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<th>Serial No</th>
<th>ISSN: 0189 – 0913</th>
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<td>Evaluation of Complementary Foods Based on Maize, Groundnut, Pawpaw and Mango Flour Blends.</td>
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<td>Nutrient Composition, Organoleptic Attributes, Multimixes, Complementary Food.</td>
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<td>Description</td>
<td>Evaluation of Complementary Foods Based on Maize, Groundnut, Pawpaw and Mango Flour Blends.</td>
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<tr>
<td>Category</td>
<td>Agriculture</td>
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<tr>
<td>Publisher</td>
<td>Nigerian Journal of Nutritional Science</td>
</tr>
<tr>
<td>Publication Date</td>
<td>2001</td>
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The Nigerian Journal of Nutritional Sciences (ISSN 0189-0913), official Journal of the Nutrition Society of Nigeria, is a peer-reviewed publication and is published biannually, two volumes per year.

The primary focus of the journal is the publication of basic and applied studies in nutritional sciences and related fields. The information for Authors appears in the first volume issue each year. Subject and author indexes appear in the second volume issue of each year.

Editorial Office
Send manuscripts to the Editor-in-chief, E.C. Okeke Ph.D., Department of Home Science and Nutrition, University of Nigeria, Nsukka, Enugu State, Nigeria.

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Institutional (individual) N4,000.00
Institutional (institution) $100.00

For local orders add N250.00 and international orders add $10.00 for postage. All requests for subscription should be addressed to:

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Colour N40,000.00
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A journal of Basic and Applied Nutritional Science

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Evaluation of complementary foods based on maize, groundnut, pawpaw and mango flour blends

N.M. NNAM
Department Of Home Science and Nutrition
University Of Nigeria, Nsukka

ABSTRACT
The study examined the nutrient composition and organoleptic attributes of composite flours based on maize, groundnut, pawpaw and mango for possible use as complementary foods. Maize grains were fermented for 48h, groundnut seeds were roasted for 10 min, while pawpaw and mango pulps were collected from their fruits. The fermented maize grains, roasted groundnut seeds and the pawpaw and mango pulps were separately dried and milled into fine flours. The flours were combined in ratios of 70:30:0, 65:30:5 and 60:30:10 (protein basis) of maize, groundnut and pawpaw or mango. Maize grains were processed to produce the maize traditional complementary food “ogī”. The “ogī” paste was dried and milled into fine flour which served as the control. Porridges were prepared from the composite flours and the flour of the maize traditional complementary food. Standard methods were used to evaluate the composite flours and the control for nutrient composition, and their porridges for organoleptic attributes. The nutrient levels of the flours were compared with the Codex Alimentarius Standard for formulated supplementary food for infants and young children. The composite flours contained higher \( \text{p}<0.05 \) levels of protein, lipids, energy, calcium (Ca), zinc (Zn), copper (Cu), provitamin A and ascorbate than the control. Relative to the Codex Alimentarius Standard, the control did not meet the recommended standards except for the energy level. The composite flours met the specification for lipids, energy and ascorbate. All the porridges were liked by the judges. The porridge made from the 60:30:10 maize/groundnut/mango flour mixture was preferred over others.

Key words: Nutrient composition, organoleptic attributes, multimixes, complementary food.

INTRODUCTION
Childhood malnutrition is widely prevalent in many parts of the world, particularly in the developing countries like Nigeria [1]. Protein, energy and micronutrients, malnutrition are the commonest form. Micronutrient malnutrition in infants and young children became a major concern of public health nutrition just before the World Summit for children in the late 80's [2]. The focus expanded from just protein and energy malnutrition to include vitamin A, iodine and iron deficiencies. There is an emerging interest on zinc and copper nutrition. Control of vitamin A deficiency (VAD), iron deficiency anaemia (IDA) and iodine deficiency disorders (IDD) remain a big challenge for Nutritionists and health workers. Food-based approaches have been recognized as the principal way of combating the nutritional problems although some other form of intervention could serve as a complement[3]. Dietary diversification to include micronutrient rich foods in the diet appear more feasible than other methods in most developing countries[3].

In Nigeria, as in most other developing countries, the infant complementary foods are grossly inadequate [4]. The traditional complementary foods consists mainly of unsupplemented cereal pap made from maize, sorghum and millet. The complementary foods are inadequately processed and are deficient in some macro and micronutrients[4]. Adequate processing and judicious blending of the locally available foods could result in improved intake of nutrients to prevent malnutrition problems.

