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# Proximate, Functional and Sensory Analysis of Powdered Meal Fortified with Soybean and Finger Millet at Different Substitutional Levels

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## Abstract

*The proximate, functional, and sensory properties of corn meal supplemented with finger millet and soya bean at different substitutional levels were investigated using standard analytical methods. Cornmeal flour obtained from fermented maize was supplemented with finger millet and soya bean flours in the ratio 100:0, 90:5:5, 80:10:10,70:15:15 and 60:20:20 coded as samples EAE, BAB, CAR AEA and DAB for easy identification respectively. Results showed that the protein contents of the corn meal increased significantly (P<0.05) with increased supplementation from 4.51% in sample EAE to 16.41% in sample DAB and a corresponding increase in ash and fat contents. The functional properties of the flour blends revealed significant improvements (P<0.05) with an increase in the levels of supplementation as the oil absorption capacity, water absorption capacity and bulk density increased significantly, with no increase in swelling capacity. Sensory qualities attributes showed samples DAB and EAE have the highest preference in terms of colours, aroma and overall acceptability. Therefore, supplementation of cornmeal with finger millet and soya bean (legumes) can be a way of improving the nutritional, functional and sensory characteristics of the products.*

**Keywords**: Cornmeal, Fortification, Proximate, Functional, Sensory

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## Introduction

Cereal-primarily based food product area units are strictly energy dense and incomplete in terms of the biological process profile of proteins. Legumes/cereal combos in food products once mixed along with complement alternative} to provide of higher quality by providing every other important quantity of the respecting limiting amino acids (Balasubramanian and Cole, 2002) Food fortification and enrichment is outlined per Codex Alimentarius Commission because the addition of small nutrients to food whether or not or not they're ordinarily contained within the food for the aim of preventing or correcting an incontestable deficiency. Enrichment of food is applicable once the natural content of some small nutrients is ordinarily accessible within the food area unit by design enlarged whereas fortification is reserved for the addition of small nutrients to a food that doesn't contain the compounds naturally. (Dary & Mora, 2012).

Maize and maize merchandise are for human consumption in developing Countries whereas, within the developed world, it's in the main used for industrial functions and animal feed. The mean chemical composition of maize contains ten.3% protein, 60.50% Starch, 1.2% Sugar, twenty-fifth crude fibre and alternative Substances (Addo-Quaye et al; 2011) one of the principal ways in which victimisation maize is by chemical action into Ogi (a cereal porridge that's typically used as complementary food). In African countries, it's referred to as Akamu in ethnos, Ogi in Yoruba and Koko in Hausa. It's an extract of wet soluble supermolecule (starch extract) from cereal grains with poor storage stability thanks to its high wet level (Obinna-Echemet al; 2014)

The supermolecule contents of legume beans (Glycine max) are comparatively low however high in proteins and contain a variety of health-promoting compounds (Anders 2013). Soya bean contains high macromolecule content and has been used extensively owing to its glorious profile of extremely edible amino acids. The macromolecule contents of legume bean oil account for regarding an hour of the dry beans by weight (protein at four-hundredth and oil at 20%) the rest consists of thirty-fifth supermolecule and regarding five-hitter ash, legume bean consists of roughly V-E Day seed coats or hull, ninetieth cataphyll and2% hypocotyl axis or germ (Anders 2013)

Finger millet, a member of the millet cluster is additionally referred to as ragee or tamba (Jideani, 2012) and is thus known because of its growth from panicles that takes the shape of many fingers (Soods et al; 2017). though a protein-free grain with a low glycemic index with the organic process and nutraceutical blessings, the grains contain a high quantity of atomic number 20 which is an important macro nutrient necessary for growth in kids, pregnant ladies and therefore the senior.

