academicJournals

Vol. 12(36), pp. 5549-5553, 4 September, 2013
DOI: 10.5897/AJB2013.12886
ISSN 1684-5315 ©2013 Academic Journals
http://www.academicjournals.org/AJB

African Journal of Biotechnology

Full Length Research Paper

Chemical and organoleptic evaluation of fermented maize *(Zea mays)* gruel supplemented with fermented cowpea *(Vigna unguiculata)* flour and roasted melon seed *(Citrullus vulgaris)* paste

Madukwe Edith U., Okoye V., Ayogu Rufina N. B. and Okechukwu Franca

Department of Home Science, Nutrition and Dietetics University of Nigeria, Nsukka.

Accepted 21 August, 2013

This work examined the chemical and organoleptic profile of fermented maize gruel enriched with roasted melon and fermented local species of cowpea *(oraludi)*. The chemical composition of the processed food samples were assessed using standard methods. Blends were formulated in the ratio of 70: 30 (14 g protein basis) of maize gruel and cowpea flour or melon paste; and 70: 20: 10 (14 g protein basis) of maize gruel, cowpea flour and melon paste. Young students of the University community were selected for sensory evaluation. Sensory attributes were assessed with a nine-point Hedonic scale. Fermented maize gruel was the control. The proximate result reveals that melon paste had higher values than cowpea flour in protein, ash, crude fibre and fat (35.00: 29.75; 3.60: 2.40; 4.85: 2.33 and 39.95: 3.15%, respectively). Cowpea flour showed superior percentage value to melon paste in moisture and carbohydrate (8.76: 2.28; 57.26: 14.32%, respectively). Melon paste and cowpea flour had close values for iron (5.53: 5.48 mg/100 g, respectively) and zinc (0.019: 0.012 mg/100 g, respectively). There was not much difference in the phytate and tannins values of melon paste and cowpea flour (0.12: 0.18; 8.81: 10.48 mg/100 g, respectively). The blends were generally acceptable (5.46 to 6.88; p>0.05). Composite blends of locally available and under-utilized legumes should be used to add variety to infant diet.

Key words: Complementary food, gruel, chemical composition, organoleptic test.

INTRODUCTION

Problems associated with infant feeding include bulkiness and monotony of diet. Various processing techniques such as fermentation, dehulling, germination, drying and milling had been employed to combat the problems of bulkiness, acceptability, quality, flavour, texture, viscosity, palatability (Hotz and Gibson, 2007; Odunfa, 1985; Nnam, 2002). These methods create variety that eliminates monotony. The presence of anti-nutrients and food toxicants limit the full utilization of cereal-legume based infant foods. This calls for the exploitation of other nutrient dense foods as valid means of enriching infant gruels and promoting the health nutritional status of infants. Low protein content and quality and monotony of diet are still problems to mothers who cannot afford good protein sources. Commercial complementary foods modified to meet infant nutrient requirements are expensive and beyond most Nigerian families (Nwamarah and Amadi, 2009; Anigo et al., 2010). Hence many depend on inadequately processed traditional foods consisting mainly of unsupplemented cereal porridges made from

*Corresponding author. E-mail: lomearnb@yahoo.com or rufina.ayogu@unn.edu.ng.

Table 1. Ratios of composite blends formulation.

Code	Composite blends	Ratio	Gram
AK	Fermented maize (48 h)	100:0:0	319.6:0:0
LB	Fermented maize, fermented cowpea roasted (15 min)	70:30:0	223.75:7.75:0
CM	Fermented maize, fermented cowpea roasted (20 min)	70:30:0	223.75:7:0
GQ	Fermented maize: fermented cowpea roasted (15 min): roasted melon seed paste	70:20:10	223.75:5.15:2
PF	Fermented maize: fermented cowpea roasted (20 min): roasted melon seed paste	70:20:10	223.75:4.7:2
TJ	Fermented maize: roasted melon seed paste	70:0:30	223.75:0:6

maize, sorghum and millet (Nnam, 2002). These problems compromise the health, growth and development of infants thereby predisposing them to protein energy malnutrition (PEM) and infections (due to lowered immunity). PEM results when an infant's body need for energy and protein or both are not satisfied by their diets (Wardlaw and Hampl, 2007).

