IMPACTS OF INSTANT BREAKFAST MEAL OF DIFFERENT RATIO FROM AFRICAN WALNUT AND FERMENTED MAIZE FLOUR FOR MALNURISHED CHILDREN

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Abstract
This work aimed at formulating and evaluating the impact of different African walnut and fermented maize flour ratio on the nutritional and sensory properties of the breakfast meal. African walnut and maize grains (Zea mays) were processed separately into flour and formulated into blends containing 25 to 45% African walnuts. The blends were evaluated for proximate, mineral contents, phytochemical screening, microbial loads and sensory properties using standard methods. Results of proximate composition were protein (13.0%-15.5%), fat (12.2%-14.0%), ash (0.90%-1.13%), crude fibre (1.23-1.40%), carbohydrate (60.6%-65.1%) and energy (413.9-425 Kcal/100g). The mineral contents obtained were lesser than that of control sample (cerelac). Phytochemical results revealed low polyphenols (6.5-7.1 mg/100g). The total viable bacterial count was 1.2×10^4 Cfg/g in blend B & C with 25% and 30% level of supplementation with walnut respectively. The trend in mould and yeast population was similar ranging from 0.03×10^4 to 0.08×10^4. The sensory scores results showed that blend C was the most preferred with the highest score of (6.5). This was followed closely by blend B (6.5), blend D (6.2), blend E (5.9). The study has shown that an acceptable nutrient-dense breakfast meal that is highly digestible can be made from African walnut for children, adult and elderly consumption.

Keywords: African walnut, sensory evaluation, proximate, phytochemical, malnutrition

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1. INTRODUCTION

The development of high-protein foods of plant origin is essential in developing countries because of the shortage and high cost of animal protein. Consumption of such products plays a major role in combating malnutrition, which is a serious problem in these countries. Various plant protein sources may be combined to obtain products with improved protein quality. Maize constitutes about 90% of cereals consumed in southern Nigeria (Aminigo and Akingbala, 2004). The grain is often processed into a fermented product known as *ogi*. A number of studies have been carried out to improve the nutritive value of *ogi* and develop a cereal based complementary foods.
Complementary foods are also known as weaning foods that can be fed into infants which are being weaned from the breast. Complementary foods were censored by WHO/FAO (2003) to contain the necessary nutritional requirements, and standards which supplies the essential nutrients required for adequate growth and preventing diseases in children and young adult. In this study, maize grain, walnut and turmeric were used for production of complementary food for older infants and young children.
Several researchers have reported that *Ogi* can be fortified with different varieties of under-utilized legumes such as okra seed, bambara seed and African yam beans (Akinwande *et al*, 2016). Adebayo *et al*, 2012 worked on production and quality evaluation of complementary food formulated from fermented sorghum, walnut and ginger. It was discovered that the use of 1g of ginger can actually purge infants and children because their reproductive system is not strong enough to process some spices and foods. Ojo and Enujiugha also worked on physico-chemical ,

chemical, and acceptability of Instant 'ogi' from blends of fermented maize, conophor nut and melon. It was reviewed that addition of melon to African walnut thereby increases the fat content of the formulated blend and reduces it shelf life and therefore go rancid very fast. And based on these limitations, African walnut could be explore to improve the nutritional composition of fermented maize flour (*ogi)* for wider appeal. A breakfast meal that is digestible could be developed from African walnut and fermented maize flour particularly for children and elderly people who have problem of digestibility.

African walnuts are largely underutilized in developing countries like Nigeria with high wastage in the farm due to short shelf life of the nut. Despite the economic importance of conophor nut, no commercial production and industrial utilization of the crop takes place in Nigeria. Based on this, complementary food can be developed from walnut and fermented maize flour for infants, children and elderly people. Natural spices such as ginger and turmeric are good antioxidants that prevent lipid oxidation in food product and extend its shelf life. These could be added to the formulated breakfast meal. Other intermediate products like milk could be added also to the breakfast meal from African walnut and fermented maize flour. The objective of this study was therefore to develop an instant breakfast meal of different ratio from African-walnut and fermented maize flour for wider appeal. The researcher also intends to evaluate the impact of different African walnut and fermented maize ratio on the nutrient and sensory properties of the complementary food.

