Formulation, Nutritional Properties and Acceptability of Complementary Food Prepared From Grains in Localities in North-west Nigeria

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Abstract

North-west Nigeria grow and produce a lot of different cereal -grains and as such grains like wheat, soya beans and groundnut can be found within the environment all year round, thereby making the production of complementary food easy and sustainable. Formulation of nutritionally adequate complementary foods from local ingredients were bought from the local market in Samaru, Zaria. Kaduna State. Wheat, Soya bean and Groundnut were all cleaned and processed with ratio: Wheat: 60: Soybean: 30: Groundnut 10: and analyzed. Nutritional composition showed the moisture content to be 4.51±0.03, Protein and Lipids were 34.08±0.74 and 19.63±0.55 respectively. Carbohydrate has the highest ratio of 40.11±1, ash and fiber 1.67±0.24 and 0.74±0.14 respectively. Phytochemical and anti-nutritional properties showed Tannin to be 1.00%, Saponin 14.00%, Phytate 0.32%, Oxalate 0.50% and Flavonoids 86.52% respectively. Minerals showed Calcium was the most abundant mineral with the concentration of 45.25mg/kg, magnesium102.25mg/kg, iron 8.125 mg/kg and zinc 0.75mg/kg respectively. All the vitamins tested (vitamin C, B6 and A) were present in the sample. Acceptability test showed 10.5%, 21.1%, 15.8% like moderately for taste, color and texture and 21.1% for mouthfeel and flavor while 10.5% dislike moderately for taste and flavor and 5.3% for color, texture and mouthfeel. Therefore, 31.6% of the panelist like moderately while 5.3% dislike moderately. The study revealed that it is possible to Formulate nutritionally adequate and acceptable complementary diet from ingredients sourced locally within the environment.

Keywords: Child malnutrition, Complementary foods, Nutrition properties, Local grains, enriched feeding.

Introduction

The presence of child malnutrition in Nigeria at the time of weaning has been attributed to inappropriate complementary feeding and is responsible for half of children mortality cases. Appropriate nutrition in the first two to three years of life is important in laying the foundation of good nutrition and health for a productive adult life. (UNICEF, 2013). Complementary foods are nutrient containing foods or liquids other than breast milk given to young children during the period of complementary feeding (6–24 months) (WHO, 2001). As a major component to child survival, the improvement of complementary feeding has been shown to be most effective in enhancing child growth and health (WHO, 2009, UNICEF 2016).

Enriched food made from locally available ingredients are a great opportunity to improve the nutrient composition of children's food in order to ensure adequate complementary feeding and sustainability in resource-poor communities in Nigeria, (Compaoré, Nikièma, Bassole, Savadogo,

Hounhouigan, Mouecoucou and Traoré, 2011). The capacity of a complementary diet to meet the protein energy requirements of children depends on its nutritional quality. Locally available foods can contribute to growth, health and development of children if properly combined and prepared with adequate nutritional composition. (Amagloh, Brough, Weber, Anthony, Allan and Jane, 2012) Locally available foods are foods that are easily available in the household and/ or market and consumed by the child, which may or may not include fortified foods.

The World Health Organization (WHO, 2017) recommends that after the age of 6 months, breast-feeding should continue until 24 months of age and beyond, whereas energy- and nutrient-dense complementary foods should be introduced to all children with an emphasis on the use of suitable locally available foods. To reduce the problem of malnutrition, untapped cereals and legumes at low cost can be processed and properly complemented with commonly available carbohydrate sources. This will provide relatively affordable complementary foods that will help to reduce protein - energy malnutrition and improve childhood nutrition. Cereals are an important source of energy and protein in human diet. Wheat is the second most produced food among the cereal crops (WHO, 2017). Cereal grains provide an incredible 68 % of the world's food supply. It is recognized as a major staple food and the cheapest source of protein and calories. Cereals main dietary contribution are carbohydrates and fibre beside these they also provide protein and a smaller amount of lipids and vitamins. It is commonly known that the main nutritional problem of cereal is the low protein content and limited biological quality of protein (highly deficient in lysine and tryptophan) (Olaoge, Onilude and Idowu, 2000), when compared with animal protein. The protein quality in the given cereal can be improved by combining it with other sources of protein. Soybeans are the best sources to improve the quantity and quality of protein found in the cereals (Akubor,2008). Soybeans addition will improve the nutritional quality of food prepared from wheat.

