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Chemical evaluation of processed maize (*Zea mays*), indeginous cowpea spp. (*Vigna unguiculata*) and melon seed (*Citrullus vulgaris*) and organoleptic attributes of their blends

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The thrust of this work was to evaluate the chemical composition of processed maize, cowpea and melon; and assess the sensory attributes of their blends. The proximate, iron, zinc, tannins and phytate composition of the processed samples were assessed using standard assay methods. Blends were formulated using 14 g protein (average protein requirement for infants 0 to 3 years) basis and subjected to sensory assay. A nine-point hedonic scale was used in assessing sensory attributes. Maize gruel served as the control. The protein, iron and zinc contents of the samples ranged from 2.19 to 35.00%, 3.63 to 5.5 mg/100 g and 0.01 to 0.12 mg/100 g, respectively. Their Phytate: Zinc Molar Ratios (PZMR) were less than 10. Sensory result of the blends was positive. Differences observed within the gruels were not significant (p>0.05). Enriching the maize gruel with either cowpea and/or melon reduced the bulk while meeting the nutritional needs of infants. The use of indigenous legumes (pulses and oil seeds) as complements to the cereal gruel given to infants should be encouraged.

Key words: Complementary diet, gruel, chemical composition, enrichment, organoleptic attributes.

INTRODUCTION

Infant feeding practices in Nigeria is still inappropriate. This has a lot of influence on child survival in developing countries. The traditional complementary infant foods are basically carbohydrate gruels from cereals and root crops. These are deficient in protein (both in quantity and quality). They are bulky and of low nutrient density (Onofiok and Nnanyelugo, 1998). There has been an increased awareness on enrichment of traditional complementary foods of infants and meals of the under fives. Various cereal/legume mixes have been popularized to improve the nutritive value of complementary foods. Soybean and groundnut have received much attention (Nnam, 2002; Opara et al., 2012) with neglect of other locally available and cheap alternatives. Most Nigerian indigenous legumes /oil seeds and nuts which are cheap sources of plant protein are under exploited and are rarely used for infant foods. These crops such as the very tasty local specie of cowpea (*Vigna unguiculata*) called "*oraludi*" by Eastern Nigerians and melon seed (*Citrullus vulgaris*) could be explored as alternatives and nutritionally adequate complementary food.

MATERIALS AND METHODS

Yellow maize (*Zea mays*), dehulled melon (*C. vulgaris*) seeds and a local variety of cowpea (*V. unguiculata*; local name: *oraludi*) used for this work were purchased from Nsukka main market in Enugu State, Nigeria.

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Table 1. Ratio of composite blend formulation for sensory evaluation.

Code	Composite blends	Ratio	Gram
AK	Fermented maize (48 h)	100:0:0	319.6:0:0
ND	Fermented maize: boiled cowpea roasted for 15 min	70:30:0	223.75:7.75:0
EO	Fermented maize, boiled cowpea roasted for 20 min	70:30:0	223.75:7.25:0
IS	Fermented maize: boiled cowpea roasted for 15 min: roasted melon seed paste	70:20:10	223.75:5.15:2
RH	Fermented maize: boiled cowpea roasted for 20 min: roasted melon seed paste	70:20:10	223.75:4.83:2
TJ	Fermented maize: roasted melon seed paste	70:30:0	223.75:6:0

AK = Fermented maize (48 h) paste; ND = Fermented maize, boiled cowpea roasted for 15 min (70:30); EO = Fermented maize, boiled cowpea roasted for 20 min (70:30); IS = Fermented maize, boiled cowpea roasted for 15 min, roasted melon seed paste (70:20:10); RH = Fermented maize, boiled cowpea roasted for 20 min, roasted melon seed paste (70:20:10); TJ = Fermented maize: roasted melon seed paste (70:30).

