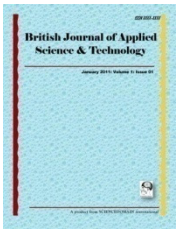

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Energy, Iron and Zinc Densities of Commonly Consumed Traditional Complementary Foods in Nigeria

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ABSTRACT

Aim: To assess the energy, iron and zinc densities of ten selected commonly consumed traditional complementary foods in Nigeria.
Study Design: Survey and Experimental study.
Place and Duration of Study: Department of Hotel and Catering Management, Yaba College of Technology, Lagos, and Department of Human Nutrition, University of Ibadan, Oyo State, Nigeria between June and August, 2004.
Methodology: A validated interviewer-administered questionnaire was distributed to 600 nursing mothers and used to identify the most commonly consumed traditional complementary foods in Nigeria. Thereafter, ten traditional complementary foods were selected and analyzed for proximate composition, iron and zinc using Association of Official Analytical Chemists (AOAC) and Atomic Absorption Spectrophotometric methods.
Results: The traditional complementary foods have high moisture content ranging from 55.80% to 91.17%. The protein content of the complementary foods ranged from 1.06g/100g to 13.81g/100g. The energy densities of the selected traditional complementary ranged from 0.48kcal/g to1.50kcal/g. The study revealed that half of the traditional complementary foods in this study did not meet the PAHO/WHO recommendation of 0.8kcal/g while the remaining half exceeded this basic requirement for

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energy densities. However, the high requirement of 7.7mg and 1.6mg for iron and zinc densities respectively, could not be met by any of the complementary foods assessed.
Conclusion: Incorporation of some animal foods into these plant based diets will have a lot of advantages as animals-source foods are good sources of readily available haemiron and zinc. Therefore, more recipes should be developed to improve the intake of animal source foods which are needed to ensure adequate protein, iron and zinc densities of complementary foods for infants in Nigeria.

Keywords: Infants; complementary foods; energy; Iron; Zinc.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

ACC/SCN: Administrative Committee on Coordination; Sub-committee on Nutrition; AOAC: Association of Official Analytical Chemists; PAHO: Pan American Health Organization; UNICEF - United Nations Children's Emergency Fund; WHO - World Health Organization; Animal source foods - foods derived from animals, including meat, milk, fish, poultry.
Energy density - the amount of chemical energy delivered per unit of food.
Micronutrients - nutrients that cannot be synthesized in the body and are required in trace amounts in the diet for certain essential physiological functions. For human nutrition, the micronutrients of major concern in the growth and development and health of children are iron, iodine, zinc, calcium, vitamins A and B12, and selenium.

1. INTRODUCTION

Every child has the right to be free from hunger and malnutrition. The survival, growth and development of these infants are the essential foundation of human development. Adequate nutrition and health during the first year of life is fundamental to the attainment of the Millennium Development Goals (MDGs) of Nigeria especially the fourth goal of reducing by two-third the under five mortality by 2015. Nigerian's infant mortality rate of 114 per 1000 live births is among the highest in sub-Saharan Africa (UNICEF, 1997) and a new born Nigerian baby has a 30-times higher chance of dying before the age of five years than a baby born in the developed, industrialized countries (UNICEF, 2001). The first Nigerian Nutrition Network of 2002 also identified poor feeding practices and shortfall in food intake as the important factors responsible for malnutrition and illness among children in Nigeria.

Infancy is a time of rapid physical growth as well as physiological, immunological and mental development. Deficiency of energy or any of the essential nutrients can have dire consequences, some of which are long lasting (Yeung, 1998). Lutter et al. (2003) therefore stated that access to energy and nutrient-dense foods during the complementary feeding period, along with appropriate feeding practices and continued breastfeeding, is needed to ensure long-term optimal growth and development. Complementary foods as defined by Brown and Lutter (2002) are the first foods introduced into an infant's diet in addition to breast milk. World Health Organization also defined complementary food as any food whether manufactured or locally prepared, suitable as a complement to breast milk or to infant formula, when either becomes insufficient to satisfy the nutritional requirement of the infant (WHO, 1981). Although the causes of malnutrition are many and diverse, inadequate intake of foods and essential nutrients has been reported to be a major contributory factor