Wheat is the most important staple crop in temperate zones and is in increasing demand as it serves as an everyday food in most household. In addition to being a major source of starch and energy, wheat also provides substantial amount of a number of components which are essential or beneficial for health.

Soybean is an important source of high quality, low cost protein and oil. Compared to other protein-rich foods such as meat, fish, and eggs, soybeans are comparably the cheapest. Soybeans is relatively high in protein. Protein is the reason that soybeans have been called the "meat of the field" or the "meat without bones. Soybeans have unique proteins typically referred to as "peptides." Examples of unique peptides in soybeans include defensins, glycinins, conglycinins and lunasin, and all are now known to provide health benefits, including benefits in the areas of improved blood pressure regulation, better control of blood sugar levels and improved immune function.

Groundnut comes second in terms of oil content among food legumes. Groundnut is an important crop grown worldwide. Commercially it is used mainly for oil production but apart from oil, the by-products of groundnut contain many other functional compounds like proteins, fibers, polyphenols, antioxidants, vitamins and minerals which can be added as a functional

ingredient into many processed foods. Recently it has also revealed that peanuts are excellent source of compounds like resveratrol, phenolic acids, flavonoids and phytosterols that block the absorption of cholesterol from diet. It is also a good source of Co-enzyme Q10 and contains all the 20 amino acids with highest amount of arginine. These bioactive compounds have been recognized for having disease preventive properties and are thought to promote longevity. The processing methods like roasting and boiling have shown increase in the concentration of these bioactive compounds

Groundnut contains high quality edible oil, easily digestible protein and carbohydrates. North-west Nigeria grow and produce a lot of different cereal -grain and as such grains like wheat, soya beans, groundnut can be found within the localities all year round, thereby making the production of complementary food sustainable.

Objectives of the Study

The main objective is to formulate a nutritionally adequate and acceptable complementary foods from local grains sourced within the environment for sustainability. Specifically, the study sought to determine the following:

1. The proximate composition of wheat. Soybean, groundnut as a complementary meal
2. The phytochemical and anti-nutritional factors of wheat, soybean and ground nut meal
3. The mineral concentration of wheat, soybean and groundnut meal
4. Vitamin analysis of wheat, soybean and groundnut meal
5. Present the organoleptic analysis of wheat, soybean and groundnut meal

Materials and Methods

Experimental research design was adopted for the study. This shows the materials and the procedure used to arrive at the results.

Food ingredients: The local food ingredients selected for the formulations were identified through a baseline survey of commonly consumed foods that are locally available and culturally acceptable among young children. This food includes wheat (*T. aestivum*), Soybean (*Glycine max*) and Groundnut (*Arachis hypogea* L.). These food ingredients (1 kg each) were mainly bought from local open-air market in Samaru, Zaria. Kaduna State in Nigeria.

Processing of the ingredients: The grains (Wheat and Soybeans) were winnowed, sorted to remove dirt and other extraneous matter, washed with tap water. The Soybeans was boiled for 25 minutes to reduce any anti-nutritional factor. The Groundnuts and Soybeans were dried in the open sun for a day and were roasted separately in an open-pan to a golden-brown color for 30 minutes each with the use of a traditional charcoal burner with continuous stirring to avoid burning of the seed coat. After being roasted to a characteristic roast flavor, the groundnut was winnowed and the three (Wheat, Soybean and Groundnut) were cooled to room temperature and milled into a smooth flour using commercial mill. The ratio was 60: 30: 10. To obtain a smooth mixture of flour, the different combinations were individually homogenized in a rotary mixer. After which they were packaged in a zip lock bag and stored in the freezer for analysis.