Maize, groundnut, paw-paw and mango are readily available foods in...
Nigeria. They have promising nutritional attributes. Maize protein varies in common varieties from about 8 to 11 percent of the kernel weight[5]. The protein is relatively rich in the sulphur containing amino acids, methionine and cystine but low in lysine and very low in tryptophan[5,6]. Groundnut is rich in protein (25.6%) and fat (46.1%)[7]. The Crotein is relatively fair in the sulphur containing amino acids, methionine and cystine but low in lysine and very low in tryptophan[5,6]. There is need to enrich maize diets with both protein and micronutrient rich foods. Fruits are valuable sources of vitamins and minerals[9]. They could provide significant quantities of micronutrients when blended with maize diets.

Mango and pawpaw are some tropical fruits rich in β-carotene and vitamin C. Pawpaw fruit contains 0.71 mg/100g β-carotene and 158.75 mg/100g vitamin C[9]. The values for mango pulp are 0.20 mg/100g g β-carotene and 300 mg/100 g vitamin C all on fresh weight basis[9]. Supplementing the traditional maize complementary food 'ogi' with groundnut seeds and pawpaw or mango pulps could improve the nutrient composition of the complementary food. Use of the multirnix might help to ensure nutrition security in infants and young children. The nutrient potentials of the food (maize, groundnut, pawpaw and mango) make it imperative that scientific studies be made on their composite for possible use as complementary food. This study which is part of exploratory work on the improvement of the nutritional quality of the traditional complementary foods in Nigeria using cheap and locally available foods was undertaken to:

1. formulate composite flours from fermented maize, roasted groundnut, and pawpaw or mango pulps for possible use as a complementary food for older infants and young children.

2. evaluate the composite flours for nutrient composition, and

3. prepare porridges from the composite flours and evaluate their sensory properties.

MATERIALS AND METHODS

Materials
Yellow maize (Zea mays L.) grains [M], groundnut seeds (Arachis hypogaea) [G], pawpaw (Carica papaya) [P] and mango (Mangifera indica L.) [M] pulp were used for the study. They were purchased from the Nsukka market in Enugu State of Nigeria.

Preparation of materials
Four kg of maize were cleaned and steeped in deionized water in a ratio of 1:3 (w/v) (grain to water). The steeped grains were allowed to ferment in a bell jar at 28±2°C for 48 h. After fermentation, the water was drained. The grains were divided into two portions. One portion was dried in an air oven (Model No. 320, Gallenkamp, England) at 55°C for 12 h to 96% dry matter (FM). The other portion was wet milled using a mixer Kenwood (MFR 200, Gallenkamp, England). The paste was made into slurry by mixing with deionized water in a ratio of 1:4 (w/v) (paste to water). The slurry was filtered through a cheese cloth to produce the maize traditional complementary food (MTCF) "ogi". The filtrate was allowed to sediment for 4 hrs. The sediment was dried in an air oven as described earlier.

Three kg of groundnuts were cleaned and roasted using a thermostatically controlled water bath (Thermomixer 95, Gallenkamp, England) set at 75°C for 10 min. The roasted seeds (RG) were dehulled manually by rubbing gently with hand and winnowed to remove the hulls. The dehulled groundnut seeds were dried in an air oven (Model No. 320, Gallenkamp, England) at 55°C to 96% dry matter.

Two kg each of ripe mango and pawpaw fruits were cleaned separately. The mango pulps (M) were scrapped from the
fruits using a fruit knife. The pawpaw was hand peeled to remove the skin or exocarp. The seeds were carefully removed to obtain the pulps (P). The fruit pulps were cut into small slices of 5mm thickness and dried using a solar drier fabricated at the National Centre for Energy Research and Development, University of Nigeria, Nsukka. The drier consists of a black polyethylene sheet stretched over a box on wooden legs. The black sheet filters ultraviolet light which destroys carotenoids. All the dry samples of maize, groundnuts, mango and pawpaw were separately milled in a laboratory hammermill (Model ED-5, Thomas Willey, England to fine flour (1 mm mesh).