It's additionally been rumoured to be made in necessary amino acids like essential amino acid, tryptophane and essential amino acid (Jideani, 2012)

## Materials and Methods

**Source of Materials:**

The maize (Yellow variety), soya beans and finger millets were sourced from the Polytechnic farm; The Federal Polytechnic, Ilaro Ogun State. Nigeria. All reagents and chemicals used were of analytical grade.

**Preparation of Fermented Maize and Finger Millet Flour**

The method represented by Emeka-Ike et al (2013) was used. every portion of the grains was ready by the standard wet edge method. The grains were sorted, washed and steeped in decent potable water at a temperature of seventy-two hours. The water for steeping was modified daily, drained on the third day then wet polished victimization disc attrition mill. The wet polished suspension/ porridge was sieved victimization fabric material and therefore the slurry allowed to settle over would possibly with the supernatant decanted. The wet cake was recovered by compression of excess water with fabric material and dried in an exceeding cupboard appliance at 50oC for eight hours. The dried meal was allowed to chill, polished into flour victimization hammer meal and so sieved. Individual soured finger miller flour was packed in high-density plastic wrap luggage and held on in an exceedingly cool dry place till required for product formulation.

Dry Maize grains
↓
Sorting and Washing
↓
Steeping (72 hours)
↓
Draining
↓
Fermented grain
↓
Milling using disc attrition mill
↓
Wet Sieving
↓
Sedimentation
↓
Decanting the supernatant
↓
Squeezing using cheese cloth/. Muslin cloth
↓
Drying using (Cabinet Dryer at 50°C for 8 hours
↓
Dry Milling using Hammer Mill
↓
Sieving
↓
Fermented Maize flour

**Fig 1:** Flow Chart for the Production of Fermented Maize Flour. Emeka- Ike *et al.*, (2013)

Dry Finger Millet grains
↓
Sorting and Washing
↓
Steeping (72 hours)
↓
Draining
↓
Fermented grain
↓
Wet milling using Disc attrition mill
↓
Wet Sieving
↓
Sedimentation
↓
Decanting the supernatant
↓
Squeezing using cheese/. Muslin cloth
↓
Drying using (Cabinet Dryer at 50°C for 8 hours
↓
Milling using Hammer Mill
↓
Sieving
↓
Fermented finger millet flour

**Fig 2:** Flow Chart for the Production of Fermented Finger Millet Flour. Emeka-Ike *et al.*, (2013)

**Preparation of Soya beans flour.**

The legume bean seeds were thoroughly cleaned by choosing stones and alternative foreign particles. The grains were then steeped in clean potable water at 30+ 20C for twelve hours, washed with clean water, and cooked for one hour at 1000C victimisation the strategy represented by Badau *et al*., (2006). The burned legume bean seed was allowed to cool down and also the husk was separated by rubbing them between the 2 palms while debilitating them at the same time. They were then dried at $55^{o}C$ for twelve hours victimisation cupboard appliance. The seed was polished when cooling and hold on in airtight plastic containers for additional process and analytical works.