Chemical Analysis: Standard procedures of Association of Official Analytical Chemists (AOAC, 1999, 2000) were used to determine the moisture content, crude fat, crude protein and ash.

Minerals (Iron, Calcium and Zinc) were determined using Atomic Absorption Spectrophotometer after digestion with hydrochloric acid. Digestion was done using sulphuric acid, nitric acid, perchloric acid according to (Osborne et al, 1978).

Crude fibre content was estimated by acid/alkali digestion method proposed by (Yimer, 2008). Total carbohydrates content was calculated by difference (Ijarotimi et al, 2012), Carbohydrate (g/100g) = 100 - (Protein (g) + Fat (g) + Ash (g) + Fibre (g)) carbohydrate and protein contents using Atwater's conversion factors (Nguyen et al., 2007)

Anti- nutritional factors: Tannin contents were determined by the modified vanillin-HCl methods. (Maxson and Rooney, 1972). Phytate content was determined by following the Latta et al., method (Latta and Eskin, 1980).

Acceptability test: The acceptability of product (complementary food) was assessed by thirty trained nursing mothers who are staff of Ahmadu Bello University Zaria. They served as panelists in the study using six attributes (taste, colour, texture, mouthfeel, flavour and acceptability) with an eight-point hedonic scale, dislike, dislike extremely, dislike moderately, neither like or dislike, like slightly, like moderately and like extremely.

For presentation to the panelists, the following method was adopted: bring water to boiling point, make paste with the composite flours, add it to the boiling water, and allow the slurry to be well cooked for about 15 minutes, stir constantly until cooked. The heat was then reduced and it was left to simmer for 10- 15 minutes. The paste was served in cups to the panelist for assessment. Water was provided for rinsing the mouth to avoid being bias. Waste buckets with lids were provided for panelists who did not wish to swallow the samples. After which acceptability were recorded

Statistical Analysis: Data collected were analyzed using both descriptive and inferential analytical statistics using SPSS statistical package. Acceptability test was reported in percentages

Results:

Table 1: The Proximate Composition of Wheat, Soyabeans and Groundnut Meal

Parameter	Values (%)
Moisture	4.51±0.03
Ash	1.67±0.24
Lipid	19.63±0.55
Protein	34.08±0.74
Fibre	0.74±0.14
CHO	40.11±1.06

Values are expressed as Mean ± Standard Deviation (SD)

The moisture content of the sample was obtained to be 4.51±0.03. The protein and lipids contained in the sample are 34.08±0.74 and 19.63±0.55 respectively. The carbohydrate level was the highest calorific contributor as it contained 40.11±1.06 of carbohydrate. The ash and fiber contents of the sample was obtained to be 1.67±0.24 and 0.74±0.14 respectively.

Table 2: The Photochemical and Anti-nutritional Factors of Wheat, Soyabeans and Groundnut Meal

Anti-nutritional factor	Concentration (%)
Phytate	0.32
Tannin	1.00
Oxalate	0.50
Saponin	14.00
Flavonoids	86.52

Table 2: the percentage of Tannin was observed to be 1.00%. Saponin, Phytate, Oxalate and Flavonoids are observed to be 14.00%, 0.32%, 0.50% and 86.52% respectively.

Table 3. The Mineral Concentration of Wheat, Soyabeans and Groundnut Meal

Parameter	Concentration (mg/kg)
Calcium (Ca)	4525
Magnesium (mg)	102.25
Iron (Fe)	8.125
Zinc (Zn)	0.75

Calcium was found to be the most abundant mineral element present in the sample with the concentration of 4525mg/kg followed by Magnesium, Iron and Zinc with the concentration of 102.25mg/kg, 8.125 mg/kg and 0.75mg/kg respectively

