Formulation and proximate evaluation of complementary diets from locally available foods in southwestern Nigeria

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Abstract

Objective: Complementary foods in Nigeria among low-income households are based on staple cereals. Malnutrition among the affected infants could be attributed to unfortified or poorly-fortified cereal-based complementary foods. The present study was conducted to formulate composite blends using locally available but cheap cereals and legumes, chemically evaluate their respective nutritive values, compare them with most traditionally used sieved maize pap ('ogi'), and also evaluate the acceptability of the composite blends.

Methods: Four composite blends were formulated from common white bean, soya bean, groundnut, fluted pumpkin, bitter leaf, crayfish, dried tomato and palm oil with unsieved yellow maize and guinea corn as the project food base. Standard procedures of Association of Official Analytical Chemists were used to determine the proximate chemical composition while atomic absorption spectrophotometer was used to determine the mineral element composition. Sensory evaluation to test their acceptability was assessed with 25 panelists using four organoleptic attributes with a five point hedonic scale.

Results: The results showed that protein, fat, ash, calcium, iron and zinc contents of the four composite blends were higher than in the traditionally most-used sieved maize pap. The results further showed that formulation with UYM + GC + GT + UG + BL + CF + O was the most acceptable composite blend by the panelists.

Conclusion: We concluded that nursing mothers do not have to spend so much money to take care of the nutritional status of their infants by adopting these new formulations of complementary foods.

Key words: Complementary foods, malnutrition, proximate chemical composition, composite blends, sensory evaluation, organoleptic attributes.

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Formulation et l'évaluation immédiate des régimes complémentaires à partir d'aliments disponibles localement dans le sud-ouest du Nigeria

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Résumé

Objectif: les aliments complémentaires au Nigeria parmi les ménages à faible revenu sont fondés sur les céréales de base. La malnutrition chez les nourrissons atteints pourrait être attribué à des aliments complémentaires à base de céréales fortifiées ou mal fortifiées. La présente étude a été menée à formuler des mélanges composites utilisant localement les céréales et les légumineuses disponibles, mais bon marché, d'évaluer leurs valeurs nutritives chimiquement respectives, de les comparer avec les plus traditionnellement utilisé tamisé maïs pap («ogi»), et d'évaluer également l'acceptabilité des mélanges composites.

Méthodes: Quatre mélanges composites ont été formulées à partir de haricot blanc, le soja, l'arachide, la courge cannelée, feuille amère, écrevisses, tomates séchées et huile de palme avec le maïs jaune non tamisé et Guinée maïs comme base alimentaire de projet. Les procédures standard de l'Association des chimistes analytiques officiels ont été utilisés pour déterminer la composition chimique proche tout spectrophotomètre d'absorption atomique a été utilisé pour déterminer la composition en éléments minéraux. L'évaluation sensorielle pour tester leur acceptabilité a été évaluée par 25 panélistes utilisant quatre attributs organoleptiques avec une échelle hédonique de cinq points.

Résultats: Les résultats ont montré que protéines, en lipides, cendres, calcium, fer et zinc contenu des quatre mélanges composites étaient plus élevés que dans le tamisé pap de maïs traditionnel le plus utilisé. Les résultats ont également montré que la formulation avec UYM + GC + GT + UG + BL + CF + O était le mélange composite plus acceptable par les panélistes.

Conclusion: Nous avons conclu que les mères qui allaitent ne doivent pas dépenser tant d'argent pour prendre soin de l'état nutritionnel de leurs enfants par l'adoption de ces nouvelles formulations d'aliments complémentaires.

Mots clés: aliments complémentaires, la malnutrition, la composition chimique proche, mélanges composites, évaluation sensorielle, propriétés organoleptiques.

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INTRODUCTION

Exclusive breastfeeding can adequately support growth and development for the first 4 to 6 months of life (1, 2). Breast milk alone can be used to properly feed infants in the first six months of life, but from then, complementary feeding is necessary. This is because the second half of an infant's first year is an especially vulnerable time, when breast milk alone is no longer sufficient to meet his or her nutritional requirements and complementary feeding should start (3). Complementary feeding is giving infants other foods or fluids along with breast milk during the complementary feeding period (7th to 24th months of life) and any food given during this period is defined as complementary food (4). Complementary foods can be specially prepared for the infant or can be the same foods available for family members, modified in order to meet the eating skills and needs of the infant (4).

