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# Nutrient Potential of Impoved Fresh Maize Moi-Moi Compared With Bean Mo-Moi

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## Abstract
The paper is on a comparative analysis of the nutrient potential of improved maize moi-moi and bean moi-moi. Samples of ordinary maize moi-moi, umproved maize moi-moi and bean moi-moi were prepared and tagged sample A, B and C respectively. The analysis done on the samples were for proximate, mineral and vitamin composition, determination of the presence of anti-nutrients (Oxalate and Trypsin Inhibitor), and sensory analysis. The statistical analyses used were mean, percentage, Analysis of Variance (ANOVA), standard deviation and least significant difference. The findings revealed that improved maize moi-moi (Sample B)'s ash, fibre and protein content improved over that of sample A (ordinary maize moi-moi) and approximate closely to that of sample C, (Bean moi-moi)). Vitamin C was not detected in any of the samples but Vitamin A detected increased from 1.15Ng/g in sample A to 2.67Ng/g in sample B and above 1.25Ng/g in sample C. Significant increase was also noticed in the mineral composition in sample B over sample A and C except for Potassium (K). Anti-nutrient (Oxalate) was not detected in sample B while Trypsin inhibitor was not detected in any of the samples conferring better nutrient availability on improved maize moi-moi. Results of sensory properties tested for were all in favour of sample B. Based on the findings, the paper concludes that improved maize moi-moi has very good organoleptic attributes, nutritive value and general acceptability. It was thus recommended that communities and home makers should adopt improved maize moi-moi as a substitute to bean moi-moi.

## Introduction

Food is one of the basic needs of life as shown by Maslow's hierarchy of needs. It is required for growth, maintenance of life and repairs of body tissues. That is to say that it is required for good health. Agreeing with this view Victora, Adair, Fall, Hallal, Martorell, Richter and Sachdev (2008) noted that hunger and malnutrition impire one's survival, cognitive function, physical capacity, resistance to disease and quality of life. Similarly, Micronutrient Initiative (2009) affirms that micronutrient deficiency undermines the growth and development, health and productivity of humans.

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The unfortunate situation however is as reported by Pinstrup-Andersen (2009) and collaborated by Godfrey, Crute, Haddad, Lawrence, Muir, Nisbett, Pretty, Robinson, Toulmin and Whiteley (2010) that one of the greatest global challenges is to secure adequate food that is healthy, safe and of high quality for all and to do so in an environmentally sustainable manner. This view calls for initiatives as to how to improve on the nutrient yield on commonly available food in a particular environment. This justifies this current study on improving the commonly available maize moi-moi.

Maize and corn-meal (ground dried maize) constitute a staple food in many regions of the world. It was introduced into Africa by the Portuguese in the 14$^{th}$ century and it has become Africa's most important staple food crop. The cereal, maize is used for a variety of food including moi-moi. Common knowledge about beans is that it is of higher food value when compared with maize as bean is often considered as proteinous food. It is for this reason that improved maize moi-moi is compared with beans moi-moi in terms of nutrient yield in this study.

The main property of food that confers on it to perform the function of maintaining health and safety of life is its ability to yield nutrients. It follows thus that the value of food is dependent on the type and quality of nutrient it yields when consumed. To guarantee the availability of nutrients in diets, diets are planned and varieties introduced. It is with this background that this study focuses on improving on maize moi-moi and determining the types and quality of nutrients yield as compared with bean moi-moi.

**Methods and Materials**

The materials used in this study were beans moi-moi prepared from common beans (*Phaseolus vulgaris*), maize moi-moi prepared from fresh yellow maize (*zea mays*) and improved maize moi-moi prepared using fresh yellow maize, egg, fish and moringa leaves.

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The samples were prepared as follows;

**Sample A: Maize moi-moi**

Fresh maize was de-husked and the grain gently removed from the cob into a container. Fresh pepper and onion were added and blended to paste of rough texture. Salt and oil were added, mixed properly and water added to loosen the paste. The paste was measured into medium sized nylon bags and tied to avoid spilling of the paste. The sachets were put into boiling water and boiled for 30 – 40 minutes. They were then removed from the water and allowed to cool for 10 – 20 minutes and were ready to be served.