Table 4. The Vitamins Analysis of Wheat, Soyabeans and Groundnut Meal

Parameter	Result
Vitamin C	+
Vitamin B6	+
Vitamin A	+

102.25mg/kg, 8.125 mg/kg and 0.75mg/kg respectively

Table 5. Organoleptic Analysis of Wheat, Soyabeans and Groundnut Meal

10.5%, 21.1%, 15.8% of the population like moderately for taste, color and texture and 21.1% for mouthfeel and flavor while 10.5% dislike moderately for taste and flavor and 5.3% for color, texture and mouthfeel. Therefore, 31.6% of the population like moderately while 5.3% dislike moderately

	F	%	F	%	F	%	F	%	F	%	F	%
Dislike			1	5.3	2	10.5	1	5.3	2	10.5		
Dislike extremely			1	5.3			1	5.3			1	5.3
Dislike moderately	2	10.5	1	5.3	1	5.3	1	5.3	2	10.5	1	5.3
Neither like nor dislike	2	10.5			2	10.5	2	10.5	1	5.3	2	10.5
Like slightly	6	31.6	1	5.3	1	5.3	3	15.8	1	5.3	2	10.5
Like moderately	2	10.5	4	21.1	3	15.8	4	21.1	4	21.1	6	31.6
Like extremely	3	15.8	7	36.8	6	31.6	3	15.8	5	26.3	3	15.8
Total	15	78.9	15	78.9	15	78.9	15	78.9	15	78.9	15	78.9
Missing system	4	21.1	4	21.1	4	21.1	4	21.1	4	21.1	4	21.1
Total	19	100.0	19	100.0	19	100.0	19	100.0	19	100.0	19	100.0

Discussion

The result of Table 1, provides answers to concerns raised by caregivers (can complementary food formulated using locally available ingredients meet the nutritional needs of children). The moisture content 4.51±0.03, protein and lipids contained are 34.08±0.74 and 19.63±0.55, the ash and fiber contents were 1.67±0.24 and 0.74±0.14 and carbohydrate was the highest calorific ratio as it contained 40.11±1.06 of carbohydrate. The Food and Agricultural Organization and the World Health Organization (1998) have also recommended that foods fed to children should be energy-dense food. This is necessary because low energy foods tend to limit total energy intake and the utilization of other nutrients. The moisture content of the complementary food prepared is within limit as high moisture may affect the storage quality of the foods. This is an important aspect in complementary food preparation as most people may want to prepare large quantities of complementary foods to prevent frequent processing, in order to have enough time activities. Complementary food ingredients must be properly air dried and avoid long shelf life, prepare and use within short duration.

The lipid and protein content of complementary food was high and this is because of the inclusion of oil-dense Soya beans and groundnut in the complementary food. This point also agrees with the recommendations of FAO/WHO, (1998), that vegetable oils be included in foods meant for children, which will not only increase the energy density, but also be a transport vehicle for fat soluble vitamins. The use of Groundnuts and Soybean in a product can help increase energy density and essential fatty acid content. The ash and fiber contents were (1.67±0.24 and 0.74±0.14) within limits, dietary fiber increases bulk and satiety but higher amount reduces nutrient digestibility and energy density and should be limited in diets of moderately malnourished children. Protein also help form new blood cells and body tissues, and help the nervous system function properly. The Iron (Heme) content of blood helps carry oxygen in the blood and prevents anemia in children. Ash refers to any inorganic material, residue (leftover material) that remains after heating removes water and organic material.

Table 2 shows 1.00%. Saponin, Phytate, Oxalate and Flavonoids to be 14.00%, 0.32%, 0.50% and 86.52% and within limit of WHO recommendation. Anti-nutrients (such as phytates, tannins, and saponins) can inhibit bioavailability of nutrients and anti-nutrient. Whole grains (often used in traditional complementary foods) contain high levels of dietary fiber and anti-nutrients. Milling reduces fiber and anti-nutrients in whole grains. For this reason, Wheat, Maize, Sorghum and Millet are used, only refined flours with reduced fiber, tannin and phytate content and longer shelf life is recommended.De-hulling coloured legumes or certain Sorghums and Millet will remove the polyphenols and phytate. Removing phytate in Soya bean completely is difficult because it is located in the cotyledon and not the hull.