The growth rate of fully breast fed infants in developing countries is comparable with that of infants in developed countries during the first 4-6 months of life (1). However, infants in developing countries commonly deviate from this satisfactory pattern of growth after this period. Lack of nutrient-dense complementary foods and frequent infections are the main factors accounting for this decline (5, 6). It is essential that infants receive appropriate, adequate and safe complementary food to ensure the right transition from breastfeeding to the full use of family foods (7).

The present study was conducted to formulate some composite blends based on the locally available cereals and legumes, and chemically evaluate their respective nutritive values. It was also part of the study to evaluate the acceptability of the composite blends using four organoleptic attributes with a five hedonic scale.

MATERIALS AND METHODS
Food Materials

The following ingredients were purchased from a local market in Osogbo, Southwestern part of Nigeria: dried tomatoes, fresh bitter leaves, fresh fluted pumpkin i.e. 'ugwu, (Telfairea occidentalis) vegetables, crayfish (Macrobrachium spp), yellow maize, dried soya beans (Glycine Max), dried white beans (Phaseolus vulgaris), dried groundnuts (Arachis hypogea), guinea corn, and palm oil (supernatant part).

Production of the Experimental Complementary Foods: Production of Sieved and Unsieved Yellow Maize Pap

The method of Baningo and Akpapunam (8) with modification was used to ferment yellow maize in this study. Five (5) kg of cleaned yellow maize grains were sorted, washed and steeped in clean water for two days in large bowl with cover. The contents were allowed to ferment at room temperature for three days. The steeped water was changed with fresh but clean water after each day. On the fourth day, the steeped water was decanted and fermented yellow maize was grounded to slurry (i.e. pap) using hydraulic mill. A larger part of the pap was squeezed with clean new white cloth to remove water, stored in a clean bowl with cover and kept in a refrigerator till further use. The remaining pap was thereafter sieved using a fine white cloth as sieve with excess water. The coarse particles were discarded and the sediment allowed to settle and squeezed to remove excess water. The wet solid sieved pap was also stored in a clean bowl with cover and kept in a refrigerator till further use.

Production of Guinea Corn Pap: Five (5) kg of cleaned white guinea corn were sorted, washed and steeped in clean water for two days in large bowl with cover. The contents were allowed to ferment at room temperature

for three days. The steeped water was changed with fresh but clean water after each day. On the fourth day, the steeped water was decanted and fermented guinea corn was grounded to slurry (i.e. pap) using hydraulic mill. The slurry was squeezed with clean new white cloth to remove water, stored in a clean bowl with cover and kept in a refrigerator till further use and analysis.

Productions of white bean, soya bean, groundnuts flours, soya bean grains, white bean grains and groundnuts were sorted separately, washed and blanched for 45 min. They were dehulled and toasted for 30 min. The toasted grains and nuts were then oven dried at 60°C for 15 min, milled and sieved to fine flours. The flours were packaged separately and sealed with food grade polyethylene bags till further use and analysis.

Productions of other Food Materials

Fresh bitter leaves and fluted pumpkin leaves were shade-dried under hygienic environmental conditions. The dried bitter leaves, fluted pumpkin leaves and dried tomatoes were roasted and grounded into powdered form separately. Dried Cray fish was also grounded separately. The powdered food materials were kept separately in clean and air-tight containers till further use and analysis.

Formulation and Preparation of Complementary Foods: Unsieved yellow maize and guinea corn served as the primary project food base for the four composite blends while beans, ground nut and soya bean served as secondary food base. Ground tomato, flutted pumpkin (ugwu), bitter leaf, crayfish, and palm oil were used to flavor the composite blends. Sieved yellow maize pap which is the traditionally most-used complementary food served as control. The formulation of the four composite blends was done as follows:

A. SYM
B. UYM+GC+GT+UG+BL+CF+O
C. UYM+GC+BN+GT+UG+BL+CF+O
D. UYM+GC+GN+GT+UG+BL+CF+O
E. UYM+GC+SB+GT+UG+BL+CF+O
KEY: SYM- Sieved yellow maize; UYM – Unsieved yellow maize; GC- Guinea corn; GT- Ground tomato; UG- 'Ugwu' leaf; BL- Bitter leaf; CF= Crayfish; BN- Beans; SB- Soya bean; GN- Ground nut; SB- Soya bean; O-Oil

Unsieved yellow maize (100 g) and guinea corn (100 g) were mixed together in a clean pot with about 1 liter of tap water and put on fire (cooking stove). It was gently stirred, on getting solidified, the ingredients were added accordingly: 5 g of ground tomato, 5 g of ground dried 'ugwu' leaf, 5 g of ground dried bitter leaf, 5 g of ground crayfish, 10 ml of oil, and sugar to taste. Likewise, five (5) g each of bean, groundnut and soya bean flours were added to the other three composite blends respectively.