2. MATERIALS AND METHODS

Materials

African walnut and maize grain (suwan 1) and turmeric were purchased from a local market in Ibadan, Oyo State, Nigeria

Methods

Flour preparation:

Fermented maize flour ("Ogi" flour) was produced according to Akingbala *et al.*, (2006) by soaking maize grains in water for 72 h. The steeping water was decanted and the softened kernel / maize were wet milled and sieved to remove the germs and hulls. The "ogi" slurry was allowed to ferment naturally in clean plastic bucket anaerobically for 48-72 h and the excess water was squeezed out to give *Ogi* cake. The cake was dried in hot air oven at 60 ^{o}C for 12 h and dry milled to produce *Ogi* flour which was packaged in clean polyethylene bag.

African walnut flour was produced according to the method of Adebayo *et al.,* (2012). The nuts was sorted, and washed to remove adhering contaminants and then cooked for 30 min in sulphited water to the removal of the shell and then soaked in 0.2% potassium metabisulfite for 5mins to facilitate the deshelling process. The deshelled walnut was size reduced with a stainless steel kitchen knife to increase surface area and then soaked to remove the bitter taste for 30 mins and also blanched by adding into boiling water and allowed standing for 5 mins before draining. The blanched walnut was dried in hot air oven at 60 ^{o}C for 5 h and ground to produce walnut flour. Then walnut flour will be packaged in clean polyethylene bag. Turmeric powder was produced according to the method of Adebayo *et al*, (2012). The turmeric roots were washed in sterile water after peeling and then dried in air oven at 50 $^{\mathbf{o}}$C 5h and ground to powder and sieved using 0.25 mm mesh screen and finally packaged.

Food formulation

The food samples were formulated with reference to FAO/WHO (2003) standards for infant/ children protein-energy requirement (10-15 g/ day). Different samples were prepared by combining 74.5%, 69.5%, 64.5%59.5% and 54.5% fermented maize flour, 25%, 30%, 35%, 40% and 45% African walnut flour with a constant 0.5% of Turmeric powder (Table 1). The flours were then made into porridges.

Sensory evaluation:

The sensory attributes were evaluated on the complementary food for color, flavour, appearance, mouth feel, taste and overall acceptability using 9-point hedonic scale, where 1- dislike extremely and 9-like extremely. All the formulated blends were made separately into gruels (20% w/v) by making a smooth cold paste and gradually pouring same into boiling water. This was stirred vigorously until the entire mass became viscous. One (1) teaspoon of sugar was added to each sample to taste and serving to a panel of 50 judges consisting of staff and students of the University who were very familiar with the porridge. The data obtained were subjected to appropriate statistical analysis.

Determination of proximate composition

Crude protein, moisture, fat and crude fibre content were evaluated using method of A.O.A.C (2004). Energy was determined according to the method of Mahgoub (1999) using the formula as shown below, while carbohydrate was calculated by difference.

Total energy (kcal/100g) = [(% available carbohydrates × 4) + (% protein × 4) + (% fat × 9)].

Determination of phytochemical and mineral contents

The phytochemical screening was done on the sample using methods as described by AOAC, (2013). The dried sample was homogenized and alkaloid was extracted from 10g of the sample for 4 hours using 20% v/v acetic acid in ethanol. The extract was filtered to remove cellulose debris and then concentrated to about one quarter of the original volume. One percent NH_4OH was added drop wise until a precipitate occurred. The crude alkaloid was dried to constant weight in an oven and the percentage alkaloid calculated. Mineral contents were determined using the spectrophotometer.

Microbiological examination

Total plate count:

About 1ml aliquot portion of each sample was aseptically withdrawn after serial dilution into sterilized plates already containing acidified potatoes dextrose agar using Pour Plate method. The plates were inverted after setting and incubated at 30^{o}C for 48 hours (A.O.A.C, 2004). Colonies was counted using Stuart Scientific Colony Counter. All counts were done in duplicates.