Sample preparation

Six kilograms of maize grains were picked clean, washed and soaked in water in the ratio of 1: 3 w/v for 48 h. Thereafter, it was washed and wet-milled with water into slurry which was sieved using muslin cloth to remove husk. The filtrate was poured into a cotton bag and squeezed to remove excess water. Twenty grams of the sample were used for chemical analysis while the remaining was packed in a polyethylene bag and stored in a freezer (at -20°C) until needed. Two hundred grams of dehusked melon seeds were washed with clean water and par boiled for 10 min such that the water dried up after cooking (to prevent loss of nutrients in the cooking water). The seeds were dried in a hot air oven (Model No 320, Gallenkamp, England) at 80°C for 30 min, roasted for 15 min and milled into fine paste using electric grinder. Twenty grams of the sample were taken for chemical analysis while the remaining portion was stored in polyethylene bag and refrigerated at +4°C until needed. Five hundred grams of cowpea grains were steeped in clean water at room temperature, dehulled by attrition; boiled till soft (but not mushy). Thereafter, it was sun dried for 6 h. The sun dried sample was divided into 2 equal portions. One portion was roasted for 15 min and the other for 20 min. They were separately hammer milled (Model ED-5 Thomas Wiley, England) into fine flour (70 mm mesh screen) and stored in labelled sealed polyethylene bags at room temperature until used.

Formulation of composites

The crude protein of each sample was estimated by the micro-Kjedahl method (Pearson, 1976). The composites were formulated on 14 g protein basis in the ratio of 100:0:0, 70:30:0 and 70:20:10 of fermented maize, boiled roasted cowpea and parboiled roasted melon seeds. Six composites blends were formulated as follows:

i) Fermented maize (48 h) 100:0
ii) Fermented maize, boiled cowpea roasted for 15 min 70:30:0
iii) Fermented maize, boiled cowpea roasted for 20 min 70:30:0
iv) Fermented maize, boiled cowpea roasted for 15 min, roasted melon seed paste 70:20:10
v) Fermented maize, boiled cowpea roasted for 20 min, roasted melon seed paste 70:20:10
vi) Fermented maize, roasted melon seed paste 70:30

Table 1 shows the ratios of the composite blends and the quantity involved.

Chemical analysis

Association of Analytical Chemists (AOAC, 1990) methods were used for chemical analyses. Crude protein was determined by micro- Kjeldahl method; crude fibre by acid hydrolysis; fat by soxhlet extraction method; ash by dry ashing method while carbohydrate was determined by difference. Minerals were evaluated using atomic absorption spectrophotometric method; phytate by Harland and Oberleas (1986) and tannins by Price and Butler (1977).

Preparation of gruel

Composites (blends) were formulated using 14 g protein (average protein requirement for infants 0 to 3 years). For each of the products, the following recipe was used. For the 5 samples, 224.0 g of fermented maize paste (base) was dissolved in 50 ml of water (at room temperature) to form a slurry. Nine hundred millilitres of boiling water was added to the slurry while stirring until it gels (base). To each of the base, appropriate quantity of composites and 5 g of granulated sugar were added and stirred until well distributed. The samples were allowed to cool to 40°C (serving temperature) and separately kept in thermos flask to maintain the serving temperature (at 40°C) for sensory evaluation.

Sensory evaluation

Thirty students were randomly selected by balloting from third and final year students of the Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka. It was based on their previous participation in similar works. A nine-point hedonic scale (Williams, 1981) was used to test for flavour, colour, texture and general acceptability of the gruels. The degree to which the product was liked was expressed as: like extremely (9 points), like very much (8 points), like moderately (7 points), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points), dislike moderately (3 points), dislike very much (2 points) and dislike extremely (1 point). Like extremely to like slightly constituted good; while dislike slightly to dislike extremely constituted poor. Neither like nor dislike showed that the product was neither good nor bad. The sensory assessment was carried out in the Food Research Laboratory of Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka. The laboratory was adequately lit and free from distraction. The judges were arranged in such a way that they could not see the grading of each other. The samples were presented in plain coloured bowls and each judge was provided with a teaspoon and a glass of water to rinse his/her mouth after each testing. The testing was done around 11.00 am and the samples were presented at 40°C (serving temperature) in portions of 250 ml.

