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Proximate and Vitamin Composition of Selected Cereals Commonly Used for Weaning Babies' Food Preparation in South-Eastern Nigeria

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Abstract
Four different cereal products commonly used in the preparation of weaning babies' food in Nigeria were analyzed for their vitamin and proximate composition to weigh their suitability as weaning foods for growing infants in Nigeria. The cereals were processed individually into dry powdered form which was used for the analysis. *Zea mays* (Yellow maize) had the highest concentration of moisture, ash, crude fibre and fat as compared to the other cereals. Except for thymine, *Zea mays* also contained the highest concentration of all the vitamins tested. It however, had the least concentration of carbohydrate among the tested cereals. *Triticum aestivum* (Common wheat) possessed the highest amount of protein among the cereals and is also considerably rich in vitamin A which is required for proper development of vision in children. *Sorghum bicolor* (Guinea corn) was found to be rich in vitamin C while *Oriza sativa* contained the least of all nutrients and vitamins tested except carbohydrate and dry matter. *Zea mays* may thus be considered a good weaning cereal for infants in this part of the world. *Triticum aestivum* which is rich in protein may also be in cooperated into babies' weaning foods to enhance proper growth and development in infants. *Oriza sativa* may not be an ideal cereal for the weaning of infants.
Keywords: proximate, vitamin, composition, weaning, cereals.

1. Introduction

Nutrition is the science that interprets the interaction of nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism. It includes food intake, absorption, assimilation, biosynthesis, catabolism and excretion (US National Library of medicine, 1998). A poor diet may cause health problems, and deficiency diseases such as blindness, anaemia, scurvy, preterm birth, stillbirth and cretinism (Whitney *et al*.,2009). It can also cause health-threatening conditions like obesity, metabolic syndrome, and osteoporosis. Chronic cases of malnutrition could cause kwashiorkor and marasmus and in extreme cases death. (Whitney *et al*., 2009).

Weaning is the process of gradually introducing a mammal infant to what will be its adult diet and withdrawing the supply of its mother's milk (Rapley, 2006). The process takes place only in mammals, as only mammals produce milk. The infant is considered to be fully weaned once it is no longer fed any breast milk or bottled substitute. Good nutrition is essential for the growth and development that occurs during an infants' first year of life. As an infant's mouth, tongue and digestive tract mature, the infant shifts from being able to only suckle, swallow and take in liquid foods such as breast milk and formula, to being able to chew and receive a wide variety of complement foods (Natureloc, 2017).

During infancy, a period of rapid growth, nutrient requirements per pound of body weight are proportionally higher than at any other time in the life cycle. Infants differ in the amount of nutrients ingested and stored, body composition, growth rate and physical activity levels (US Department of Agriculture, Food and Nutrition Service, 2009). The Daily Required Intake for vitamins, minerals and proteins are set at levels thought to be high enough to meet the nutrient needs of most healthy infants. Infants need energy from food for activity, growth, and normal development. This energy comes from foods containing carbohydrate, protein, or fat (US Department of Agriculture, Food and Nutrition Service, 2009). The required dietary intake for infants from 0-12 months include 60g- 95g/day of carbohydrate, 9.1-11g/day of protein, 30-31g/day of fat, 400-500 µg Retinol active equivalent of vitamin A, 4m-5mg/day of α-tocopherol, 40-50mg/day of vitamin C, 0.2-0.3mg/day of thiamine, 0.3mg-0.4mg/day of riboflavin, 2mg-4mg/day of preformed niacin.(US Department of Agriculture, Food and Nutrition Service, 2009).

A cereal is any grass cultivated for the edible components of its grain. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop and are therefore staple crops (Head, 2016). In some developing countries, cereals especially rice, wheat and maize constitutes the major part of daily food (Head, 2016). In Nigeria, cereal constitutes a large portion of daily diet especially in young children and babies. Many of these cereals are processed into various forms e.g corn flakes, golden morn, ogi, dawa, cerelac, frisocream etc. The cereals are consumed majorly by infants (during weaning) who need all the nutrients they can, get at that critical point of their life (growth and development). The four cereals in this study were chosen because they are the most common cereals used in Nigeria to prepare weaning babies' food.