Most of our indigenous legumes which are cheap sources of plant protein are under exploited and rarely used for infant foods. Outside soybean and peanut and a few other legumes, the rest are consumed in only one or two forms. These varieties are equally cheap. They are cultivated in home gardens during planting seasons, therefore, are available. Melon seed *(Citrullus vulgaris)* is underutilized. Outside its use in soup preparation (*egusi* soup), only a few localities roast and eat it as snack and a few local recipes. The under-utilized local crops could be explored as cheap alternative and nutritionally adequate complementary foods.

MATERIALS AND METHODS

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

Sample preparation

Six kilograms of maize grains was 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 gram (20 g) of the sample was used for chemical analysis while the remaining was poured into a polyethylene bag and stored in a freezer 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) 80°C for 30 min; roasted for 15 min, and milled into fine paste using electric grinder. Twenty gram (20 g) of the sample was taken for chemical analysis while the remaining portion was stored in polyethylene bag and refrigerated until needed.

Five hundred grams of cowpea grains were steeped in water at room temperature and dehulled manually by rubbing them between palms (attrition). The dehulled grains were fermented (liquid state fermentation) for 24 h. It was divided into 2 portions and roasted for 15 and 20 min, respectively. Each portion was hammer milled separately (Model ED-5 Thomas Wiley, England) into fine flour (70 mm mesh screen) and stored in separate labelled 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, fermented cowpea and parboiled roasted melon seeds. Six composites blends were formulated as follows (Table 1):

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 sphectrophotometric method; phytate by Harland and Oberleas (1986) and tannins by Price and Butler (1977).

Quantitative ration of composite blend

The gram portion of each composite was determined using simple proportion. The quantity of protein that should be supplied by each composite sample was determined from the ratio of composite blend (using 14 g protein as 100%). The quantity needed to fill each requirement was then derived using simple proportion (based on protein composition of the samples). The quantities derived were later halved because of the large quantities of sample that would not be required.

Preparation of gruel

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 composite 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 for sensory evaluation.

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

Composite	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	Fat (%)	CHO (%)
AK	46.00±0.05	2.19±0.02	1.50±0.05	0.10±0.02	1.60±0.05	48.61±0.01
FCR_1	8.76±0.06	27.13±0.15	2.30±0.6	2.25±0.06	2.30±0.06	57.26±0.93
FCR_2	8.48±0.05	29.75±0.1	2.40±0.51	2.33±0.05	3.15±0.08	53.89±0.79
PER	2.22±0.02	35.00±0.01	3.60±0.01	4.85±0.0	39.95±0.04	14.32±0.04

Mean±SD of 2 determinations; CHO, Carbohydrate; AK, Fermented maize (48 h); FCR_1, Fermented cowpea, roasted 15 min (flour); FCR_2 -, Fermented cowpea, roasted 20 min (flour) paste; PER, 10 min parboiled melon, roasted 15 min (paste).

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

Mineral	AK	FCR_1	FCR_2	PER
Iron (mg/100 g)	3.63±0.04	4.83±0.02	5.48±0.1	5.53±0.15
Zinc (mg/100 g)	0.07±0.05	0.01±0.01	0.01±0.01	0.12±0.08

Mean±SD of 2 determinations; AK, Fermented maize (48 h) paste; FCR_1, Fermented cowpea, roasted 15 min (flour); FCR_2 -, Fermented cowpea, roasted 20 min (flour); PER, 10 min parboiled melon, roasted 15 min (paste).

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 (nine points), like very much (eight points), like moderately (seven points), like slightly (six points), neither like nor dislike (five points), dislike slightly (four points), dislike moderately (three points), dislike very much (two points), dislike extremely (one 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.

Statistical analysis

Means, analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) were the statistical tools employed. Significance was accepted at $P \leq 0.05$.

RESULTS

Chemical composition of fermented maize paste, fermented cowpea flours and roasted melon seed paste is presented in Table 2. The protein level of the samples ranged from 2.19% in fermented maize to 35.0% in melon seed paste. The ash values ranged from 1.5% in fermented maize paste to 3.6% in roasted melon seed paste. Cowpea flours (2.3 and 2.4%) and melon seed paste (3.6%) also proved superior to maize (1.5%) in terms of ash values. Roasted melon seed paste had high fat value (39.95%) as against fermented maize and cowpea flours whose values ranged from 1.6 to 3.15%. Fermented cowpea flours had the highest level of carbohydrate value (57.26 and 53.89%). This was followed by fermented maize (48.61%) while melon seed paste recorded the least carbohydrate value (14.32%).