Table 2. Proximate composition of fermented maize, boiled cowpea and roasted melon seed paste (%/100 g).

Composite	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	Fat (%)	CHO (%)
$AK_{(48)b}$	46.00±0.05	2.19±0.02	1.50±0.05	0.10±0.02	1.60±0.05	48.61±0.01
BCR_{1a}	8.10±0.03	27.13±0.14	3.15±0.18	2.70±0.05	1.6±0.04	57.32±0.05
BCR_{2a}	8.04±0.04	28.88±0.09	3.00±0.16	2.75±0.01	2.35±0.02	54.94±0.32
PER_a	2.28±0.2	35.00±0.01	3.60±0.01	4.85±0.05	39.95±0.04	14.32±0.04

Mean ± SD of 2 determinations; a = Analysis on a dry weight basis; b = Analysis on a wet weight basis; AK = Fermented maize (48 h) paste, CHO = Carbohydrate; BCR_1 = Boiled cowpea, roasted 15 min (flour); BCR_2 = Boiled cowpea, roasted 20 min (flour); PER = 10 min parboiled melon, roasted 15 min (paste).

Table 3. Iron and zinc content of fermented maize, boiled cowpea and roasted melon seed (mg/100 g dry weight basis).

Mineral	AK_{48}	BCR_1	BCR_2	PER
Iron (mg/100 g)	3.63±0.04	4.33±0.14	4.50±0.04	5.53±0.15
Zinc (mg/100 g)	0.07±0.05	0.01±0.01	0.01±0.02	0.12±0.08

Mean ± SD of 2 determinations; AK = Fermented maize (48 h) paste; BCR_1 = Boiled cowpea, roasted 15 min (flour); BCR_2 = Boiled cowpea, roasted 20 min (flour); PER = 10 min parboiled melon, roasted 15 min (paste).

Table 4. Value of tannins, phytate and phytate zinc molar ratio (PZMR) of fermented maize, boiled cowpea and roasted melon seed paste (mg/100 g dry weight basis).

Variables	AK	BCR_1	BCR_2	PER
Tannin (mg/100 g)	5.60	14.47	14.85	8.81
Phytate (mg/100 g)	0.20	0.56	0.52	0.12
PZMR	0.28	5.05	4.68	0.63

Mean ± SD of 2 determinations; AK = Fermented maize (48 h) paste; BCR_1 = Boiled cowpea, roasted 15 min (flour); BCR_2 = Boiled cowpea, roasted 20 min (flour); PER = 10 min parboiled melon, roasted 15 min (paste); PZMR = Phytate zinc molar ratio.

Statistical analysis

Means, analysis of variance (ANOVA) and Duncan's new multiple range test (DNMRT) were the statistical tools employed. Significance was accepted at P≤0.05.