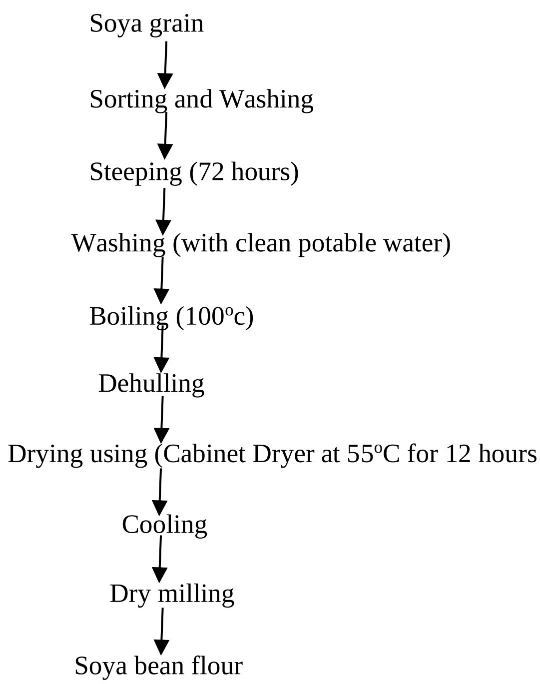


**Fig 3:** Flow Chart for the Production of Soya bean Flour. Badau *et al.,* (2006)

**Recipe Formulations**

The fermented maize flour was supplemented with fermented finger millet flour and soya bean flour at different levels 100:0:0; 90:5:5; 80:10:10; 70:15:15 and 60:20:20 coded as EAE, BAB AEA, CAB and DAB respectively as shown in Table 1.

**Table 1: Formulations of Corn Meal Substituted with Finger Millet and Soya Bean Flour**

| | EAE | BAB | AEA | CAB | DAB |
|---|---|---|---|---|---|
| MF(g) | 100 | 90 | 80 | 70 | 60 |
| FMF | 0 | 5 | 10 | 15 | 20 |
| SF(g) | 0 | 5 | 10 | 15 | 20 |

MF = Corn flour, FMF= Finger millet Flour, SF = Soya bean Flour

**Analytical Procedures**

**Proximate Composition:**

The proximate composition of fortified corn meal was determined according to the official method of analysis described by the Association of Official Analytical Chemists (AOAC, 2005). Energy value was determined by the method of Atwater and Snell (Cited in Foss 2003) This was done by multiplying the values obtained for protein, carbohydrate and fat by the factors of 4,4 and 9 kcal per gram respectively

**Function Properties**

**Water absorption capacity:** The water absorption capability that was evaluated because the weight of the water absorbed by one (1) gram of the sample was conducted victimisation the strategy delineated by Ojinaka et al. (2013). One (1) g of the sample was weighed and placed into a weighed tube. 10ml of H2O was supplementary to the tube and mixed completely. The mixture was then allowed to square for a half-hour at temperature, then centrifuged at 3500 revolutions per minute for a half-hour during a centrifuge. The supernatant was decanted and therefore the residue within the tube was inverted over AN absorbent paper (tissue pad). it had been allowed to empty utterly before the tube and its content control by the flour was measured: This was expressed because of the volume of water controlled by flour per gram of flour.

$$\text{Water Absorption Capacity} = \frac{\text{weight water absorbed (ml)}}{\text{Weight of flour (g)}}$$

**Bulk density:** This was done using the method described by Ojinnaka et al., (2013). 10g of each flour sample was measured into a clean 100 ml graduated measuring cylinder. It was tapped repeatedly on a padded table until a constant volume of flour was obtained. This was expressed as the weight of flour per its constant volume.

$$\text{Bulk density} = \frac{\text{Weight of flour (g)}}{\text{Weight of company volume of flour (cm3)}}$$

**Swelling Capacity**: The swelling capability was evaluated by mistreatment of one (l) g of flour sample. 30ml of $H_2O$ was adscititious into a 50ml Centrifugal tube containing the sample and mixed gently. The suspension shape was heated in a water bathtub at 95oC for half-hour and later centrifuged at 3500rpm for 10 minutes. The supernatant was decanted and also the weight of the paste was taken and expressed as the weight of the paste per weight of flour (Adepeju et al., 2014.)

$$\text{Swelling capacity} = \frac{\text{weight of paste (g)}}{\text{Weight of flour (g)}}$$

**Oil Absorption Capacity**: The oil absorption capability was verified victimisation the tactic delineated by Adebowale et al., (2007). 10ml of sunflower-seed oil was supplementary to 1g of every sample. Samples were stirred for five minutes and allowed to face for thirty minutes at temperature. The suspension was centrifuged within the same condition as in water absorption capability. OAC was obtained because of the distinction between the initial volume of sunflower-seed oil supplementary to the sample and also the volume of supernatant