Zea mays, also known as corn, is a large grain plant first domesticated by indigenous peoples in southern Mexico (University of Utah Health Science, 2016) about 10,000 years ago. Maize has become a staple food in many parts of the world, with total production surpassing that of wheat or rice (Franklyn, 2013). Its root system is generally shallow, so the plant is dependent on soil moisture. In 2016, corn (maize) production was forecast to be over 15 billion bushels, an increase of 11% over 2014 American production (US Dept of Agric, 2016). Introduced into Africa by the Portuguese in the 16th century, maize has become Africa's most important staple food crop (Oluwalana, 2014). Corn flakes are a common breakfast cereal in North America and the United Kingdom, and found in many other countries all over the world. Maize have been reported to possess suboptimal amounts of the essential amino acids tryptophan and lysine (UN-FAO, 1992). *Oryza sativa* is the most important staple food for a large part of the world's population. It is the most important grain with regard to human nutrition and caloric intake providing more than one-fifth of the calorie consumed worldwide by the human species (Mian Kamran, 2014). *Triticum spp* is a staple food used to make flour for leavened, flat and steamed breads, biscuits, cookies, cakes, breakfast cereal pasta, noodles (Cauvain, 2003). It is a cereal grain that originated in Africa commonly known as grain sorghum which belongs to the general class of sorghum. *Sorghum bicolor* grain is the fifth most important cereal in the world (FAO, 2008). In Africa, it comes second after maize in terms of production. Nigeria accounts for one of the highest products of *Sorghum bicolor*.

The major constraint in weaning babies' food in Nigeria is finance. Since most families in Nigeria who are still in the productive age belong to the low or average class, most of them cannot efficiently afford nutrient and vitamin enriched milk formulas and processed baby cereals, some may not afford whole fruits and vegetables in their natural form. The only option left to them is therefore whole grains. These whole grains in their natural form are more affordable and likely to be richer and more nutritious than the processed ones which may have lost some nutrients during processing. Since infants usually graduate from liquids to semi solid foods, extra effort must be made to enrich the semi solid foods as most food which can be processed into semi solid foods are cereals and grains. These cereals are usually soaked in water overnight or for two nights in order to soften the grain, after this the grains are ground into a fine paste with water, the ground paste is finally sieved using a clean piece of cloth to remove the fibre and collect a fine textured paste which is usually made into pap. The food can be served with milk, sugar, salt or even soyabean powder, etc.

Babies are a very delicate group of individuals and experience the highest level of growth and cell division during their first year of life. The type of nutrition they receive at this very important stage of their life affects almost every aspect of their growth and general development. Malnutrition in children has also become a very serious issue of concern especially in the developing countries where we have the highest number of illiterate and low income mothers. It is imperative therefore that this research is carried out to increase public awareness on the choice of food for babies especially during the weaning period. This research seeks to investigate the nutrient composition of each of these cereals mentioned above, in order to advice on their use in making babies' weaning food. The research would provide information on the nutrient profile of selected cereals and the concentration of each nutrient in the cereals.

2. Materials and Methods

2.1 Equipments:

Weighing balance (Ohaus, U.S), Jenway. This was used to weigh all the cereal samples, beakers, conical flasks throughout the experiment. UV-Visible spectrophotometer, (Keison UK) was used to read the absorption of each sample throughout the experiment. Water bath-HH-1042-0,(Germany) was used to incubate samples at a uniform constant temperature during the process. Desiccator (Fisher Scientific U.S.A), Dry powdered samples were stored in the desiccator until analysed. Soxhlet apparatus (B.BRAN-England) was used for the determination of fat, Digestion unit (kjeldahl, VELP Scientifica-Malaysia) was used for the determination of protein. Centrifuge (B.BRAN Scientific England), All spinning during the experiment to separate components were performed using the centrifuge.

2.2 Collection and Identification of Cereal Grains

The cereal grains were purchased from Umuahia town market in Abia State, Nigeria. The yellow variety of *Zea mays*, one of the commonly consumed varieties of *Oryza sativa* (Mama Gold), *Triticum aestivum* (the brown coloured wheat) and *Sorghum bicolour* (The red coloured guinea corn) were all purchased from Umuahia town market in Abia State, Nigeria. The collected cereals were identified at National Root Crop Research Institute, Umudike Abia State. One hundred grams (100 g) of each sample was dried and ground to powder for analysis. All determinations were performed in triplicates.