RESULTS

Table 2 shows the proximate composition of fermented maize, boiled cowpea and roasted melon seed paste (%/100 g). It showed that PER had the least moisture value of 2% as against BCR_1 and BCR_2 that recorded 8% each. In terms of protein, crude fibre and fat values, PER showed appreciably higher values than BCR_1 and BCR_2. In ash content, PER, BCR_1 and BCR_2 shared similar values but BCR_1 and BCR_2 recorded lower values as against PER. Table 3 reveals the iron and zinc content of the samples. The values for iron ranged from 3.63 to 5.53 mg/100 g. PER had the highest value (5.53 mg) while BCR_1 and BCR_2 shared similar values (4.33 and 4.5 mg/100 g). The range for zinc was 0.01 to 0.12 mg/100 g. PER still had the highest value (0.12 mg/100 g) while BCR_1 and BCR_2 both had 0.01 mg/100 g. AK_{48} showed higher values (0.07 mg/100 g) than BCR_1 and BCR_2. Table 4 presents the tannins and phytate in the samples and their phytate zinc molar ratios. The tannins values ranged from 5.6 to 14.85 mg/100 g. BCR_1 and BCR_2 (14.47 and 14.85 mg/100 g, respectively) showed higher values than the others with AK_{48} having the least value (5.6 mg/100 g). The phytate values ranged from 0.12 to 0.56 mg/100g. BCR_1 and BCR_2 showed higher values (0.56 and 0.52 mg/100 g, respectively) than both PER and AK (0.12 and 0.2 mg/100 g). However, the PZMR of all the samples was less than 10. The range was 0.28 and 5.05. Table 5 shows the sensory scores of the respective samples. In terms of flavour, the score ranged from 6.00 to 7.07. RH had the highest score (7.07) while AK had the least (6.00). However, the flavour scores of the samples showed no significant difference (p>0.05). The scores for colour attribute ranged from 6.07 to 7.40. Though, IS had the highest score, the difference in the colour scores was not significant (p>0.05). The scores on texture varied. It ranged from 6.93 to 7.37. ND had the highest score (7.37), followed by IS (7.30) and AK had the least (6.93). However, there was no significant difference (p>0.05) in the scores. The general acceptability scores ranged from 6.29 to 7.29. RH was the most generally accepted (7.29). It was followed by ND (6.96). Nevertheless, the general acceptability scores of the samples revealed no significance difference (p>0.05).

Table 6 shows that 213.6 g maize paste (AK) would be required to meet 1/3 of the 14 g protein requirement of infants 6 to 12 months of age while only approximately 154 g of enriched maize paste would be required to meet

Table 5. Sensory evaluation of traditional fermented maize gruel enriched with either boiled cowpea flour and/or roasted melon seed paste (as consumed).

Composite	Flavour	Colour	Texture	General acceptability
AK	6.00±0.34$_a$	7.20±0.23$_a$	6.93±0.32$_a$	6.29±0.4$_a$
ND	6.970±0.26$_a$	7.33±0.24$_a$	7.37±0.2$_a$	6.96±0.24$_a$
EO	6.57±0.17$_a$	7.23±0.24$_a$	7.11±0.18$_a$	6.54±0.23$_a$
IS	6.83±0.28$_a$	7.40±0.22$_a$	7.30±0.27$_a$	6.86±0.30$_a$
RH	7.07±0.2$_a$	6.93±0.29$_a$	7.23±0.24$_a$	7.29±0.26$_a$
TJ	6.27±0.37$_a$	6.07±0.37$_a$	7.00±0.32$_a$	6.78±0.31$_a$

Mean ± SEM of 30 respondents; AK = Fermented maize (48 h) paste; ND = Fermented maize, boiled cowpea roasted for 15 min (70:30); EO = Fermented maize, boiled cowpea roasted for 20 min (70:30); IS = Fermented maize, boiled cowpea roasted for 15 min, roasted melon seed paste (70:20:10); RH = Fermented maize, boiled cowpea roasted for 20 min, roasted melon seed paste (70:20:10); TJ = Fermented maize: roasted melon seed paste (70:30).

Table 6. Portion (uncooked size) that meets the nutrient requirement of infant (6 to 12 months).