(Kikafunda et al., 2003). Studies have shown that at 6 months or less, only 17 percent of mothers in Nigeria are exclusively breastfeeding their infants, and by 6 and 9 months, 63 percent of Nigerian mothers have introduced complementary foods while continuing breastfeeding (ACC/SCN, 2004). Therefore, complementary foods of adequate nutrient densities are needed for optimal growth and development of infants after 6 months of age.

In Nigeria, as in most other developing countries, the traditional complementary foods have been reported to be grossly inadequate when compared to estimated needs (Fernandez et al, 2002; Nout, 1993; Ladeji, 2000). The most popular complementary food fed to infants in Nigeria is a fermented cereal gruel called 'pap', 'Akamu' or 'Ogi' which is generally perceived by mothers as easy to digest (Onofiok and Nnanyelugo, 1998; Ibeanu and Okeke, 2001). The availability, minimal cost, and ease of preparation make 'pap' the preferred complementary food for the majority of Nigeria infants. Other traditional complementary foods are based on local staples such as rice, millet, sorghum, groundnuts, soybeans and beans singly or in combination (Nkama et al, 1995). However, the formulation and development of nutritious complementary foods from locally and readily available raw materials has received a lot of attention in Nigeria (Nkama et al, 1995; Ketiku and Ayoku, 1984; Nnam, 2002). This has brought a lot of varieties to the traditional complementary foods used in Nigeria as the maize gruel 'pap' is now being enriched with legumes, nuts and fish.

Zinc is an essential mineral, vital to human metabolism, growth and immune function (Aggett and Comerford, 1995). Zinc deficiency may significantly contribute to growth stunting in young children.; such that what has been termed Protein Energy Malnutrition especially low height-for-age, may be due to poor diet quality including low levels of bioavailable zinc rather than an inadequate quantity of either protein or energy. Mild to moderate zinc deficiency may present clinically as impaired growth, which have previously been attributed to other factors (Brown et al., 1998). Iron deficiency is the most common cause of anemia although other nutrition and non-nutrition related cause can be involved in the origin of anemia. Hallberg and Rossander (1984) reported that anemia is most prevalent in children between 6 and 24 months of age and the major causes are inadequate dietary intake of bioavailable iron, malaria and parasitic infections. Infants with iron-deficiency anemia are easily fatigued, are more irritable, and have shorter attention spans. They also do less well in tests of psychomotor development during later childhood than those who are not iron-deficient in infancy (Lozoff et al., 1991). Furthermore et al., (2002) reported that the prevalence of anaemia is higher during infancy and early childhood than at any other time in the life cycle. The high prevalence is consistent with data showing dietary iron to be inadequate and of low bioavailability in most complementary foods (Lutter, 2003). It is also not surprising given the high dietary requirement of iron per body weight and the small amount of food needed in this age group to meet energy needs.

This study was carried out to estimate the nutrient composition of the traditional complementary foods commonly consumed in Nigeria as well as assess the energy, iron and zinc densities of the foods. Data on the nutrient content of traditional complementary foods is essential in order to know the appropriateness of these foods for infants and to improve infant diets and thus, nutritional status in Nigeria. Again, the data was used to find out if these foods meet the recommendations of the developed Guiding principles for complementary feeding of the breast fed child (PAHO/WHO, 2003).

2. MATERIALS AND METHODS

2.1 Materials

All ingredients used for the preparation of the selected complementary foods were purchased from Onyigbo market of Mainland Local Government Area, Lagos State.

2.2 Selection of Samples

A well structured questionnaire was used to assess current complementary feeding practices from the six major regions of the country which are the North-North, North-East, North-West, South-South, South-East and South-West. A total of 600 mothers were asked to indicate the complementary foods most preferred and given to their children. Recipes of these foods were also collected from the mothers by the researchers through a quasi-interview method.