**Preparation and Sensory Evaluation of Corn Meal Fortified with finger millet and Soybean flour.**

Badau et al., (2005) was used for the preparation of corn meal. The porridge made from the flour blends was ready by constituting 40g every in 50 ml of fresh water and was introduced into 150 ml boiling water to offer 20%(w/v) concentration. it had been then heated for one minute and perpetually stirred. The method represented by (Badau et al; 2005) was used for this purpose. Forty-five style panellists drawn from students of the Food Technology Department and polytechnic institute Community were used for the sensory analysis. The panellists were served the ready samples in white clear plastic cups and spoons. The containers with the samples were coded to avoid the state of affairs and permit freelance judgment. Participants were reminded to rinse their mouths with contemporary water between samples. A 9-point hedonistic scale was wont to rank the gruels on style, mouth feel, colour, aroma and overall acceptableness, that square measure expressed as 9-like extraordinarily, 8-like noticeably, 7- like moderately,6- like slightly, 5- neither like or dislike, 4- dislike slightly, 3- dislike moderately, 2- dislike noticeably, 1- dislike extraordinarily.

**Statistical Analysis**

Data generated were subjected to analysis of variance (ANOVA) using SPSS Statistical Version 2,6. Means were separated using Duncan Multiple Range Test (DMRT) at a 5% confidence level.

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## RESULTS AND DISCUSSION

### Results

**Table 2: Proximate Composition of Cornmeal Substituted with Finger Millet and Soybean Flours**

| Sample | Moisture % | Crude Fiber % | Ash Content % | Fat Content % | Protein Content % | Carbohydrate % | Energy (Cal/100g) |
|---|---|---|---|---|---|---|---|
| EAE | $3.90^{a} \pm 0.14$ | $0.61^{a} \pm 0.02$ | $0.13^{a} \pm 0.04$ | $5.60^{b} \pm 0.01$ | $4.51^{a} \pm 0.01$ | $85.39^{e} \pm 0.01$ | $407.06^{e} \pm 0.01$ |
| BAB | $5.46^{c} \pm 0.01$ | $1.03^{b} \pm 0.01$ | $0.28^{b} \pm 0.01$ | $4.29^{a} \pm 0.01$ | $10.22^{c} \pm 0.01$ | $78.72^{d} \pm 0.01$ | $375.25^{c} \pm 0.01$ |
| AEA | $6.53^{d} \pm 0.01$ | $1.17^{c} \pm 0.01$ | $0.49^{c} \pm 0.01$ | $5.95^{c} \pm 0.01$ | $13.12^{d} \pm 0.01$ | $72.73^{b} \pm 0.01$ | $370.64^{b} \pm 0.01$ |
| CAB | $4.23^{b} \pm 0.01$ | $1.19^{e} \pm 0.01$ | $0.69^{d} \pm 0.01$ | $6.50^{d} \pm 0.01$ | $9.60^{d} \pm 0.01$ | $77.79^{c} \pm 0.01$ | $386.54^{d} \pm 0.01$ |
| DAB | $5.45^{d} \pm 0.01$ | $1.83^{d} \pm 0.01$ | $1.09^{e} \pm 0.01$ | $7.51^{e} \pm 0.01$ | $16.41^{e} \pm 0.01$ | $67.73^{a} \pm 0.01$ | $360.23^{a} \pm 0.01$ |