Sensory Evaluation of Complementary Food Mixes

The acceptability of the four complementary foods was assessed by twenty-five nursing mothers who served as panelists in the present study using four organoleptic attributes (colour, taste, odour and texture) with a five point hedonic scale, where 1= very bad, 2 = bad, 3 = just okay, 4 = good and 5 = very good.

Chemical Analysis

Standard procedures of Association of Official Analytical Chemists (AOAC) were used to determine the moisture content, crude fat, crude protein (N x 6.25) and ash. Minerals (iron, calcium and zinc) were determined by a Zeeman Polarized Atomic Absorption Spectrophotometer, Hitachi Model 180-80.

Statistical Analysis

Primary data collected were analyzed with

both descriptive and inferential analytical statistics using SPSS statistical package. The results of sensory evaluation were reported as mean scores for each sample.

RESULTS

Table 1 shows the proximate chemical composition of complementing unsieved yellow maize with guinea corn, beans, soya beans, groundnut, ground dried tomato, ground dried 'ugwu' leaf (fluted pumpkin), ground dried bitter leaf, ground crayfish and oil. They were analyzed for micro and macronutrient composition per 100g portion wet weight value. Sieved yellow maize which served as control complementary food has the highest moisture content. Whereas, protein, fat, ash, calcium, iron and zinc contents of the four composite blends were higher than in the traditionally most-used sieved maize pap. Formulation with UYM +GC+SB+ GT+UG + BL + CF + O had the highest protein content (4.69%) while UYM +GC+GN + GT+UG+BL+CF+O had the highest fat content (0.93%). Calcium contents were highest (2.00 mg/100g) in UYM +GC+BN + GT + UG + BL + CF + O and UYM +GC+GN + GT + UG + BL + CF + O. Iron content was highest (72 mg/100 g) in blend with UYM +GC+GT+UG + BL+ CF +O while zinc content was highest (1.5 mg /100g) in UYM +GC+SB+ GT + UG + BL + CF + O. It was obvious that the quality of the corn pap with the addition of guinea corn, beans, groundnut, ground tomato, crayfish, 'ugwu', bitter leaf, soya beans and oil increased the nutritive quality of the complementary foods. Any of such complementary foods could be adopted for use by the nursing mothers.

Table 2 shows the sensory evaluation average scores of the four project complementary foods as evaluated by 25 nursing mothers. It was observed that composite blend with unsieved yellow maize, guinea corn, ground tomato, 'ugwu' (fluted pumpkin), crayfish, bitter leaf, and oil was most liked by the

mothers.

DISCUSSION

In developing countries, complementary foods are mainly based on starchy tubers like cassava, cocoyam and sweet potato or on cereals like maize, rice, wheat, sorghum and millet (9). Cereal-based foods are generally low in protein and are limited in some essential amino acids, particularly lysine and tryptophan. Supplementation of cereals with locally available legumes increases the protein content of cereal-legume blends and their protein quality through mutual complementation of their individual amino acids (10). The consumption of maize, beans, groundnuts, soya beans, and leafy green vegetable by both children and adults in Nigeria is not new (11). Despite the fact that these are rich in protein, fat, calcium and iron, they are rarely fed to infants. Some of the reasons for this low consumption were development of flatulence and other gastrointestinal discomfort (11). In this study, the protein content of the sieved yellow maize pap was 0.04 % compared to 1.65 %, 2.21 %, 3.35 % and 4.69 % observed in UYM +GC+GT+UG+ BL+ CF +O, UYM +GC+BN + GT+ UG + BL + CF + O, UYM +GC+GN + GT+ UG + BL + CF + O, and UYM +GC+SB+ GT+ UG + BL + CF + O respectively. The increase in protein content may be as result of complementation of maize and guinea corn that served as project food base in this study with legumes, crayfish and vegetables. This is in support of previous studies (10, 12, 13, 14, 15, 16).

The results of our study further showed increase in fat (energy) content in all the composite blends when compared with sieved yellow maize pap which served as control complementary food. This could be attributed to inclusion of oil-dense soya beans and palm oil in the complementary foods. This attribute tends to agree with the recommendations of FAO/WHO that

vegetable oils be included in foods meant for infants and children, which will not only increase the energy density, but also be a transport vehicle for fat soluble vitamins (16, 17).