**Sample B: Improved Maize moi-moi**

The process of preparing improved maize moi-moi is similar to that of the ordinary maize moi-moi described in the preparation of sample A except that, moringa leaves, egg and fish particles or crayfish were added and mixed properly before bagging them for boiling.

**Sample C: Beans moi-moi**

Three milk cups of common beans was measured and soaked in water for five minutes and then washed to remove the seed coat. With the seed coat removed, it is removed from that water and soaked in fresh water for 30 – 45 minutes and then removed out of the water. Onion and fresh pepper were added and then blended to smooth paste. Oil, pepper and salt were added to paste and mixed properly. Water was then added to loosen the paste. The paste was scooped into a medium sized nylon bag and tied to avoid spill. Each sachet was put into boiling water and steam for 30 minutes and then removed from the water. They are allowed to cool for 10 – 20 minutes and was ready to be served.

**Analysis of Sample**

Proximate composition, mineral composition, vitamins and anti-nutrient and sensory analysis of the samples were done. Proximate composition analysis entailing; protein, moisture, total ash, crude fibre, fat and carbohydrate contents were done by subtraction. Minerals analyzed for were; Potassium (K), Sodium (Na), Magnesium (Mg) and Phosphorus (P). Vitamins analyzed for were; Vitamin A and Vitamin C(Ascorbic Acid). Anti-nutrients analysis for Phytate, Oxalate and Trypsin inhibitor were also done

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## Proximate Composition Analysis

### Determination of Crude Protein Content

Determination of Crude Protein procedure by the Association of Official Analytical Chemist, AOAC (2000) was adopted for use.

A few glass beads (anti-bumps) were placed in a clean dried 100ml kjeldahl digestion flask containing 8g $CuSO_4$-$Na_2SO_4$ VI – disodium tetraoxosulphate IV, respectively. 2g of each sample were weighed and transferred into the macro kjeldahl flask and 25ml of concentrated tetraoxosulphate IV acid ($H_2SO_4$) was added and gently stirred until no particles of the sample adhered to the bottom of the digestion flask. The digestion flask was placed in a heater in fume cupboard titled to $40^0$c. Heat was applied gently until the initial frothing ceased followed by strong heating to clear the solution into light blue-green colour. Heating was continued for another one hour making the total digestion time to be about two hours. The digested sample was allowed to cool to $40^0$c and 100ml distilled water was added. The sample was then warmed to dissolve the soluble materials and then quantitatively transferred into 250ml volumetric flask and topped to the mark. A blank determination using 2g of sucrose in place of sample was carried out in duplicate for each of the samples. 5ml of the digested sample was pipetted into the distillation units and 7ml of sodium hydroxide (NaOH) solution was added. The unit was closed and ammonia ($NH_3$) gas evolved was steamed distilled into 5ml boric acid indicator mixture. About 10ml of the distillate was collected and titrated with 0.1m0idm3 hydrochloric acid (HCL) until the green colour change to purple. This procedure was repeated for all the three samples.

### Crude Fat Content

Crude fat content determination procedure by the Association of Official Analytical Chemists, AOAC (1984) was used for the study.

Two grams (2g) of each of the samples were weighed and dried in a hot air oven and the dried weight used for calculation. The weighed samples were placed in extracting

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thimbles and covered with cotton wool placed in the extraction arm of the extractor. 150ml of diethyl ether was added in the extractor arm. The reflux was filled and the tap turned on. The heater was set at $70^0$c. Fat was extracted for 5 hours. The solvent was vaporized into the extractor arm after removing the extracted sample. The solvent was recovered into the recovery flask. The extract flask was cooled in desiccators and reweighed.

**Crude Fibre Content**

Determination of Crude Fibre procedure by the Association of Official Analytical Chemists, AOAC (2002) was uThree grams (3g) of each sample were weighed. The oil in each sample was extracted with petroleum spirit (diethyl ether) by stirring, setting and decanting three times. The extracted samples were oven dried and transferred to 100ml beakers with 1.25% $H_2SO_4$. The beakers were placed in digestion apparatus with pre-adjusted hot plate and boiled for extra 30 minutes. It was allowed to stand for one minute and filtered immediately through Buckner's funnel with breaking suction pressure. The resulting residue was washed with boiling water until it was free of acid. It was digested with alkali using NaOH, the same procedure for acid was followed. The residue was washed successively with boiling water until it was free of acids. After this, it was washed twice with ethanol and 3 times with ether. The resulting residue was dried at $130^0c^{\pm}1^0c$ for 2 hours and cooled in desiccators and weighed. The dried, cooled and weighed residue was transferred into a muffle furnace and ignited at $600^0c^{\pm}100c$ for 30 minutes, cooled and the residue re-weighed.