The data collected showed that the mothers traditionally prepared three types of complementary foods:- (i) Cereal gruel (pap) with the addition of legumes and pulse such as soyabeans, melon seeds, groundnuts, etc (ii) Cereal gruel (pap) with animal proteins such as crayfish, milk, eggs and (iii) mashed tubers, grain porridges and puddings.

Based on these data, ten (10) most preferred and consumed complementary foods were selected for the study. The selected complementary foods are specially prepared for the children and the mothers' responses showed that these foods are prepared only for the infant or younger members of the family.

2.3 Preparation of Samples

The recipes for the complementary foods collected from the mothers were standardized by the researchers and used to prepare the complementary foods. The sample dishes were prepared at the training kitchen of the Department of Hotel and catering management, Yaba College of Technology, Yaba, Lagos. After preparation, the dishes were packed cooled in refrigeration and sent to the laboratory for further analysis.

2.4 Chemical Analysis

Distilled and deionized water and 'analar' reagents were used in the analysis. Each sample was homogenized separately and 2g taken for moisture determination using the air oven method (Association of Official Analytical Chemists, 1990). The remaining was dried at about 550c – 600c, ground and stored in desiccators for further analysis. Proximate analysis of the food samples were carried out according to the procedures of AOAC (1990). Ash was determined by combustion in muffle furnace, at 500℃ for 5 hours, fat was determined by the soxhlet extraction method, protein by the MicroKjedahl method and carbohydrate by difference.

The minerals were analysed from solutions obtained by first dry ashing the sample at 525°C and dissolving the ash in deionized water with a few drops of concentrated hydrochloric acid. The minerals were then determined by means of an atomic absorption spectrophotometer (Buck scientific Inc., Model 200A/21D, Connecticut, 1993). The

metabolizable energy content (kcal) was estimated using the Atwater conversion factor (Passmore and Eastwood, 1986) as follows: 1g of carbohydrate yields 4 kcal of energy (17KJ); 1g of protein yields 4 kcal of energy (17KJ); 1g of lipid of fat yields9 kcal of energy (37KJ). The values reported are the means of three replicates.

3. RESULTS AND DISCUSSION

3.1 Ingredients Used in the Preparation of Traditional Complementary Foods

The recipes of the traditional complementary foods show that most of these foods are cereal based except for the egg custard, plantain pudding and yam pottage (Table 1). More than half of the selected complementary foods as shown in Table 1 were based on the maize gruel (pap) which is the most popular and often the first food introduced to infants by mothers in Nigeria. This is supported by the report by Ibeanu and Okeke (2001) that pap is the most commonly used complementary food in Nigeria. Yeung (1998) also reported that cereals are usually the first solid foods given to infants because they are readily available and culturally acceptable. These cereals usually form the basis for most of the traditional complementary foods (Onofiok and Nnanyelugo, 1998). After the successful introduction of cereal gruel, other staple foods in the family menu are given to the child. These foods according to Onofiok and Nnanyelugo (1998) include yam, rice, garri, and cocoyam which may be eaten with sauce or soup.

3.2 Nutrient Composition of the Traditional Complementary Foods

The selected traditional complementary foods had high moisture content ranging from 55.80% in plantain pudding to 91.17% in sorghum pap. These complementary foods generally had low fat contents except plantain pudding and yam pottage. Furthermore, the carbohydrate content of the selected complementary foods ranged from 6.7±0.60g/100g in Pap with crayfish to 28.8±2.20g/100g in rice pudding.

The nutrient composition of the traditional complementary foods as shown in table 2 revealed that the traditional complementary foods have high moisture content ranging from 55.80% to 91.17%. This invariably means that the infants will need to consume a large quantity of the food to meet up their nutritional requirements. However, this may not be possible considering their stomach size, which is small. The high moisture content of the local diets may also affect the storage quality of the foods. High moisture content in foods has been shown to encourage microbial growth (Temple et al., 1996). This is an important consideration in local feeding methods in Nigeria because some mothers may want to prepare large quantities of infant foods and keep in containers to avoid frequent processing, in order to have spare time and energy for other domestic activities.