Formulation of composite flours

The protein level of each flour was estimated by the microKjeldahl procedure[10]. Composites were formulated from the processed foods in ratios of 70:30:0, 65:30:5, 60:30:10 (protein basis) of maize, groundnuts, mango and pawpaw as follows:

- Fermented maize and roasted groundnuts (70:30:0) (FM:RG:M/P)
- Fermented maize, roasted groundnuts and mango pulp (65:30:5) (FM:RG:M)
- Fermented maize, roasted groundnuts and pawpaw pulp (65:30:5) (FM:RG:M)
- Fermented maize, roasted groundnuts and mango pulp (60:30:10) (FM:RG:M)
- Fermented maize, roasted groundnuts and pawpaw pulp (60:30:10) (FM:RG:M)

Maize traditional complementary food “ogi” (100 %) served as the control for evaluating the composite flours. The nutrient composition of the composite flours and the maize traditional complementary food “ogi” were determined according to the Codex Alimentarius Commission’s Guidelines on Formulated Supplementary Foods for Older Infants and Young Children [11]. This was to check whether the flours met the recommended standards by the commission.

Chemical analyses

The nutrient composition of the flour mixtures was determined according to the standard assay methods of AOAC [10]. Crude protein was determined by the microKjeldahl method using 6.25 as the conversion factor. Fat and ash contents were determined by Soxhlet extraction and dry ashing methods respectively. Minerals (calcium, iron, zinc and copper) were determined by atomic absorption spectrophotometer (Model 3030 Perkin-Elmer, Norwalk, USA). Ascorbic acid was determined using 2, 6-dichloro-phenol indophenol method while Provitamin A was determined using the method adopted from IVACG[12]. Carbohydrate was determined by difference while gross energy was calculated using Atwater’s conversion factors [13]. All assays were performed in triplicate.

Preparation of porridges

Porridges were prepared from both the composite flours and the flours from the maize traditional complementary food “ogi”. One hundred grams of each flour were mixed with 550 ml of deionized water. The slurry was heated in a thermostatically controlled water bath (Thermotirrer 95, Gallenkamp, England) set at 75°C for 15 min. Two grams of granulated sugar were added to the porridge. The samples were allowed to cool at room temperature (28±2°C) to 40°C (serving temperature). The porridges were kept separately in thermos flasks to maintain the serving temperature of 40°C.

Sensory evaluation

Sensory evaluation of the porridges was conducted in the food research laboratory of the Department of Home Science and Nutrition, University of Nigeria, Nsukka. One hundred mothers selected through random sampling from the Nigerian Journal of Nutritional Science Vol. 23 (1 & 2), 2002
Mother and Child Health (MCH) Clinic of the Bishop Shanahan Hospital, Nsukka, participated in the sensory evaluation. The judges were divided into four groups of twenty-five each. Morning and afternoon evaluation sessions were organized for two days. Each group participated in one of the evaluation sessions. Each of the panelists was seated in an individual compartment with fluorescent lighting and free from distraction. The judges evaluated the samples using a nine point hedonic scale, where 9 was the highest score and 1 the lowest[14]. The degree to which a 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). Three digit codes were inserted in the hedonic scale (XYZ, YYZ, WXY, UVW, XXV). The porridges were presented to each of the panelists in a Thermos flask (20 ml of sample), coded as in the hedonic scale.

Clean water was provided to the judges to rinse their mouth in-between testing of the porridges to avoid carry over effect. Room temperature of 28°C was maintained throughout the testing sessions. Each panelist was given five white plastic cups and teaspoons for use in the sensory test. Statistical analysis. Analysis of variance (ANOVA), Duncan's New Multiple Range Test (DNMRT) and Least Significance Difference (LSD) Test[15] were used to test the significance of differences between means (p<0.05).

RESULTS

Table 1 presents the nutrient composition of maize, groundnut, mango or pawpaw-flour blends; flour from the maize traditional complementary food and the Codex Alimentarius Commission Guideline (CAC/GL 08-1991) for formulated supplementary foods for older infants and young children [11]. The protein level of the flour from the maize traditional complementary food—"ogi" was lower (p<0.05) than that of the composite flours (3.25% vs 14.01 – 14.92%). The flour mixture containing maize and groundnut had higher (p<0.05) protein level than the blends containing maize, groundnut and either mango or pawpaw pulps. The protein levels of the flour mixtures and the flour of the maize traditional complementary food were lower than the guideline specified by the Codex Alimentarius Commission (15%) [11].