**Moisture Content**

Determination of Moisture Content procedure by the Association of Official Analytical Chemists, AOAC (2000) was used

Five grams (5g) of each sample were weighed in duplicates into petric dishes of known weights and covered immediately. These were put into the oven, uncovered and dried to fairly constant mass at $150^0c^{\pm}2^0c$ for 3 hours. The samples were then put into desiccators and reweighed soon after reaching room temperature.

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### Ash Content

Determination of Ash content procedure by the Association of Official Analytical Chemists, AOAC (2000) was used.

Five grams (5) of each sample were weighed in triplicates into crucibles (ashing dishes) that had been previously weighed and their masses recorded. The dishes were placed in muffle furnace and ignited at $55^0$c for 5 hours, cooled and reweighed to fairly constant weight. The difference in weight between the fresh and dry samples was noted.

### Carbohydrate Content

Carbohydrate determination involved the use of results obtained from values of moisture, protein, fats, fibre and ash content.

### Vitamin A Content

Determination of Vitamin A Content procedure by the Association of Official Analytical Chemists, AOAC (1990) was used.

Three grams (3g) of each sample was weighed, homogenized and saponified with ethanolic KOH (an antioxidant) for 30 minutes. The sample was transferred to separator funnel, water was added then extracted with 1-1.5 volume of hexane, extraction was repeated and extract was combined and washed repeatedly with equal volume of water. It was filtered through a paper containing 5g anhydrous $Na_2SO_4$ into a volumetric flask, the filter was rinsed hexane. Standard curve using USP vitamin A reference standard dilution was prepared yielding A620 value ranging from 0.07 to 0.7 was plotted against $\mu g$ vitamin A. 1ml of chloroform was added plus a measured amount of $SbCL_3$ solution. Hexane was evaporated from sample and standard solutions by placing the sample into a Calometric with adjustment to 100% T. 1ml of chloroform was added followed by an amount of $SbCL_3$ solution equal to that added to the standard blank and reading was taken immediately. The calculation was done using the following formula;

$\mu g$ vitamin A/g =A620 x SL x (v/wt)

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Where A620 = corrected absorbance at 620nm, which is equal to A440 – CF (correction factor for carotenoids).

SL = slope of standard curve (vitamin A concentration/A620 reading).

V = final volume in calorimeter tube

Wt = sample weight (g)

**Vitamin C Content**

Determination of vitamin C Content procedure by Onwuka (2005) was used

2g of each sample was measured and dissolved in 100ml glacial acetic acid then thoroughly mixed and filtered. Indophenol solution was titrated against the sample until a faint pink colour that persists for 15sec occurred. The concentration was expressed as mg ascorbic acid equivalent to 1ml of dye solution.

**Determination of Mineral Content**

Determination of minerals using dry ash Procedure as put forward by the Association of Official Analytical Chemists,AOAC (2000) was used.

The sample was finely grinded after drying to approximately $80^0$c for 12 hours, 1g of the sample was weighed into a silica then ash in a muffle furnace at 475-$500^0$c for 2-4 hours then cooled and dissolved in 5ml of 20% HCl warming it to effect complete dissolution of the residue. The solution was filtered through an acid washed filter paper into 50ml volumetric flask washed filter paper with hot water and distilled to volume after cooling with distilled water.

**Anti-Nutrient Determination**

The soluble and total oxalate concentration in the samples was determined by titrimetric method while Trypsin inhibitor in the test samples was determined by the calorimetric method as used by Sjoberg and Alanko (1994).

**Sensory Analysis**

The products were presented for sensory evaluation as adopted by Rao, Syed and Rusvi (1989). With this method, a 10 member panelists was selected. They were provided with water to rinse their mouth after each test and score card evaluation were given to them to

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rate the samples in a five point hedonic scale on the basis of colour, consistency and flavour of the products, where 1 represented dislike very much, 2 dislike much, 3 like nor dislike, 4 like much and 5 like very much.