Table 3 shows the iron and zinc content of the samples. The iron content of the samples ranged from 3.63 to 5.53 mg/100 g. PER recorded the highest value of 5.53 mg/100 g followed closely by FCR_2 (5.48 mg/100 g). The least value was found in AK (3.63 mg/100 g). Zinc content of the samples was low (0.01 to 0.12 mg/100 g). PER recorded the highest value of 0.12 mg/100 g followed by 0.07 mg/100 g in AK. The least value of 0.01 mg/100 g was recorded by both FCR_1 and FCR_2

Table 4 reveals the tannin, phytate and phytate zinc molar ratio of the samples. The level of tannins ranged from 5.60 to 11.48 mg/100 g. FCR_1 had the highest value of 11.48 mg followed by FCr_2 (9.96 mg/100g). The least value was recorded by AK (5.60 mg/100 g). The PZMR of the samples ranged from 0.28 to 1.76. FCR_1 had the highest value of 1.76 followed by FCR_2 with 0.66.

Table 5 shows the sensory attributes of the composite blends. The flavour of the blends in the Hedonic scale differed. It ranged from 5.20 to 6.83. GQ had the highest score (6.83) followed by TJ (6.27). However, the flavour difference observed in these gruels was not significant ($P>0.05$). In terms of colour, differences were observed. It

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

Phytochemical	AK	FCR_1	FCR_2	PER
Tannin (mg/100g)	5.60	11.48	9.96	8.81
Phytate (mg/100g)	0.20	0.16	0.08	0.12
PZMR	0.28	1.76	0.66	0.63

Mean±SD of 2 determinations; AK; Fermented maize (48 h) paste; FCR_1, Fermented cowpea, roasted 15 min (flour); FCR_2 -, Fermented cowpea, roasted 20 min (flour); PER, 10 min parboiled melon, roasted 15 min (paste); PZMR, Phytate zinc molar ratio.

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

Composite	Flavour	Colour	Texture	General acceptability
AK	$6.00{\pm}0.34^a$	$7.20{\pm}0.23^a$	$6.93{\pm}0.32^a$	$6.29{\pm}0.4^a$
LB	$5.20{\pm}0.4^a$	$6.10{\pm}0.27^a$	$6.57{\pm}0.3^a$	$5.46{\pm}0.4^a$
CM	$5.80{\pm}0.39^a$	$6.90{\pm}0.23^a$	$6.80{\pm}0.31^a$	$5.88{\pm}0.45^a$
GQ	$6.83{\pm}0.29^a$	$7.37{\pm}0.27^a$	$7.30{\pm}0.23^a$	$6.88{\pm}0.28^a$
PF	$6.20{\pm}0.32^a$	$6.87{\pm}0.28^a$	$7.03{\pm}0.23^a$	$6.63{\pm}0.35^a$
TJ	$6.27{\pm}0.37^a$	$6.07{\pm}0.37^a$	$7.00{\pm}0.32^a$	$6.78{\pm}0.31^a$

Figures with the same subscript in the same column are not significantly different (P>0.05); Mean ± SEM of 30 respondents.

ranged from 6.07 to 7.37. GQ had the highest value (7.37) followed by AK (7.20) and TJ had the least (6.07). However, there was no significant difference in the colour attribute (P>0.05).

Texture of the gruels revealed some differences in the scores. GQ had the highest score (7.30), followed by PF (7.03) while LB had the least score (6.57). The differences, however, were not significant (P>0.05). In over all acceptability score of the gruels, the values differed. It ranged from 5.46 to 6.88. GQ had the highest score of 6.88, followed by TJ with 6.78 and PF with 6.63. In any case, no significant difference was observed (P>0.05).