The macronutrient and micronutrient contents of the four composite blends were higher than in the control food. The calcium, iron and zinc contents of the four complementary foods were remarkably higher than that of sieved yellow maize pap which is commonly used as weaning food in Nigeria. This mirrors previous studies done on the macronutrient and micronutrient status of complementary foods (16). However, this result is at variance to the pattern observed in the study of Dewey et al (18) where one of the complementary feed fortified with vitamins and minerals resulted in improved micro nutrient status. It could be suggested that most of the feed in their study are rich in phytate and fibre content which may likely impair iron and zinc absorption (19). Although the phytate content of the complementary foods of our study was not performed, it could be suggested that they were of low phytate content. The high moisture contents observed in the four complementary foods, though lower than in control complementary food, may affect their storage quality. High moisture content in foods has been shown to encourage microbial growth (13). Use of large quantity of water in the preparation of the composite blends might have been responsible for their high moisture contents since most of the food ingredients used in this study were dried.

All the four complementary foods evaluated in our study were generally acceptable by the panelists (nursing mothers) considering their mean scores, and it was observed that mothers are willing to adopt and prepare this improved complimentary foods. Modified complementary pap containing unsieved yellow maize, guinea corn, tomato, fluted pumpkin ('ugwu'), bitter leaf, crayfish and oil was most preferred by

the nursing mothers. Addition of sugar and oil was found to improve the sensory attribute of the formulated foods and as well contributed to their higher acceptability. This mirrors similar study done by Muhimbula, et al (10) on sensory evaluation of complementary foods in Iringa, Tanzania.

CONCLUSION

Based on the results obtained in this study, we could conclude that complementation of the popular maize pap among Nigerians and Africans with local, cheap and readily available legumes and leafy-green vegetables used in this study improved protein, fat (energy), macronutrient, and micronutrient contents of the four complementary foods. Any of such complementary food could be adopted for use by the nursing mothers and that they do not have to spend so much money to take care of the nutritional status of their infants using these food stuffs.

Conflict of Interest: No conflicts of interest declared.

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Table 1: Proximate chemi cal composition of complementing unsieved yellow maize pap in different b lends with g uinea corn, b eans, Soya beans, g roundnut, g round tomato, fluted pumpkin (ugwu), bitter leaf, crayfish, and palm oil.

Groups	Samples	Moisture %	Protein %	Fat %	Ash %	Ca (mg/100g)	Fe (mg/100g)	Zn (mg/100g)
A	SYM	94.04	0.04	0.10	0.01	0.01	-----	------
B (i)	UYM +GC	86.92	1.47	0.28	0.11	0.50	9.00	0.01
(ii)	UYM+GC+ GT+UG BL+ CF+O	84.57	1.65	0.50	0.23	1.00	52.00	0.50
C (i)	UYM +GC+ BN	86.38	1.92	0.30	0.19	0.50	9.50	0.50
(ii)	UYM +GC+ BN+GT+UG+ BL+CF + O	79.69	2.21	0.68	0.42	2.00	15.50	0.56
D (i)	UYM +GC+ GN	87.48	2.02	0.45	0.27	1.00	33.50	0.01
(ii)	UYM +GC+GN + GT +UG+BL+ CF + O	76.92	3.35	0.93	0.59	2.00	41.00	0.50
E (i)	UYM +GC+SB	77.93	4.63	0.28	0.56	0.55	27.50	0.50
(ii)	UYM +GC+SB + GT +UG + BL + CF + O	74.75	4.69	0.76	0.63	1.00	43.50	1.50

KEY:

SYM- Sieved yellow maize; UYM – Unsieved yellow maize; GC-Guinea corn;

GT- Ground tomato; UG -'Ugwu' leaf; BL- Bitter leaf; CF= Cray fish; BN - Beans;

GN- Ground nut; SB-Soya bean; O - Oil

Table 2: Mean score of sensory evaluation of the four complimentary blends as tasted by the nursing mothers

	Organoleptic attributes N= 25				
Complementary Blends	Colour	Taste	Odour	Texture	Overall Score
UYM +GC+GT + UG + BL + CF + O	5.00	5.00	5.00	4.88	19.88
UYM +GC+BE + GT+ UG + BL + CF+ O	4.20	4.40	4.40	4.20	17.20
UYM +GC+GN + GT+ UG + BL + CF + O	4.25	4.25	4.25	3.75	16.50
UYM +GC+SB+ GT+ UG + BL + CF + O	4.28	4.28	3.28	3.38	15.69

KEY:

UYM – Unsieved yellow maize; GC-Guinea corn; GT- Ground tomato; UG- 'Ugwu' leaf; BL- Bitter leaf; CF= Cray fish; BN- Beans; GN - Ground nut; SB - Soya bean; O-Oil