The protein contents of the complementary foods varied considerably with low levels of protein found in sorghum pap (1.06g/100g), maize pap (1.08g/100g) and yam pottage (2.68g/100g). Egg custard however had the highest protein content (13.81g/100g). If these meals are consumed 3-4 times daily, the infants will be able to meet their protein requirement of 14mg/day (WHO/UNICEF, 1998) except for the maize pap and sorghum pap. Apart from the low protein contents of maize and sorghum, the processing into pap may also be the reason for the very low protein contents recorded for maize pap and sorghum pap.

The traditional complementary foods were also observed to contain low amounts of fat with the exclusion of plantain pudding (25.50g/100g) and yam pottage (16.23g/100g) which are meant mostly for older infants (10 – 12 months). All other nutrients (calcium and potassium) were found to be low in these foods meant for infants.

Table 1. Ingredients used in the preparation of traditional complementary foods

Complementary Food	Ingredients	Amount	Estimated Serving Size
1. Maize Pap	Corn paste,	25g.	150g
	Clean water	250ml	
	sugar (optional)	to taste	
2. Sorghum Pap	Sorghum paste	25g.	150g
	clean water	250ml	
	sugar (optional)	to taste	
3. Pap with ground nut	Corn paste	25g	180g
	Water	250ml	
	Groundnuts seeds	1 milk tin	
4. Pap with Ground crayfish	Corn paste	25g	160g
	water	250ml	
	Ground crayfish	1 tablespoon	
5. Pap with soybeans flour	Corn paste	25g	180g
	water	250ml	
	soybean	1 milk tin	
6. Millet pudding	Millet	1 milk tin	100g
	raw groundnut	22g	
	crayfish	10g	
	palmoil	2 tablespoon	
	onions	1 medium size	
	salt	to taste	
7. Rice pudding	Rice	2 tablespoon	120g
	milk (evaporated)	70ml	
	water	300ml	
	sugar (optional)	to taste	
8. Egg custard	Egg	1 medium size	75g
	milk (evaporated)	50mls	
	sugar	to taste	
9. Plantain pudding	Unripe plantain	80grms	
	crayfish (ground)	250grms	
	palmoil	20mls	
	onion	1 small size	100g
	water	100mls	
	tomato	2 medium sizes	
	salt	to taste	
10. Yam pottage	Yam	3 medium slices	
	tomatoes	2 medium sizes	
	onion	1 medium size	100g
	red palmoil	3 tablespoon	
	water	300ml	

Table 2. Nutritional composition of the traditional complementary foods

Complementary food	Moisture Content, %	Protein (g)	Fat (g)	Carbohydrate (g)	Ash (g)	Calcium (mg)	Potassium (mg)
Maize Pap	89.95	1.08	0.09	8.41	0.47	0.44	0.31
Sorghum Pap	91.17	1.06	0.07	7.57	0.13	0.26	0.17
Pap with roasted groundnut powder	73.22	7.78	0.16	12.24	6.60	19.69	6.35
Pap with ground crayfish	86.65	4.69	0.70	5.60	2.36	11.90	1.84
Pap with soybeans flour	82.49	7.82	1.35	3.27	5.07	10.60	6.35
Millet pudding	70.75	8.21	4.09	11.85	5.10	47.27	29.86
Rice Pudding	63.99	3.74	0.82	29.98	1.47	13.11	8.74
Egg custard	65.90	13.81	1.02	15.80	3.47	5.27	2.40
Plantain pudding	55.80	3.50	25.50	6.33	8.90	5.60	1.68
Yam pottage	76.23	2.68	16.23	1.97	2.89	3.42	1.67

