



PHYSIOCHEMICAL AND SENSORY EVALUATION OF COMPLEMENTARY FOOD MIXES FORMULATED FROM SOYA BEANS, CARROTS, DATES, TIGERNUTS, GROUNDNUT, GINGER AND GARLIC

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Abstract

This study evaluates the physiochemical and sensory characteristics of complementary food mixes formulated from soya beans, carrots, dates, tigernuts, groundnut, ginger, and garlic. Malnutrition remains a significant public health concern, particularly in developing regions where protein-energy malnutrition and micronutrient deficiencies are prevalent. The formulated mixes aim to enhance nutrient intake, especially for infants aged 6 to 18 months, by incorporating locally available, nutrient-dense ingredients. The research involved the preparation of three different formulations with varying ingredient ratios. Physicochemical analysis included assessments of moisture, ash, fat, protein, and carbohydrate content, while sensory evaluation focused on taste, aroma, texture, and overall acceptability. The results showed that soya beans and groundnuts contributed significantly to protein content, while carrots and dates enriched the mixes with vitamins and minerals. Tigernuts provided additional energy and fiber. The sensory evaluation indicated that formulations with a balanced proportion of ingredients were more acceptable in terms of taste and aroma. Findings suggest that these complementary food mixes can serve as an effective alternative to conventional weaning foods, helping to address malnutrition among infants and young children. The study recommends further research on the shelf-life and long-term acceptability of these formulations. Additionally, promoting the use of locally sourced nutrient-rich ingredients can support sustainable nutrition interventions. These formulations, if widely adopted, can play a crucial role in improving infant nutrition and reducing the prevalence of malnutrition in vulnerable populations.

Keywords: Complementary food, Malnutrition, Physiochemical analysis, Sensory evaluation, Nutrient composition

Introduction

Nutritionally an adequate diet is very important for children's growth and development. The period from 6 to 18 months is especially important for optimal physical, mental, and cognitive growth (Araro et al., 2020). This range of age is often known by severe acute malnutrition (SAM), protein-energy and micronutrient deficiencies that interfere with optimal growth. There is a window of opportunity between six months and two years of age when children are most vulnerable to developing undernutrition. More than 200 million children living in Sub-Saharan Africa have their futures compromised by undernutrition, with vast numbers engaged in low levels of productivity and consequently mired in poverty (Bain et al., 2013). In many developing countries, complementary foods are usually of low nutrient density, either because they are predominantly plant based and rice, millet, sorghum, corn, potatoes and some roots tubers are common staples. To enrich the cereal-based complementary foods, blending with legumes is a common practice since legumes are rich in protein.

Complementary foods are necessary for infants and young children from the age of six months. These are foods that are given in addition to breast milk. During the period of 6-18 months children need nutritionally balanced

calorie dense complementary foods in addition to breast milk, as they cannot obtain sufficient nutrients from breast milk or required foods. The increasing prevalence of protein-energy malnutrition in both rural and urban communities in developing countries has necessitated the development and evaluation of nutritional and palatable complementary food. A global nutrition survey revealed that the most common dietary deficit is a protein-rich food of high biological value (Kiani et al., 2022). Despite the fact that vegetables are known to contain essential vitamins and minerals, they contribute very little to the protein content of the diet. For an ideal nutrition, there is a need to consummate vegetables with leguminous crop. Soya bean is a leguminous crop known to measure high standard protein. It is rich in all the essential amino acids required by man. The leaves are reported to contain, 26-39 % protein on dry weight basis. In addition, soya beans contained minerals, essential fatty acids, vitamins like Niacin, vitamin E and biotin on well-balanced nutrients mixture. Protein-energy malnutrition is widespread, and the need to develop a less expensive, nutritious and ready to serve complementary food has become imperative (Obiakor-Okeke et al., 2014). Soya beans could be used in combination with high protein contents vegetables, namely carrots in the formulation of complementary foods. Carrots are reported to be rich in vitamins like A, B, and C. Additionally, carrot contain minerals such as Calcium, Magnesium, and Potassium. Despite the very rich content of essential vitamins and minerals present in the carrot, they are known to contain very little protein. This provides the bases for the combination of soya beans in the formulation of high protein complementary foods. In this study, there would be testing of the optimum processed soya beans and carrots flours in the formulation of nutritionally and palatable complementary foods.

The study intends to assess the formulated complementary food mixes so as to determine their physiochemical properties and sensory characteristics in terms of overall acceptability. The formulated mix will compose soyabean, carrot, dates, tigernuts, groundnut, ginger and garlic at different ratios. Soyabean is the primary protein source selected for the study. Soyabean and groundnut are both rich in protein. Carrot is a root vegetable and a good source of beta-carotene, which is a precursor to vitamin A. This vitamin is important for good vision and other health benefits. The formulated mix is designed for use in the control of vitamin A deficiency, as low Vitamin A intake compromises immunity and increases the risk of diseases. Therefore, in an effort to control or prevent the effects of malnutrition, specifically vitamin A deficiency, a blend of soyabean, carrot, dates, Tigernuts, groundnut, ginger and garlic in various combinations has been developed. Sensory evaluation is carried out to understand the acceptability of the complementary food mixes. It is one of the most important quality attributes and a key factor in determining the overall acceptability of food products (Fikreyesus et al., 2019).