The carbohydrate levels of the flours varied with the food ingredients used and the level of supplementation. The flour of the maize traditional complementary food had higher (p<0.05) carbohydrate (91.04%) than the composites (64.32% – 66.04%). The 60:30:10 composite flours contained lower (p<0.05) levels of carbohydrate than the 65:10:5 flour mixtures. The composite flours contained higher (p<0.05) levels of lipids than the flour of the maize traditional complementary food. The lipid levels of the composite flours (11.82% - 12.52%) were within the range (10 – 25%) specified by the Codex Alimentarius Commission [11] while that of the control (2.50%) was below the specification. The ash levels of all the flours were low and comparable (p>0.05). The flour mixtures contained higher (p<0.05) fiber levels than the flour of the maize traditional complementary food. The blends containing either mango or pawpaw had higher (p<0.05) fiber than those not containing the fruits. The fiber level in the blends containing fruits increased with an increase in the proportion of fruit in the mixtures.

The energy values of the flours were high (1695.43 – 1836.67 KJ). The composites contained more energy than the

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“ogí” flour. The flour mixture containing maize and groundnut had the highest energy value (1680 KJ) by the Codex Alimentarius Commission for formulated supplementary foods for older infants and young children [11].

The calcium (Ca) composition of the composite flours were higher (p<0.05) than that of the flour of the maize traditional complementary food. However, the Ca levels of all the flours were very low relative to the Codex Alimentarius Commission’s standard (534.00 mg/100 g) for complementary food formulation [11]. The iron (Fe) levels of the flours varied (5.14 to 5.72 mg/100 g) and were lower than the Codex Alimentarius Commission’s standards (8.00 mg/100 g) [11]. The zinc (Zn) levels of the flours varied with the various combinations. The flour of the maize traditional complementary food contained lower (p<0.05) Zn than the composites. However, the Zn levels of the flours were low relative to the Codex Alimentarius Commission’s standards. The copper (Cu) levels of the composite flours were higher (p<0.05) than that of the maize traditional complementary food. The blend containing maize, groundnut and pawpaw (60:30:10) had higher (p<0.05) level of Cu than the other composites.

The provitamin A levels of the flours varied with the base ingredients used in formulation of the composites and their ratio in the mixtures. The composites containing either mango or pawpaw had higher (p<0.05) provitamin A than either the blend not containing the fruit or the control. However, the composites containing pawpaw had higher (p<0.05) levels than those containing mango. The provitamin A levels of the flour mixtures increased (p<0.05) as the ratio of mango or pawpaw increased from 5% to 10%. The ascorbate levels of the flours were influenced by the level of supplementation and the food ingredients used in the formulation. The flours containing either pawpaw or mango had higher (p<0.05) levels of ascorbate than the control or the blend supplemented with only groundnut. However, the composite containing mango had higher (p<0.05) level of ascorbate than those containing pawpaw. The ascorbate levels (16.25 mg/100 g - 64.62 mg/100 g) of the mixtures containing either mango or pawpaw were higher than the Codex Alimentarius Commission standards (13.34 mg/100 g) [11] while the levels of the control and the flour mixture supplemented with only groundnut were lower than the standard.

Table 2 presents the sensory scores associated with porridges made from the composite flours and the fermented maize flour used as traditional complementary food. The flavour of the porridges were liked moderately by the judges except for the 65:30:5 maize/groundnut/pawpaw blend, which was liked slightly. However, there was no significant (p>0.05) difference in flavour among the porridges. There appeared to be (a) a trend towards improvement in flavour as the quantity of fruit in the blend increased and, (b) preference by the judges for the flavour of the porridges containing mango. The texture of the porridges were influenced by supplementation. There was a significant (p<0.05) difference between the texture of the porridges made from the fermented maize flour and the composite flours. The textures of the products made from the composite flours were liked slightly (6.18 - 6.74) while the control made from fermented maize flour was liked moderately (7.34). The colour of the porridges were comparable (p>0.05). The judges liked the colour of all the porridges moderately. There was no significant (p>0.05) difference in acceptability among the porridges. The judges accepted and liked all the porridges moderately.
DISCUSSION