The panelists used were untrained but experienced panelist consisting the staff and students of the Department of Food, Nutrition and Home Sciences in the laboratory of Kogi State University, Anyigba, in Kogi State of Nigeria.

**Statistical Analysis**

The method of statistical analysis described by Larmond, and adopted by Evans, Omoaruenike and Mohammed (2013) was used. The data generated were subjected to various statistical analyses, using means, analysis of variance (ANOVA), standard deviation, percentage and least significant difference (LSD) to compare and separate the means.

**Results**

The results of analysis of the three samples (A, B and C) were presented in tables

**Table1: Proximate Content of Maize Moi-moi, Improved Maize Moi-moi and Beans Moi-moi**

| Sample | Moisture % | Ash % | Fibre % | Fat % | Protein % | Carbohydrate % |
|---|---|---|---|---|---|---|
| A | 38.00 | 3.00 | 4.60 | 11.00 | 14.88 | 28.52 |
| B | 46.20 | 3.50 | 5.00 | 10.20 | 17.81 | 17.09 |
| C | 55.40 | 2.50 | 2.80 | 4.80 | 20.50 | 11.50 |

The result shows that sample A (Maize moi-moi) had 38.00% moisture content, 3.00% ash, 4.60% fibre, 11.00% fat, 14.88% protein and 28.52% carbohydrate. when improved

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in sample B had 46.40% moisture content, 3.50% ash, 5.00% fibre, 10.20% fat, 17.81% protein and 17.09% carbohydrate while sample C (Beans moi-moi) had 55.40% moisture, 2.50% ash, 2.80% fibre, 4.80% fat, 20.50% protein and 11.50% carbohydrate.

In comparing result obtained from the analysis of sample B and that of sample C; sample C has higher moisture content (55.40%) than sample B (46.40%).This is most likely due to the high moisture content of beans as compared to maize. The high ash, fibre and fat content of the sample B over that of sample C is due to the improvement made in sample B, and of course, texture, roughages and oil content in maize is naturally higher than beans.

The high protein content of sample C (20.50%) over that of sample B (17.81%) is of natural occurrence as beans is naturally endowed with high proteins content. It is however noteworthy that the protein content of sample B improved from 14.88% as seen in sample A to 17.81% due to the improvement made on sample A. It thus follows that though maize naturally is of low protein content, it can be improved upon to improve the nutrient potential. The was also a decrease in carbohydrate content from 28.52% in sample A to 17.09% in sample B due to the improvement made on sample B. while the low carbohydrate content in sample C is due to the fact that bean is naturally of low carbohydrate content as compared to maize (sample A and B) as sources for sample preparations.

The overall proximate analysis of samples A, B and C when compared to that of Frank-Peterside, Dosumu, and Njoku, (2002) in proximate analysis of African yam beans which gave a result of 40.8% carbohydrate, 18.4% crude protein, 7.1% ash, 8.3% crude fibre, 25.4% crude fat and 20% moisture content is higher in all parameters compared to that of sample, A, B and C.

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**Table 2: Vitamin Constituents of Samples**

| Sample | Vit A (Ng/g) | Vit C (Ng/g) |
|---|---|---|
| A | 1.15 | ND |
| B | 2.67 | ND |
| C | 1.25 | ND |

*ND = Not detected*

Vitamin A is highest in sample B (improved maize moi-moi) 2.67 Ng/g followed by sample C (Beans moi-moi) 1.25 Ng/g indicating that maize is naturally endowed with higher vitamin A than beans. Vitamin C was not detected in all the samples showing that beans and maize naturally lack vitamin C.

**Table 3: Mineral Constituents of Samples**

| SAMPLE CODE | Mg (ppm) | K (ppm) | Fe (ppm) | Ca (ppm) | P (ppm) |
|---|---|---|---|---|---|
| A | 8.00 | 98.20 | 10.02 | 12.10 | 6.10 |
| B | 18.60 | 50.25 | 15.25 | 19.10 | 8.00 |
| C | 9.20 | 102.14 | 11.67 | 15.25 | 6.98 |

The magnesium content in sample B is higher than that of sample C followed by that of sample A; having values 18.60(PPM), 9.20(PPM), and 8.00 (PPM) respectively.