2.3 Proximate analysis of cereals

Moisture was determined by the gravimetric method of James, (1995), fat **and** crude protein compositions were determined by the soxhlet extraction method and the kjedahl method as described by A.O.A.C (1975). Fibre was

determined by Wende method (James, 1995), total ash was determined using the gravimetric method (AOAC 1990), carbohydrate content was determined by difference in the nitrogen free extraction (NFE) a method separately described by Pearson (1976) and James (1995).

2.4 Vitamin analysis of cereals

Vitamins C and B_1 (thymine) were determined by the barakat titrimetric method, vitamins E, A, B_2 (Riboflavin) and B_3 (Niacin) were determined by the spectrophotometric method of the association of vitamin chemist described by Pearson [1976]. Each parameter determined was analysed three times for each of the cereal samples. The values obtained were analysed statistically using one way analysis of variance (ANOVA).

2.5 Statistical analysis

Statistical analysis of the data obtained from the research was carried out using one way analysis of variance (ANOVA) followed by post hoc LSD test (Fisher 1935).The significance in difference was accepted at $p<0.05$.The results were expressed as mean ± SD (standard deviation).

3. Results

3.1 Result of proximate composition of the cereals

Selected Cereals	Moisture content (%)	Dried matter (%)	Ash (%)	Crude fibre (%)	Fat (%)	Crude protein (%)	Carbohydrate (%)
Triticum aestivum (Wheat)	9.79 ± 0.01c	90.21±0.01a	2.38±0.02b	1.73±0.01b	3.34±0.07b	12.39±0.04a	70.33±0.04c
Zea mays (Maize)	10.37±0.02a	89.63±0.02d	3.17±0.02a	1.85±0.01a	4.07±0.02a	10.79±0.01b	69.74±0.00d
Oriza sativa (Rice)	9.24±0.00d	90.76±0.00b	0.78±0.02d	0.84±0.01d	0.14±0.00d	8.76±0.00d	80.22±0.02a
Sorghum bicolour (Guinea corn)	10.17±0.02b	89.87±0.04c	1.83±0.02c	1.63±0.02c	1.94±0.01c	9.85±0.01c	74.57±0.01b

Values are means ± standard deviation of three determination values on the same column with different superscripts are significantly different ($P \leq 0.05$). Carbohydrate is clearly predominant in all the cereals tested, followed closely by protein, fat, ash and crude fibre. *Zea mays* possessed the highest concentration of most nutrients tested.

3.2 Result of Vitamins composition of cereals

Selected Cereals	Vitamin A (IU/g)	Riboflavin (vitamin B_2) (mg/100g)	Thiamine (vitamin B_1) (mg/100g)	Niacin (vitamin B_3) (mg/100g)	Vitamin C (mg/100g)	Vitamin E (IU/g)
Triticum aestivum (Guinea corn)	3.25±0.01*b*	0.09±0.00d	0.09±0.00c	0.07±0.00b	0.49±0.00c	0.92±0.00c
Zea mays (Maize)	4.29±0.01a	0.53±0.01a	0.13±0.001b	2.67±0.03a	7.85±0.01a	1.65±0.00a
Oriza sativa (Rice)	0.16±0.00d	0.06±0.001c	0.08±0.001c	0.05±0.00b	0.25±0.01d	0.85±0.00d
Sorghum bicolour (Wheat)	1.29±0.01c	0.28±0.00b	0.19±0.00a	0.55±0.72b	4.67±0.03b	1.30±0.00b

Values are means ± standard deviation of three determinations. Values on the same column with different superscripts are significantly different ($P \leq 0.05$). *Zea mays* possessed the highest concentration of almost all vitamins analysed whie *Oriza sativa* possessed the least of all vitamins tested.

Note: 1IU of vitamin A = 300mg retinol, 1IU of vitamin E=0.67mg d-∝ tocopherol.