The higher \((p<0.05)\) protein levels for the flour blends than the control demonstrates the beneficial effect of adequate processing and supplementation. Nnam [16] made a similar observation when the sorghum traditional complementary food was supplemented with barnhara groundnuts and sweet potatoes. The sieving process used in the preparation of "ogi", the maize traditional complementary food, leads to considerable loss of nutrients particularly the proteinacious bodies and other water soluble nutrients [16]. Addition of groundnut which has high protein level (25.6% [7]) to the blends could also account for the higher \((p<0.05)\) protein levels of the composites. The lower protein level of the composites containing either mango or pawpaw than the one not containing the fruits might be due to low protein contents of the fruits (0.4% - 0.6% in pawpaw and 3.99% - 4.96% in mango) [9,19]. The protein levels of the blends (14.01% - 14.92%) were lower than that of Nutrend (16.64%) [18], a complementary food manufactured by Nestle Foods Nigeria PLC, but higher than those reported for flour mixtures formulated for use as complementary foods in Nigeria [18, 19,20]. The lower protein levels of the composites relative to the Codex Alimentarius Commission's standard could be attributed to the ratio of ingredients in the flour mixtures. The protein levels of the flour mixtures could be upgraded by increasing the ratio of groundnut in the blends Nnam [18] observed that an increase in the ratio of African yam bean (from 28% to 48%) in a maize/African yam bean/cocoyam mixture increased the protein level (from 12.61% to 15.61%) to meet the specification by the Commission.

The flour of the maize traditional complementary food appear to be rich in carbohydrate. The possible reason for this is that the flour is a sediment of corn starch. Proteins and other nutrients are concentrated in the residue. A similar result was obtained with sorghum traditional complementry food and its composite flours [16]. The higher \((p<0.05)\) levels of lipids in the multimixes than in the flour of the maize traditional complementary food could be due to the supplementation effect of groundnut which is an oil seed with high lipid level (46.1%)[7]. The high fat level of groundnut upgraded the lipid levels of the composites to meet the standard specified by Codex Alimentarius Commission. The higher energy values of the composite flours than the "ogi" flour was probably because of the high lipid level of groundnut which translated to high energy value (2360 KJ/100 g). The flour mixtures had higher energy levels than was recorded for some multimixes formulated from some local staples for use as complementary food in Nigeria [4,19]. The higher energy levels of the composites than the Codex Alimentarius Commission's standard is an indication that the formulated multimixes could provide adequate energy for infants and young children.

The higher \((p<0.05)\) Ca, Fe, Zn and Cu levels of the composites than the levels for the "ogi" flour could probably be because of (a) loss of the nutrients during "ogi" preparation and, (b) the supplementation effect of groundnut and either pawpaw or mango on the maize flours. The traditional method of "ogi" preparation; involves sieving and washing which leads to loss of minerals and other nutrients [5]. The lower Ca, Fe and Zn levels of both the composites and the "ogi" flour than the Codex Alimentarius Commission's standard might be attributed to the low levels of the minerals in maize and other ingredients used in the composite flour formulation. Richer sources of the minerals, like vegetables and animal products, could be included as base ingredients in the formulation of the composite flours to increase the levels of the minerals. It is known that animal products are the only foods that have high enough zinc to provide the requirement of the

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The composites containing either mango or pawpaw appeared to be rich in provitamin A and ascorbate probably because of the high levels of the nutrients in the fruits [9]. However, the higher provitamin A level of the flour mixtures containing pawpaw than those containing mango was likely due to the higher level of the nutrient in pawpaw than in mango (0.20 mg/100 g in mango and 0.71 mg/100 g in pawpaw) [9]. Conversely, the higher ascorbate level in the flour mixtures containing mango than in the ones containing pawpaw could be because of the levels of the nutrients in the fruit pulps. The increase in the levels of provitamin A and ascorbate as the quantities of mango or pawpaw in the mixtures increased showed the beneficial effect of using fruits as base ingredients in infant food formulation, to upgrade levels of the vitamins. The higher levels of ascorbate in only the multimixes containing either mango or pawpaw than the Codex Alimentarius Commission's standards further confirms the benefits of using fruits in infant food formulation to improve micronutrient levels.