Total fungi count:

About 1ml aliquot portion of the sample was aseptically withdrawn after serial dilution into sterilized plates already containing acidified potatoes dextrose agar using the pour plate method. The plates were inverted after setting and incubated at 30^{o}C for 48 hours (A.OAC, 2004). Colonies were counted using Stuart Scientific Colony Counter. All counts were done in duplicates.

Total coliform count:

About 1ml aliquot portion of the sample was aseptically withdrawn after serial dilution into sterilized plates already containing mackonkey agar using pour plate method. The plates were inverted after setting and incubated at 30^{o}C for 48 hours (A.OAC, 2004).Colonies were counted using Stuart Scientific Colony Counter. All counts were done in duplicates.

Table 1: Formulations of African-walnut based complementary food.

Blends	Fermented Maize flour	Walnut flavour	Turmeric
A	100	-	-
B	74.5	25	0.5
C	69.5	30	0.5
D	64.5	35	0.5
E	59.5	40	0.5
F	54.5	45	0.5

KEY:
A(FMF:WF:T, 100:0 :0), B(FMF:WF:T,74.5:25:0.5), C(FMF:WF:T,69.5:30 :0.5)
D(FMF:WF:T, 64.5:35:0.5), E(FMF:WF:T,59.5:40:0.5),
F(FMF:WF:T 54.5:45 :0.5)
N:B :FMF-Fermented maize flour, WF- Walnut flour, T-Turmeric.

3. RESULTS AND DISCUSSION

Chemical composition of the formulated food

The results of the proximate composition are presented in Table 2. The values obtained for ogi flour and African walnut flour were similar to the results reported for ogi flour by Adejuyitan *et al.*, (2012) and African walnut flour by Edem *et al.*, (2009). It was recorded that the protein content of the preferred blends increased with an increasing proportion of walnut flour ranging from 13.0%-15.5%.The findings showed that the protein and energy-density of the formulated complementary food were higher than those of the traditional complementary food (ogi) and comparable to a commercial formula (cerelac). This could be due to high protein content present in African walnut used for producing the complementary food. Carbohydrate content decreased with the addition of walnut flour. This was in agreement with the findings of Adebayo et al., (2012) who reported a decrease in carbohydrate content with increase in soybean flour fortification. The fat content of blend B (12.2%) and blend C (14.0%) were significantly higher when compared with those of cerelac and *ogi* flour. This is could be as a result of high fatty acids present in African walnut. Ash content of the formulated blends ranged from 0.90% to 1.13%. These values are similar to the value reported from the production of legumes-fortified weaning food (Eounlety, 2002). The ash content of obtained higher than that of ogi and lower than that of cerelac. The fiber content decreases as the African walnut flour proportion decreases with blend C (1.74%) having higher value than blend B (1.23%) and *ogi* flour. The energy level of blend C (421.3 Kcal) was higher than that of bend B (413.9 Kcal) and there were significant differences in the energy values of the formulated food and the control - cerelac (P<0.05).

The above findings revealed that energy values of the formulated food samples were higher than the minimum desirable level (400 Kcal/100g) for infant and children complementary food as recommended by FAO/WHO (2003). The lower moisture content observed for the formulated blends (9.6%) is a good indicator for their potential to have longer shelf life. This is in line with the findings of Adebayo *et al*, (2012). It is believe that materials such as flour and starch containing more than 12 % moisture have less storage stability than those with lower moisture content. For this reason, a water content of 10 % is generally specified for flours and other related products.