Composite	1/3 daily protein requirement (g)	Medium 10% absorption		Low 5% absorption		Energy requirement for infants 9 to 12 months (%)
		% Fe req•	% Zn req	% FE req	% Zn req	
AK	213.10	70.0	2.5	36.80	1.35	49.50
ND	154.27	49.53	1.73	25.94	0.93	35.99
EO	154.17	49.58	1.73	25.94	0.93	35.99
IS	154.02	49.65	1.73	25.94	0.93	35.99
RH	154.22	49.68	1.73	25.94	0.93	35.99
TJ	153.16	49.89	1.73	25.94	0.93	35.99

Mean ± SEM of 30 respondents; AK = Fermented maize (48 h) paste; ND = Fermented maize, boiled cowpea roasted for 15 min (70:30), EO = Fermented maize, boiled cowpea roasted for 20 min (70:30); IS = Fermented maize, boiled cowpea roasted for 15 min, roasted melon seed paste (70:20:10); RH = Fermented maize, boiled cowpea roasted for 20 min, roasted melon seed paste (70:20:10); TJ = Fermented maize: roasted melon seed paste (70:30); • = requirement.

the same requirement. Under low (5%) absorption, AK would provide 36.8% of iron and 1.35% of zinc. Under medium (10%) absorption, it would furnish 70% iron and 2.5% zinc. For all the other samples, 154 g of each would under medium (10%) absorption provide about 50% of daily iron requirement and 1.73% of zinc. Under low (5%) absorption, 154 g of each of the test samples would provide about 26% of infant daily iron need and 0.93% of zinc. All the samples (154 g) including the control (213 g) would meet one-third energy requirement of infant 9 to 12 months of age.

DISCUSSION

The lower values of protein, ash and crude fibre for fermented maize alone shows that infants should not be fed on maize gruel alone. Enrichment and supplementation should be used to make up for what is missing in this readily available traditional infant food. The higher values seen in enriched maize gruels lend credence to this. The high values of iron in the enriched composites suggests that infants fed on the samples require rich vitamin C sources to enhance iron absorption since non haem iron is not readily available biologically (Yip, 2001). With the addition of vitamin C, these composites can be relied upon to provide the recommended nutrient intake of the infants for iron since at about 6 months of life, iron stores become depleted and the infant needs exogenous iron to cope with the challenges of rapid growth and increase in body size (Dallman; 1980; Yip, 2001). It was also observed that boiled and roasted cowpea is a good source of protein and ash (minerals). However, roasted melon had superior nutritional value. This was probably due to its low moisture content. The lower the moisture values of food, the higher the nutrients per 100 g (Okeke and Obizoba, 1986). Oil seeds are good sources of protein, minerals and fat soluble vitamins (Ene-Obong, 2001; Pamplona-Rogers, 2004; FAO, 2012). The provitamin A in oil seeds have been reported to enhance iron and zinc status. Dietary vitamin A either as preformed or provitamin A increases the bioavailability of inorganic iron by counteracting its inhibition by phytic acid (Solomons, 2001b). This implies that zinc bioavailability will also be improved since its absorption is also impaired by phytic acid.

The high values of protein, crude fibre and fat for boiled cowpea roasted for 20 min shows that roasting for a longer time not only eliminates moisture but also concentrates the nutrients in the food. This is essential in infant feeding because not only that bulk is reduced, nutritionally, the infant fares better. Good zinc status has been associated with enhanced immunity (Dibley, 2001; Solomons, 2001a). These composites have been shown to provide zinc of medium bioavailability since the phytate zinc molar ratios were a little above 5. This implies a lower risk of diarrhoea and other infections of infancy. The high general acceptability scores of the composites were expected. This is a result of the organoleptic attributes of flavour, colour and texture of the composites. This observation was similar to previous observations (Onoja and Obizoba, 2009). The stomach of the infant can take only a small quantity of food at a time. It is important that at each feed, the infant receives adequate quantity of nutrients to meet with its increased body demands. The composites are ideal for this. Only 154 g could provide the required protein and iron for the infants. However, in preparing the feeds, much water should be avoided to prevent creating bulk and reducing the nutrient value.

Conclusion

Enrichment of cereals with local variety of cowpea (*oraludi*) and melon seed has good nutritional implications. This should be incorporated into infant feeding to fight the problem of malnutrition in infants and increase their chances of survival.

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