The comparable flavour scores of the porridges made from the control with those prepared from the composites showed that the judges accepted the flavour of roasted groundnuts, pawpaw or mango used to supplement the maize traditional complementary food. The preference of the judges for the flavour of the porridges made from the composites containing mango could likely be that mango pulp imparted a more desirable flavour to the porridges than the other ingredients. The preference for the texture of the porridge made from the fermented maize flour over those made from the composite flours could be attributed to the supplementation effect of groundnut, mango and pawpaw on maize flour. The high fat level (46.1%) [7] of groundnut could partly account for the lower (p<0.05) texture scores of the composites. This is because, addition of oil or fat to porridges reduces viscosity [22]. Groundnuts have been used to reduce the water-holding capacity of gruels prepared from cereals [22]. The low starch levels of the fruits used in formulation of the composites could also be a reason for the lower texture scores of the composites containing fruits than for the control. Pawpaw and mango contain fair quantities of carbohydrate which is present as cellulose, sugar and small amount of starch [23]. When porridges are cooked, the starch granules break open and absorb water, they then swell, making the gruel thick. Further interaction of amylase, amylpectin, starch granules and water result in a gelatinization of the gruel. When fruits (mango and pawpaw) low in starch are used to prepare porridges, gelatinization is minimal and the water-holding and binding capacity of the porridge is low. This result in very thin porridge. More quantities of the composite flours would be added to achieve the desired consistency as with the porridge made from the flour of the maize traditional food. The comparable (p>0.05) colour scores of all the porridges showed that the judges accepted the colour blends of the ingredients. The similar (p>0.05) moderate acceptance of all the porridges might have been due to the desirable flavour, texture and colour of the porridges. The comparable (p>0.05) acceptability of all the porridges by the judges showed that the composites could be accepted by infants and young children in place of the traditional maize complementary food.

CONCLUSION

The composite flours showed nutritional superiority over the control in terms of protein, lipids, Ca, Zn, Cu, provitamin A and ascorbate nutriture. The fruits (pawpaw and mango) were beneficial in improving the provitamin A and ascorbate levels of the composites. Relative to Codex
Alimentary Standards for formulated supplementary foods for older infants and young children, the control did not meet any of the specification listed, except for energy. The composite flours however met the standards specified for lipids, energy and ascorbate. The mineral concentrations of the composites and the control were lower than the Codex Alimentarius Commission’s standards. There is need for further supplementation of the complementary foods with richer sources of the minerals. The flavour, texture and colour of all the porridges were liked by the judges. The porridges had comparable moderate acceptability. This showed that the composite flours with their richer nutritional attributes than the “ogi” flour could be accepted by infants and young children to replace the inadequate maize traditional complementary food. Studies are underway to upgrade some of the macro and microminerals content of the complementary foods to adequately meet the requirements of older infants and young children.

### TABLE 1: Nutrient composition of maize, groundnuts, mango or pawpaw flour blends and flour from the maize traditional complementary food on dry weight basis with the Codex Alimentarius Commission guideline (CAC/GL 08 – 1991) for formulated supplementary foods for older infants and young children.