4. Discussion

Four months into the growth and development of a newborn, breast milk alone is not sufficient to meet the child's nutritional requirement and thus supplementary feeding is required (Ijarotimi, 2006). As a result of this, so many versions of preparatory weaning foods have been developed and marketed in most developing countries including Nigeria (Okafor *et al*., 2008). These foods are usually made from cereal grains into a semi-solid porridge form. The suitability of each of these selected cereals as a weaning food was analysed in order to advice properly on their use as weaning food for babies. The nutrient and vitamin composition of the cereals especially *Zea mays* compared favourably with some of the commercial milk formulars like; NAN and Lactogen milk formulars.

From the result obtained from this research, it is obvious that *Zea mays* may be the most suitable cereal for preparing weaning babies' food in this part of th world as compared to the other cereals; it may be combined with *Triticum aestivum* which possessed the highest amount of protein among the cereals since protein is required for proper growth and development in babies. *Oriza sativa* does not appear to be a very good cereal for preparing weaning babies' food as it contained the least amount of all tested nutrients (except carbohydrate) and vitamins essential for proper growth and development of the baby. While rice may be useful in supplying the energy required for daily activities especially in growing children, it may not be sufficient to supply all the other nutrients as it had

the least values for most nutrients tested.

The Carbohydrate and protein levels of tested cereals were adequate within the recommended dietary allowance of 60-95g/day and 9.1-11g/day respectively for infants between the ages of 0 to 12months of age (Whitney *et al*,2009). The selected cereals showed good tendency to supply adequate carbohydrate and protein required in weaning babies. For the vitamins, *Zea mays* is adequate to supply the recommended daily allowance for vitamins B_2 (0.3-0.4mg/day), vitamin B_3 (2-4mg/day) while *sorghum bicolour* provided slightly below the required amount of vitamin B_2. The cereals were also observed to be adequately sufficient to meet the Required Daily Allowance for vitamins A (400-500µg/day), E (4-5mg/day) and C (40-50mg/day), being that baby receives at least two-three servings in a day. A combination of one or more cereal could also be tried in order to obtain maximum satisfaction and benefit, besides the cereals are usually given to babies most times with some supplements like milk and soybean which also help to fortify the meal even more. *Sorghum bicolour* met the daily requirement for vitamin B_1 (0.2-0.3mg/day) per 100g .The cereals may also be supplemented with the appropriate vitamins (where necessary) to ensure maximum benefit of the nutrients they contain.

From our result in proximate analysis, maize (*Zea mays*) had the richest nutritional value followed by guinea corn (*Triticum aestivum*), then wheat (*Sorghum bicolour)* and finally rice. Table 1 also shows that guinea corn had significantly ($P<0.05$) higher protein content than other samples. Due to the high crude protein in guinea corn, it might be beneficial to incorporate it into weaning food for babies since protein is very important at this stage for cell division. Guinea corn (*Triticum aestivum*), should thus be well blended into the nutrition of weaning babies because of the importance of protein in body building and repair of worn tissues. Coincidentally rice also had the lowest value of all vitamins tested, among the cereals further confirming it as the least nutritious of the four cereals. The vitamin C content of *Zea mays* and *Triticum aestivum* are encouraging, they could help check scurvy in weaning babies.

The high content of vitamin A in *Sorghum bicolor* and *Zea mays* is very important especially for babies since vitamin A helps boost the integrity of the immune system and promotes growth (Sommer, 1990). *Sorghum bicolor* might also be useful in the control of infantile beriberi. The vitamin B_2 content of wheat (0.19), rice (0.08mg/100g), maize (0.13mg/100g) was found to be in agreement with what was reported by FAO (1999). Vitamin E is essential in neurological functions (Muller, 2010). Neurological functions are vital for the growth and development of babies. This implies that maize may be helpful in the development of neurological functions in babies.

Conclusion

The study revealed differences in proximate and vitamin composition of the selected cereals. From the result of this research, maize is nutritionally richer than the other cereals tested for the feeding of babies, while rice may not be a very suitable meal for weaning of infants given its low content of nutrients and vitamins. The use of *Zea mays* (maize) in the formulation of weaning babies' food should be encouraged, also the use of *Oriza sativa* (Rice) as a weaning food should be greatly discouraged among young mums. *Triticum aestivum* could also be incorporated into weaning babies' food to increase the protein supply required for proper growth and development in infants.

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