour by Oppong [17]. Some level of crude fibre is lost during refining processes. Crude fibre reduces the rate of release of glucose into the blood stream and also reduces the intercolonic pressure, hence reducing the risks of colon cancer and diabetes [18]. Most of the nutrient values recorded in this study contribute large percentage of the required nutrient intake (RNI) for the various nutrients. Effective awareness of the health benefits of using nutritious alternatives and how to prepare them for maximum nutritional value, should be carried out.

3.2 Sensory Properties of the Composite Meals

Although significant differences were not observed in the different sensory attributes, increased general acceptability of M-C flour mix indicates its preference by the assessors to the other two composite flours. This may be due to the observed changes in the flour’s texture, taste and aroma by the assessors. All the three composite flour meals recorded good results for all the sensory parameters.

The acceptability of a product depends greatly on the different sensory attributes (colour, taste, smell, texture, and flavour). Texture is perceived through vision, hearing, touch, consistency, thickness, creaminess, crunchiness, firmness, fragility, chewiness and smoothness of the food [19] which strongly affects the quality, consumption and acceptability of different food types. The preferred colour of GC-M blend over the other composite flours can be attributed to the colour blends of both cereals. The grey colour from the millet reduced the intensity of the brown colour from the guinea corn, giving the composite flour a ‘tom-brown’-like colour. Colour characteristic is an important criterion that affects the quality of the final products [20].

An individuals’ appetite and crave ability arouses with the appearance of a meal which also affects its acceptance even before tasting the products [21]. Taste and flavour are also important in consumer’s acceptability. The similarities in taste
between the three composite flours can be attributed to the nature of the finished products (swallow) such that no distinct taste was observed in the prepared flours. Aroma was found observed to be slightly higher in the M-C and GC-M flour mixes, compared to UP-C blend. The reason for this variation may have been from the ripening of the corns. ‘Good’ aroma from food excites the taste buds, making the system ready to accept the product while ‘poor’ aroma may cause outright rejection of food before they are tasted. This phenomenon is expected because it has been reported that appearance of food evokes the initial response, however the flavor of food determines the ultimate final acceptance or rejection by the consumer [22]. All three composite blends were highly acceptable and recorded a good ‘taste’ rating which means consumers would enjoy these formulations when prepared as a meal (paste) for consumption with delicious indigenous soups.

4. CONCLUSION

The results from this study show that combining two or more flours to make a composite meal may be of better nutritional value than the commonly sold single processed flours or popularly consumed starchy foods like cassava flour ‘eba’ and yam flour ‘elubo’. The M-C flour mix was also most acceptable and recorded the lowest fat and energy value compared to the other two mixes. There is the need for enlightenment in the area of making healthy dietary choices from existing indigenous foods in order to achieve the necessary dietary adjustments that will help in keeping both adults and children energized, healthy and still reduce the risk of diseases such as obesity, diabetes mellitus, cancers and PEM. These three formulated blends are of good food quality from the results, hence their palatability and general acceptability should go a long way to promote their consumption.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

8. IFT (Institute of food Technologists). Sensory evaluation methods. The Society for the Food Technologists, Chicago, IL; 2007
12. Iwe MO. Handbook of sensory methods and analysis. PROJOIN Communications Services Ltd, Enugu. 2002;70-72.

15. Okafor GI, Ugwu FC. Production and evaluation of cold extruded and baked ready-to-eat snacks from blends of breadfruit (Treculia africana), cashew nut (Anacardium occidentale) and coconut (Cocos nucifera). Food Science Quality and Management. 2014;23:65-77.