**Table 3: Selected Functional Properties of Corn Meal Fortified with Finger Fillets and Soybean Flour**

| Sample | Bulk density g/cm3 | Swelling Power (g) | Oil absorption (g/g) | Water absorption m/g |
|---|---|---|---|---|
| EAE | 0.66$^{c}$ ±0.14 | 15.99$^{a}$ ±0.01 | 92.00$^{a}$ ±0.01 | 199.22$^{a}$ ±0.01 |
| BAB | 0.64$^{a}$ ±0.00 | 15.99$^{a}$ ±0.02 | 137.01$^{b}$ ±0.01 | 299.00$^{b}$ ±0.01 |
| AEA | 0.66$^{c}$ ±0.00 | 15.99$^{a}$ ±0.01 | 140.00$^{c}$ ±0.01 | 299.01$^{c}$ ±0.01 |
| CAB | 0.65$^{b}$ ±0.00 | 17.99$^{b}$ ±0.01 | 146.99$^{b}$ ±0.01 | 199.22$^{a}$ ±0.01 |
| DAB | 0.68$^{e}$ ±0.00 | 15.99$^{s}$ ±0.01 | 149.01$^{d}$ ±0.01 | 279.00$^{b}$ ±0.01 |

**Table 4: Sensory Properties of Corn Meal Fortified with Fingers Millet and Soybean Flours**

| Sample | Colour | Taste | Aroma | Mouth feel | Overall Acceptability |
|---|---|---|---|---|---|
| EAE | 7.75$^{a}$ ±0.97 | 7.35$^{a}$ ±1.23 | 7.65$^{b}$ ±1.04 | 6.95$^{a}$ ±1.05 | 7.55$^{a}$ ±1.00 |
| BAB | 7.55$^{a}$ ±1.00 | 7.75$^{a}$ ±0.89 | 7.45$^{ab}$ ±0.83 | 7.30$^{a}$ ±1.45 | 7.20$^{a}$ ±1.24 |
| AEA | 7.25$^{a}$ ±1.07 | 7.20$^{a}$ ±0.95 | 6.85$^{a}$ ±1.18 | 7.15$^{a}$ ±1.14 | 7.35$^{a}$ ±1.14 |
| CAB | 7.30$^{a}$ ±1.13 | 7.75$^{a}$ ±1.07 | 7.30$^{ab}$ ±1.03 | 7.20$^{a}$ ±1.11 | 7.60$^{a}$ ±1.14 |
| DAB | 7.60$^{a}$ ±0.94 | 7.35$^{a}$ ±1.09 | 7.20$^{ab}$ ±1.11 | 7.00$^{a}$ ±1.17 | 7.80$^{a}$ ±0.83 |

## Discussion

Table 2 showed the proximate composition of corn meal fortified with finger millet and soybean flours at different substitutional levels. The moisture content ranged from 3.90 to 6.53% revealing significant differences (P<0.05) among the sample. Sample EAE (control with the addition of fingers millet and 10% soybean flour) had the least value of 3.90% while AEA (80 %corn flour, 10% finger millet flour and 10% soybean flour) had the highest value of 6.53%. The moisture contents of the samples were within the acceptable level of not more than 10% for long-term storage. Moisture content would prevent the growth of mould and reduce moisture-dependent biochemical reactions (Onimawo & Akubor, 2012). The crude fibre varied from 0.61 to 1.83%. It was observed that there was an increase in fibre content as the level of substitution with finger millet and soybean flour increased. The increase can be related to the complementation of finger millet flour which has high fibre content (Saleh et al., 2013) and soybean flour (Ikya et al., 2013). Fibre plays a role in the utilization of nitrogen and the absorption of another micronutrient. Ash is an indication of the availability of mineral composition in food materials. (Nnamani et al., 2009). It varied from 0.13 to 1.09%, indicating significant differences among samples. The observed increase in ash contents could be due to finger millet soybean flour supplementation which is in agreement with previous work reported by Ikya et al (2013). Fat contents obtained in the result revealed significant differences (P<0.05) among the samples evaluated. It ranged from 4.29 to 7.51%. The increase in fat content as the level of substitution increases could be a result of an increase in the oil-bearing seeds in the blends. Protein contents varied from 4.51 to 16.41% for the samples. The highest protein content of 16.41% was obtained for sample DAB (sample containing 20% finger millet and 20% soybean flour) while sample EAE (100% maize flour) had the least value of 4.51%. This result also showed a significant difference (P<0.05) and agrees with a similar work by Patience et al., (2017). The increase in protein content as the substitution increase could be ascribed to the soybean which is very high in protein. Carbohydrate content of 85.3%, 78.72%, 72.73, 77.79% and 67.73 were obtained for samples EAE, BAB, AEA, CAB, and DAB (100% maize flour, 90%. 5:5, 80:10:10,70,15,15,60,20:20 Maize flour; Finger millet flour; Soybean flour. It was generally observed that there was a decrease in the carbohydrate contents of the sample as the level of supplementation with both finger millet and soybean flour increases revealing significant differences (P<0.05) among the sample. The inclusion of finger millet and soybean flour has led to a decrease in the amount of carbohydrate content of the samples (Ikya et al, 2013). The caloric value (energy value) showed that as the supplementation increases, the energy value decreases. The high energy value in sample EAE (control) could be attributed to the breakdown of carbohydrates (starch) which predominates in maize to supplement sugars leading to the increase in calories.