DISCUSSION

The proximate composition of the samples collaborated with the report of other findings (Onoja and Obizoba, 2009; FAO, 2012). The low level of protein as observed in the fermented maize was because it is cereal. Cereals are not good sources of protein but legumes are (Ene-Obong, 2001) as can be seen in the high protein content of the cowpea and melon seed, in comparison. The high nutrient profile of roasted melon seed paste was attributed to its low moisture value. Its high ash value suggests a rich mineral source. The low ash value of maize implies that infants fed on maize gruel alone are at risk of micronutrient deficiency especially iron, zinc and calcium. The low fibre value of cowpea and maize was as a result of dehulling which not only rids the sample of its seed coat but also its vitamin B compounds. The least carbohydrate content of melon was attributed to its low moisture content. The higher the moisture values of food, the lower its nutrients per 100 g (Okeke and Obizoba, 1986). The high level of iron in the roasted melon seed paste implies a good complementary source to breast milk. Breast milk is a poor source of iron and as an infant grows older, its iron need is increased and stores depleted (Ene-Obong, 2001; Fraser et al., 2006). Roasted melon paste added to complementary food forms a good source of iron and absorption can be enhanced by introducing fruits in season. In addition, zinc status is enhanced, diarrhoea prevented and childhood infections curbed. Zinc is immune system booster (Wardlaw and Hampl, 2007). The low phytate zinc molar ratio (<5) of the samples infers good absorption of the zinc in the samples.

The similarity (P>0.05) in the sensory attributes of the samples suggests high acceptance and variety. The high general acceptability scores of the gruels was not a surprise. All had high scores for flavour, colour and texture and these were not significantly different (P>0.05). Fermentation and roasting add flavour to food and these may have influenced the general acceptability of the gruels. Onoja and Obizoba (2009) also reported high acceptability of 24 h fermented blends as a result of improved flavour and mutual supplementation.

Conclusion

Variety and adequacy are factors of importance in the formulation of complementary foods for children. The addition of roasted melon seed to maize and cowpea gruels proved more nutritious and better accepted. It should therefore, be incorporated into complementary mixes.

REFERENCES

Anigo KM, Ameh DA, Ibrahim S, Daubauch SS (2010). Nutrient composition of complementary food gruels fermented from malted cereals, soybean and groundnut for use in North Western Nigeria. Afr. J. Fd. Sc. 4(3):65-72.

Ene-Obong HN (2001). Eating right. University of Calabar Press, Calabar.

FAO (2012). West African Food composition Table. Stadlmayr B, Charrondiere UR, Enujiugha V, Romaric N, Bayili G, Fagbohoun E, Samb E, Addy P, Barikmo I, Ouattara F, Oshaug A, Akinyele I, Annor GA, Bomfeh K, Ene-Obong H, Smith IF, Thiam I, Burlingame B (Eds.). FAO, Rome.

Fraser DM, Cooper MA, Nolter-Anne GN (2006). Myles Textbook for midwives, African ed. Churchill Livingstone, Edinburgh.

Harland BF, Oberleas D (1986). Anion exchange method for determination of phytate in foods: Collaborative study. J. Assoc. Anal. Chem. 69(4): 667-669.

Hotz C, Gibson RS (2007). Traditional food processing and preparation practices to enhance the bioavailability of micronutrients in plant based diets. J. Nutr. 137:1097-1100.

Nnam NM (2002). Evaluation of complementary foods based on maize, groundnut, pawpaw and mango flour blends. Nig. J. Nutr. Sc. 23:1-4.

Nwamarah JU, Amadi VO (2009). Chemical and sensory evaluation of complementary foods for infants (6 - 24 months) using locally available Nigerian staples. Nig. J. Nutr. Sc. 30 (1):112-121.

Odunfa SA (1985). African fermented foods, in: Wood, J.B. (Ed.), Microbiology of fermented foods. Elsevier Science Publications, London, New York.

Okeke EC, Obizoba IC (1986). The nutritive value of all vegetable protein diets based on legumes, cereals and tubers in weanling rats. Qual. Pl. Fd. Hum. Nutr. 36: 213 - 222.

Onoja US, Obizoba IC (2009). Nutrient composition and organoleptic attributes of gruel based on fermented cereal, legume, tuber and root flour. J. Trop. Agric. Fd. Environ. Ext. 8(3): 162 - 168.

Pearson D (1976). The chemical analysis of foods. Churchill Livingstone, Edinburgh.

Price ML, Butler LG (1977). Rapid visual estimation and spectrophotometric determination of tannin content of sorghum grain. J. Agric. Fd. Chem. 25: 1268 - 1273.

Wardlaw GM, Hampl JS (2007). Perspective in Nutrition, seventh ed. McGraw - Hill, New York.

Williams AA (1981). Scoring methods in the scoring analysis of foods and beverages. Fd. Technol. 17: 163 - 175.