Table 2: Proximate Composition of African walnut flour, fermented maize flour (ogi), cerelac and the most preferred formulated complementary food

Parameters	African walnut flour	Fermented maize flour	Blend B	Blend C	*Nestle Cerelac
Moisture (%)	9.1±0.02	9.6±0.01	9.6±0.01	9.9±0.01	5.0±0.05
Protein (%)	30.2±0.01	1.6±0.01	13.0±0.01	15.5±0.01	15.0±0.01
Fat (%)	16.9±0.02	0.8±0.01	12.2±0.02	14.2±0.01	9.0±0.02
Ash (%)	3.8±0.01	0.7±0.00	1.13±0.03	0.90±0.01	2.60±0.01
Crude Fibre (%)	2.7±0.02	0.3±0.00	1.23±0.02	1.74±0.01	2.95±0.01
Carbohydrate (%)	37.5±0.02	87.1±0.01	65.1±0.02	60.6±0.01	67.95±0.01
Energy (Kcal / 100g)	422.3±0.03	361.5±0.03	413.9±0.05	60.6±0.01	413.0±0.01

Mean of triplicate determination, significant at level (P<0.05)
N.B: FAO/WHO (2003): Protein: 10-15%; fat: 10-25%; fibre: 5.0 max; energy: 400Kcal/100g; carbohydrate: 55-75%.

Table 3: Some mineral contents of African walnut flour, fermented maize flour (ogi), cerelac and the most preferred formulated complementary food.

Minerals (mg / 100 g)	African walnut flour	Blend B	Blend C	Nestle Cerelac
Fe^{2+}	8.3±0.02	3.5±0.01	4.1±0.01	10.0
Ca^{2+}	277.±0.05	139±0.02	151±0.01	420.0
Mg^{2+}	25±0.01	12±0.01	15±0.01	NA
Na^{2+}	348±0.02	164±0.02	171±0.01	NA
K^{+}	44±0.02	22±0.01	29±0.02	700.0

Mean of triplicate determination, significant at level ($P<0.05$).
NA- means not available.
KEY:
B (FMF:WF:T, 74.5:25:0.5), C(FMF:WF:T, 69.5:30:0.5)
CC (Commercial Complementary food-cerelac)

Table 3 showed the mineral elements of African walnut flour and the formulated blends. They contain rich source of minerals which are essential for body maintenance. Fe^{2+} (8.3 mg/100g), Ca^{2+} (277 mg / 100 g), Mg^{2+} (25 mg / 100 g), Na^{+} (348 / 100 g), K^{+} (44 mg / 100 g) were present in African walnut flour, whereas the most preferred blend C contains Fe^{2+} (4.31 mg / 100 g), Ca^{2+} (151 mg / 100 g), Mg^{2+} (15 mg /100 g), Na^{+} (171 / 100 g), K^{+} (29 mg / 100 g). Meanwhile the results obtained from African walnut flour and the most preferred blend C is lower than that of cerelac. This may be due to fortification of cerelac (a commercial complementary food) with adequate amount of minerals (Ca^{2+}: 420 mg / 100g, Na^{+}: 220 mg / 100g, K^{+}: 700 mg / 100 g).

Table 4 showed the phyto-chemical properties of the complementary foods, compared with ogi and African walnut flour. African walnut flour had higher tannin and saponin (57.0 mg, 280 mg), followed by blend C (28.2mg, & 288.0 mg), blend B (24.4 mg, & 275.0 mg) while ogi flour had the lowest (13.0 mg & 3.7 mg respectively. The low level of anti-nutritional factors found in the most preferred blends justified the choice of raw materials and efficiency in processing operation. This is especially evident when compared with some of those option reviewed by (Enujiugba, 2006) for weaning food in tropical climate. Phytic acids in cereal based food inhibit iron absorption and low iron absorption from cereal contributes to high prevalence of iron deficiency in infant in the developing countries (Enujiugba 2006). The polyphenol found in the formulated blends was small but biologically desirable as antioxidant.

Table 4: Some Phytochemical contents of African walnut flour, fermented maize flour (ogi), cerelac and the most preferred formulated complementary food.

Constituent	African walnut flour	Fermented Maize Flour	Blend B	Blend C
Tannins	57.0±0.05	13.0±0.03	24.4±0.02	28.2±0.02
Saponins	280±0.05	3.7±0.02	275±0.01	288.0±0.01
Flavonoids	145±0.00	9.17±0.01	75.3±0.01	81.7±0.01
Polyphenols (GEA/100)	12.3±0.05	6.5±0.01	6.5±0.01	7.1±0.01

N:B. Mean of triplicate determination , significant at level ($P<0.05$).