Table 3 shows calcium was found to be the most abundant mineral element present in the sample with the concentration of 4525mg/kg followed by magnesium, iron and zinc with the concentration of 102.25mg/kg, 8.125 mg/kg and 0.75mg/kg respectively. Calcium was found to be the most abundant mineral element present in the sample

with the concentration of 525mg/kg.As children grow, they lay the foundations for healthy bones later in life and dietary calcium is needed to accomplish this phase. Bone growth is most active throughout childhood and adolescence, this is when children need calcium the most on average, 90% of people reach their optimal bone mass by age 18 (for girls) and age 20 (for boys). At that point, bones have reached their maximum strength and density, which makes investing in bone health crucial during the early years. The higher the peak bone mass developed in childhood the lower the risk of poor bone health later in life. The body needs iron to make hemoglobin-a protein in red blood cells that carries oxygen to the brain, muscular system, immune system, and other parts of the body (PAHO/WHO, 2003.). Without adequate oxygen, the physical and mental capacity of a child is reduced. A reduction in red blood cells is called anemia. Zinc in bone is very important during the stages of rapid growth in children as it plays a crucial role as a catalyst of many enzymes that affect bone development, formation and metabolism. It interacts with hormones involved in bone growth such as insulin-like growth factor 1, osteocalcin, testosterone and insulin. magnesium relaxes or decreases activity, its importance in the diet of children cannot be over emphasized as its responsible for more than 300 biochemical reactions in the body. Signs and symptoms of magnesium deficiency include muscle twitches, spasms, anxiety, constipation, high blood pressure, angina, blood sugar abnormalities, low energy, poor sleep and osteoporosis.

Table 4 shows all the vitamins tested for (vitamin C, B6 and A) are present in the sample. Vitamins play a very important roles in the diet of children as vitamins C is important for keeping body tissues, such as gums, bones, and blood vessels, a cut or wound because it helps young children heal quickly, deficiency can result in scurvy, hemorrhage etc. Vitamin A plays an important role in clear eyesight, night vision and helps the body fight infections by boosting the immune system while B6 helps the body to resist infection aid metabolism, energy production, and healthy circulatory and nervous systems. Vitamin B6 (active form, Pyridoxal Phosphate) served as a coenzyme in decarboxylation, deamination and racemization reactions of amino acids. Lack of it causes convulsions in young child FAO/WHO (2001). Vitamin B6 cannot be stored in the body over significant lengths of time and therefore require continuous intake in dietary form. Magnesium assists in the utilization of calcium and potassium, and functions in enzyme reactions to produce energy. Magnesium protects the lining of arteries and helps form bones in young children (WHO, 2008).

Table 5 shows consumer acceptability of the complementary food as 10.5%, 21.1%, 15.8% of the panelist like moderately for taste, color and texture and 21.1% for mouthfeel and flavor while 10.5% dislike moderately for taste and flavor and 5.3% for color, texture and mouthfeel. Therefore, 31.6% of the panelist like moderately while 5.3% dislike moderately. The study is in agreement with World health Organization (2017) that supports that energy- and nutrient-dense complementary foods should be introduced to all children after six months with an emphasis on the use of appropriate locally available foods.

Conclusion and Recommendation

Formulated complementary food using locally sourced ingredients from within

the locality are adequate nutritionally and have acceptable properties and can reduce or help solve the problem of severe acute malnutrition in the locality. Locally available foods can contribute to improved intakes and better meet the nutrient requirement of young children. Based on this conclusion, the following recommendation is made:

Locally available foods are adequate nutritionally and could help reduce the problem of severe acute malnutrition in children, thus, there should be more awareness through healthy workers and community-based groups (CBO) to encourage and enlighten caregivers in the community.

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