The result of the selected functional properties of meals produced by fermented maize flour, finger millet flour and soya bean flour are shown in table 3. The functional properties evaluated are water absorption capacity, bulk density, swelling power, and oil absorption capacity. Bulk density varied from 0.64g/cm$^3$ to 0.68g/cm$^3$ for samples under consideration. This result is similar to a previous work on complementary food produced from ofada rice blended with bambara groundnut by Adebayo et al (2011), where bulk density ranged from 0.63 to 0.69g/cm$^3$. Swelling Capacities of 15.99g, 15.99g, 15.99g, 17.99g and 15.99 g were obtained for the samples. Higher and lower values were also recorded in previous work by Asima et al., (2006). Oil Absorption Capacity varied from 92.00g/g to 149.01g/g for the samples. There was a gradual increase in oil absorption capacity as the level of substitution with finger millet and soybeans flour increased and oil absorption capacity is an important (vital) functional property of flour because it enhances mouth feel while preserving the flavour of food products. Okache *et al.*, (2020) earlier reported that the low oil absorption capacity observed in EAE (control) could be due to the presence of a hydrophilic group from the fermented maize flour. Water Absorption Capacity ranged from 199.22 to 299.01m/g. Osundanusi et al., (2003) reported that higher water absorption capacity is desirable in the food system to improve the yield and consistency of such food products.

Table 4 showed the sensory properties of commercially fortified with finger millet and soya bean flours. Sample EAE (control) had the highest mean value of 7.75 while sample AEA (80:10:10; corn flour finger millet: Soya bean flour) has a value of 7.25. However, there are no significant differences (Pv0.05) among samples, but the control sample was most preferred because people are familiar with the colour since they are regularly consumed. In terms of taste, sample CAB with a 30% level of inclusion of both finger millet and soya bean flour had the highest taste quality value of 7.75 with sample AEA (20% inclusion of finger millet and soya bean flour having the least value of 7.20. Also, there are no significant differences (P>0.05) among the samples evaluated. Taste is a code given to different foods by the sensorial palate when the food is ingested into the mouth (Okache *et al*., 2020). According to Okache *et al*., (2020), the aroma is a fundamental sensory attribute which refers to the sensation in the nostrils as a result of rinsing food or drinks with volatile compounds. The values ranged from 7.20 to 7.65, with control (EAE) having the highest value and DAB (40 % inclusion of finger millet and soya bean flours) with the least value. The highest value obtained in the control is due to fermentation since it helps to improve the flavour and aroma of foods. There are no significant differences in the mouth feel of all the samples (P<0.05) while the panellist preferred sample DAB (40% finger millet and soya bean flour with a mean value of 7.80.

## Conclusion

This work has vividly shown that improvement occurred in terms of nutrients in the proximate composition of corn meal supplemented with finger millet and soya bean flours. The functional properties also improved in oil and water absorption capacities while the sensory attributes (mouth feel, taste and overall acceptability revealed that supplementation is possible in the overall quality characteristic of Ogi Gruel.

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