With Potassium content higher in sample C and sample A than in sample B, it indicates that the improvement made to sample B reduced its potassium content with increase in Iron (15.25 ppm), calcium (19.10 ppm) and phosphorus (8.00 ppm) against a lesser value in sample C (Fe 11.67, Ca 15.25 and P 6.98) and sample (A Fe 10.02, Ca 12.10, and P 6.10).

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**Table 4: Anti-Nutrient Composition**

| Sample | Oxalate mg/g | Trypsin inhibitor mg/g |
|---|---|---|
| A | 0.0012 | ND |
| B | ND | ND |
| C | 0.0014 | ND |

ND = Not Detected

The oxalate content of sample A (maize moi-moi), 0.0012 mg/g is lower than that of sample C (Beans moi-moi) 0.0014 and was not detected in improved maize moi-moi (Sample B).

The presence of the anti-nutrients in sample A(0.012) and in sample C (0.014) indicates that derivable nutrients in the samples were limited as anti-nutrients are known to limit nutrient availability when consumed (Musa and Agbadoyi, (2012). This confers advantage on improved maize moi-moi.

**Table 5: Sensory Properties of Samples**

| SAMPLE | TASTE | MOUTH FEEL | FLAVOUR | COLOUR | OVERALL ACCEPTABILITY |
|---|---|---|---|---|---|
| A | $1.5 \pm .527$ | $1.6 \pm .699$ | $1.8 \pm .421$ | $1.6 \pm .516$ | $1.9 \pm .567$ |
| B | $2.5 \pm .527$ | $3.2 \pm .788$ | $2.6 \pm .516$ | $3.0 \pm .471$ | $3.0 \pm .471$ |
| C | $1.9 \pm .737$ | $2.1 \pm .567$ | $2.1 \pm .567$ | $2.0 \pm .827$ | $2.2 \pm .739$ |

*Mean +SD*

Means with the same letter along vertical column are not significantly different ($p<0.05$)

**Taste Parameter**

Sample B $(2.5 \pm .527)$ has the highest rating followed by sample C $(1.9 \pm .737)$ and then sample A $(1.5 \pm .527)$.

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**Mouth Feel Parameter**
Sample B had the highest rating followed by sample C and A having values of $3.2 \pm .788$, $2.1 \pm .567$ and $1.6 \pm .699$ respectively.

**Flavour Parameter**
With flavour as parameter, sample B had the highest rating with values of $2.6 \pm .516$, followed by sample C $2.1 \pm .567$ and sample A had the lowest rating of $1.8 \pm .421$

**Colour Parameter**
Sample B had the highest rating with values of $3.0 \pm .471$, followed by sample C with values of $2.0 \pm .827$ and sample A had the lowest rating ($1.6 \pm .516$).

**Overall Acceptability**
Sample A had the overall acceptability value, followed by the sample C and sample A was rated lowest based on overall acceptability; with samples having values of $1.9 \pm .567$, $3.0 \pm .471$, $2.2 \pm .739$ respectively.

All parameters used as measures of the sensory evaluation were high in sample B than in other samples due to different factors but majorly because of the improvement made on the sample. The overall acceptability which is a function of basically both colour and flavour, indicates that sample B would generally be accepted and preferred by the community.

## Conclusion and Recommendation

### Conclusion

The nutritive value of maize moi-moi is dependent on the level of improvement on it. Using the locally available resources to diversify and enhance overall acceptability of the maize moi-moi consumption in African society generally and particularly in Nigeria would enhance its acceptability. Since the preparation of moi-moi is commonly by the use of beans as major source there seem to be a mental rejection of maize moi-moi and few people desiring its' consumption. With the result and discovery made in this work, the issue of monopoly of bean moi-moi can be solved using improved maize moi-moi as a substitute. This will create new taste and desire for moi-moi consumption and nutrient utilization. The absence of anti-nutrients in improved maize moi-moi is also a strong factor in favour of it.

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## Recommendation

The improved maize moi-moi has a very good organoleptic attributes, nutritive value and general acceptability. Therefore it is strongly recommended that communities and homemakers should use available resources to improve maize moi-moi so as to diversify and maximize high nutrient value for the home and individual family members most especially as the cost of beans is usually higher than that of maize. The use of improved maize moi-moi is therefore recommended as a cheaper alternative to beans moi-moi.

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