Table 3. Energy, Zinc and Iron densities of the traditional complementary foods

Sl. No.	Name of complementary foods	Energy content (Kcal/100g)	Energy density (Kcal/g)	Iron content (mg/100g)	Iron Density (mg/100kcal)	Zinc Content (mg/100g)	Zinc density (mg/100kcal)
1.	Maize Pap	38.77	0.39	0.83	2.46	0.19	0.49
2.	Sorghum Pap	35.15	0.35	0.99	2.82	0.16	0.46
3.	Pap with roasted groundnut powder	81.55	0.82	1.97	2.42	0.79	0.97
4.	Pap with ground crayfish	47.46	0.47	1.63	3.43	0.54	1.14
5.	Pap with soybeans flour	56.51	0.57	2.19	3.88	1.72	3.04
6.	Millet pudding	117.05	1.17	3.01	2.57	1.27	1.09
7.	Rice Pudding	142.26	1.42	2.28	1.60	1.91	1.34
8.	Egg custard	127.62	1.28	2.14	1.68	1.14	0.89
9.	Plantain Pudding	268.82	2.69	1.41	0.52	0.44	0.16
10.	Yam pottage	164.67	1.65	2.14	1.30	0.71	0.48

3.3 Energy, Zinc and Iron Densities of the Traditional Complementary Foods

The WHO recommendations for complementary feeding of the breast fed child suggests that infants between 6 and 8 months receive at least 200kcal/day from complementary foods and 300kcal/day for infants 9 to 12 months (Dewey and Brown, 2003). These recommendations also assume good maternal nutritional status and adequate breast milk intake and composition of breast milk. Based on these WHO recommendations, infants feeding on pap alone (maize or sorghum) will not be able to meet their energy requirement, considering the high moisture content of pap as well. However, other complementary foods analyzed were shown (Table 3) to have moderate energy values which will possibly be adequate for infants 6 – 12 months of age consuming such meals 2 – 3 times daily.

Furthermore, the guiding principles for complementary feeding of the breast fed child (PAHO / WHO, 2003) recommends energy density of 0.8kcal/g and that they be fed 2 or 3 times a day to infants 6 to 8 months of age, and 3 to 4 times a day to infants 9 to 11 months and children 12 to 24 months. The energy density of the complementary foods as shown on Table 3 revealed that less than half of these complementary foods do not meet this recommendation while six out of the ten selected traditional complementary foods exceeded this basic requirement. This result contrasts the highly held belief that complementary foods fed to infants in developing countries haves energy density below 0.3kcal/g (SCN, 2001).

Iron and Zinc are critical micronutrient for the growth, development, immunity and health of infants and are known to be limiting nutrients in the diets of infants and young children (Dewey and Brown, 2003). Table 3 also shows the content and densities of iron and zinc in the traditional complementary foods. The recommended iron density of complementary food for infants 6 to 8 months of age is 7.7mg/100kcal for diets of low iron bioavailability compared with 4.6mg/100kcalfor infants 9 to 11 months (Table 4) (PAHO/WHO, 2003). In this analysis, all the selected traditional complementary foods were considered to have low iron bioavailability, as the ingredients are basically of plant origin. However, none of the traditional complementary foods met the recommended iron density. On the other hand, the recommended density for zinc in complementary food for infant 6 to 8 months of age is 1.6mg/100kcal. The data as presented on Table 3 revealed that only pap with soybean (3.04mg/100kcal) met the recommended density for zinc.

Table 4. Recommended Density (PAHO/WHO, 2003)

Energy		
6-23 months	0.08 kcal/g	
Iron (mg/100kcal)	Low bioavailability	Average bioavailability
6 – 8 months	7.7	4.0
9 – 1 months	4.6	2.4
12 – 23 months	1.6	0.8
Zinc (mg/100kcal)		
6 – 8 months	1.6	
9 – 11 months	1.1	
12 – 23 months	0.6	

4. CONCLUSION

Most of the traditional complementary foods assessed were deficient in both macro and micro nutrients especially iron and zinc. The researchers therefore recommend that foods from animal sources such as fish, liver etc which are known to be good sources of iron and zinc should be used to enrich these traditional complementary foods so as to make it nutritionally adequate for the infants consuming them.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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