Peroxide value was carried out on the formulated blends to determine rancidity value of the blends during storage. Peroxide value obtained in the formulated diet was 1.5 meq O_2 /kg after eight weeks of storage. This indicated that the food has not gone rancid because the value obtained is within standard specification (20 meq O_2/kg).

Microbial load of the complementary food

Data on the microbiological properties of the formulated complementary diet were presented in Table 5. This analysis was carried out to ascertain the safety of the product for consumption. The microbial loads detected in the samples were within standard specifications. The total viable bacterial count was 1.2×10^4 Cfg/g in blend B & C with 25% and 30% level of supplementation with walnut respectively. The trend in mould and yeast population was similar ranging from 0.03×10^4 to 0.08×10^4. This could be probably due to the antioxidant effect of spice-turmeric (Adebayo *et al*, 2012).

Sensory evaluation of the formulated

The acceptability parameters measured are Taste, appearance, colour, aroma, mouth feel and overall acceptability. Table 6 below shows the result. The results showed that blend C was the most preferred with the highest score of (6.5) and protein content of (15.5%). This was followed closely by blend B (6.5), blend D (6.2), blend E (5.9) in that order. Sensory analysis results showed that the complementary food had highest value in term of color and generally acceptable by the panelists. While the result of control samples (ogi & cerelac) in term of aroma, taste and mouth feel were slightly higher when compared with the formulated blends.

Table 5: Evaluation of microbial load of the complementary food

Sample	Total Viable count (Cf/u/g)	Yeast count × 10^4 (Cfu/g)	Mould count × 10^4 (Cfu/g)
B	1.2×10^4	0.08×10^4	0.08×10^4
C	1.2×10^4	0.04×10^4	0.08×10^4
Ogi	1.1× 104	0.03×10^4	0.06×10^4
Cerelac	Nil	Nil	Nil

Table 6: Sensory attributes of formulated blends compared with a commercial Complementary food (cerelac) and "ogi".

Blends	Colour	Aroma	Taste	Appearance	Mouthfeel	Overall acceptability
A	6.4^b	7.5^a	7.3^a	7.5^a	7.5^a	7.6^a
B	7.9^a	6.4^b	6.3^b	6.5^b	6.7^b	6.5
C	7.9^a	6.3^b	6.3^b	6.5^b	6.5^b	6.5^b
D	7.8^a	6.2^{bc}	6.2^{bc}	6.3^{bc}	6.3^c	6.2^{cd}
E	7.8^a	6.0^c	6.0^c	6.2^c	5.9^d	5.9^d
F	7.7^a	5.7^d	5.5^d	6.0^d	5.4^e	5.5^e
*CC	6.0^c	6.3^b	6.5^{ab}	6.0^d	7.0^{ab}	7.5^{ab}

KEY:
A (FMF:WF:T, 100:0:0), B (FMF:WF:T, 74.5:25:0.5), C (FMF:WF:T, 69.5:30:0.5)
D (FMF:WF:T, 64.5:35:0.5) E (FMF:WF:T, 59.5:40:0.5), F (FMF:WF:T, 54.5:45:0.5)
*CC (Commercial complementary food-cerelac)
FMF-Fermented maize flour, WF- Walnut flour, T-Turmeric

Statistical Analysis: Data generated were subjected to analysis of variance (ANOVA) using SPSS and treatment means that are significantly different were compared using the Duncan's multiple range test to separate the means with the aid of System Analysis System (SAS).

4. CONCLUSION

The study has shown that an acceptable nutrient-dense complementary food can be made from African walnut. The 30% of African walnut substitution was the most preferred and acceptable blend followed by blend B (containing 15% and 13% protein respectively). The formulated meal can serve as breakfast meal for children and elderly people who have problem of digestibility because the breakfast meal from African walnut and fermented maize flour is digestible. The Formulated African walnut based complementary food can therefore be considered suitable for preventing proteins-energy malnutrition in children and provide essential nutrients to the adults.

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