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<th>Nutrient</th>
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<th>70:30:0</th>
<th>60:40:5</th>
<th>65:10:5</th>
<th>60:50:10</th>
<th>60:50:10</th>
<th>Control</th>
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<td>Protein (%)</td>
<td>3.25%</td>
<td>14.92%</td>
<td>14.53%</td>
<td>14.14%</td>
<td>14.50%</td>
<td>14.01%</td>
<td>0.3681</td>
<td>15.00</td>
</tr>
<tr>
<td>Carbohydrates (%)</td>
<td>91.04%</td>
<td>65.83%</td>
<td>66.04%</td>
<td>65.51%</td>
<td>64.39%</td>
<td>64.32%</td>
<td>0.4628</td>
<td>-</td>
</tr>
<tr>
<td>Lipids (%)</td>
<td>2.50%</td>
<td>12.52%</td>
<td>11.82%</td>
<td>12.34%</td>
<td>12.21%</td>
<td>12.04%</td>
<td>0.2547</td>
<td>10.25</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>2.64%</td>
<td>2.48%</td>
<td>2.36%</td>
<td>2.10%</td>
<td>2.03%</td>
<td>2.01%</td>
<td>0.0955</td>
<td>-</td>
</tr>
<tr>
<td>Fiber (%)</td>
<td>0.57%</td>
<td>4.21%</td>
<td>5.25%</td>
<td>6.01%</td>
<td>6.87%</td>
<td>7.02%</td>
<td>0.0564</td>
<td>-</td>
</tr>
<tr>
<td>Energy (KJ)</td>
<td>1695.43</td>
<td>1836.67</td>
<td>1807.03</td>
<td>1808.93</td>
<td>1792.90</td>
<td>1787.29</td>
<td>-</td>
<td>1680</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>42.01</td>
<td>56.08</td>
<td>57.12</td>
<td>54.21</td>
<td>55.27</td>
<td>56.21</td>
<td>0.2621</td>
<td>534.00</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>5.02</td>
<td>5.72</td>
<td>5.26</td>
<td>5.14</td>
<td>5.21</td>
<td>5.44</td>
<td>0.1426</td>
<td>8.00</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>1.61</td>
<td>2.42</td>
<td>2.31</td>
<td>2.92</td>
<td>2.71</td>
<td>2.36</td>
<td>0.0164</td>
<td>6.70</td>
</tr>
<tr>
<td>Copper (mg)</td>
<td>0.80</td>
<td>1.24</td>
<td>1.52</td>
<td>1.41</td>
<td>1.53</td>
<td>1.66</td>
<td>0.0629</td>
<td>-</td>
</tr>
<tr>
<td>Thiamine (ug)</td>
<td>4.59</td>
<td>3.92</td>
<td>10.21</td>
<td>27.42</td>
<td>28.02</td>
<td>56.59</td>
<td>0.9245</td>
<td>-</td>
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<tr>
<td>Ascorbic acid (mg)</td>
<td>0.12</td>
<td>0.22</td>
<td>3.70</td>
<td>16.25</td>
<td>64.62</td>
<td>28.12</td>
<td>0.4185</td>
<td>13.34</td>
</tr>
</tbody>
</table>

*Control

For each nutrient, values with similar letter in each row are statistically similar (p>0.05) while those with different letters are statistically (p<0.05) different.

- MTCF: Flour of the maize traditional complementary food ("ogi")
- FM:RG:M:P: Composite flour of fermented maize and roasted groundnuts (without mango or pawpaw)
- FM:RG:M: Fermented maize, roasted groundnuts and mango pulp composite flour
- FM:RG:P: Fermented maize, roasted groundnuts and pawpaw pulp composite flour
- CAU/GL 08-1991: Codex Alimentarius Commission guideline for formulated supplementary foods for older infants and young children.

*Flour of the maize traditional complementary food ("ogi") Fermented maize and roasted groundnuts (without mango or pawpaw) Fermented maize, roasted groundnuts and mango pulp composite flour Fermented maize, roasted groundnuts and pawpaw pulp composite flour Codex Alimentarius Commission guideline for formulated supplementary foods for older infants and young children.
Table 2: Sensory scores of porridges made from maize, groundnuts and mango or pawpaw flour blends and the flour of maize traditional complementary food - "ogi".

<table>
<thead>
<tr>
<th>Flavour*</th>
<th>1*MTCF</th>
<th>1*FM:RG/M/P</th>
<th>1*FM:RG:M/P</th>
<th>1*FM:RG:P/M</th>
<th>1*FM:RG:M/P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
<td>70:30:0</td>
<td>65:30:5</td>
<td>65:30:5</td>
<td>60:30:10</td>
</tr>
<tr>
<td>Color*</td>
<td>7.62²</td>
<td>7.36²</td>
<td>7.41²</td>
<td>7.25²</td>
<td>7.70²</td>
</tr>
<tr>
<td>General</td>
<td>7.53²</td>
<td>7.29²</td>
<td>7.08²</td>
<td>7.46²</td>
<td>7.84²</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Control Means not followed by the same letter in a row are significantly (p<0.05) different

Scores are based on a 9 point hedonic scale where scores of:
- 9: Like extremely
- 8: Like very much
- 7: Like moderately
- 6: Like slightly
- 5: Neither like nor dislike
- 4: Dislike slightly
- 3: Dislike moderately
- 2: Dislike very much
- 1: Dislike extremely

1*MTCF - Porridge made from the flour of maize traditional complementary food.
1*FM:RG:M/P - Porridge made from fermented maize and roasted groundnuts (without mango or pawpaw) composite flour.
1*FM:RG:M - Porridge made from fermented maize roasted groundnuts and mango composite flour.
1*FM:RG:P - Porridge made from fermented maize, roasted groundnuts and pawpaw composite flour.

REFERENCES