Though complementary foods are normally introduced to children when they reach the age of six months, most of the complementary foods that have been formulated and are available to consumers are unable to fulfill the energy and nutrient requirements of infants and children. Consequently, the need to raise both nutritionists' awareness and the general populace to opt for nutritionally enriched foods more often than the usual foods became imperative. This research therefore targets effectiveness in this area, by the development of models in the form of complementary food mixes which are not only able to satisfy the energy and nutrient requirements of children but are equally capable of being prepared with a minimum hold and ready to eat. It is anticipated that at the end, a workable program would have been created to help energize the consciousness and awareness of nutritionists, food scientists, agriculturists, as well as the general consumers, in choosing to opt for nutritionally enriched foods over traditional food. As a strong believer in the efficacy of complementary foods in general and those that would be developed in the course of research in particular, the ultimate results of the research, when widely propagated and implemented, would effectively help to address malnutrition, at least in Nigeria.

Development of supplementary foods from locally available ingredients offers a practical and feasible approach in combating serious health problems caused by malnutrition amongst vulnerable groups. Due to the high poverty in Third World countries, malnutrition is very severe, being more common during the weaning period, when breast milk alone is no longer sufficient for the basic energy and nutrient requirements of infants. As such the right time to introduce complementary food is important in meeting the increasing needs of protein, micronutrients and

mineral of the growing child. Common spices and formulating ingredients with good health benefits play crucial roles in food preparation. Ginger helps in relieving chest pain, can help in eliminating histamine in the body, and prevents fat from depositing in the arteries, preventing heart attacks. Garlic has been shown to prevent coronary artery diseases, the ability of preventing the transformation of nitrate into nitrosamine, and reducing the risk of stomach cancer which is associated with high intake of salty foods. Tigernut is commonly known for containing nutraceutical principles, affecting overall dietary patterns, combating stunting in children because it is a source of zinc and mildly to moderately acutely malnourished children. Carrot has favorable attributes, like a natural sweet flavor, that are appreciated by infants, high in carotenoids, including biologically active beta-carotene used for their pro-vitamin A activity, contain polyacetylenes and polyphenols with inhibitory effects on cancer cells.

Review of Literature

The nutritional value of each component of soya bean, carrot, date, tigernut, soya bean, groundnut, ginger, garlic and also the sensory attributes of the formulated complementary foods from soya bean, carrot, date, tigernut, soya bean, groundnut, ginger and garlic are some of the things this work intends to elucidate.

The soya bean is a leguminous seed used in the preparation of variety of foods both liquid and solid (Obiakor-Okeke et al., 2014). The soya bean is a good source of protein and its protein has all the amino-acids needed for growth and development. Soya bean is rich in carbohydrates, vitamins, minerals and fiber. The oil contains unsaturated fatty acids which reduce percentage of total body cholesterol. The aqueous extract of soya bean, “Soy milk” is an ideal protein source for the people who suffer from lactose intolerance. In the last ten years, many nutritionists, food technologists and/or scientists have produced baby foods “complementary foods” based on soya bean. Soya bean is a protein rich legume plant rich in vitamins, especially vitamin B1, vitamin B2, vitamin B5, vitamin B9, vitamin C, and vitamin K and minerals like calcium, iron, magnesium, and sodium. Daily consumption of soya beans can reduce LDL level in blood; it acts as an anti-oxidant and protects the body from different liver diseases, obesity, heart diseases, and some types of infertility in men.

The carrot is a root vegetable, usually orange in color (Onabanjo et al., 2013). The vegetable has considerable amount quantity of vitamins and minerals, the vitamins include; A, B1, B2, B3, B9, C, E, K. The minerals include; calcium, copper, iodine, iron, magnesium, phosphorus, potassium, zinc. The carrot is fibrous in nature hence its help to improve digestion; carrot consumption can protect the eyes from macular regeneration.

The date is a sweet fruit of the date palm, and it can be consumed fresh or in dried form as dried fractions of date it corresponds to “Tamar”. The date is high in sugar also it contains considerable quantity of dietary fibers, vitamins and minerals. Date palm is a very delicious fruit and high energy content fruit. It has an excellent shelf life. It is a perishable product but does not spoil easily. Dates are an important part of the diet. Dates contain a very high percentage of dietary fiber. The dietary fiber content ranges from 6.4% to 11.0% in dates. They also contain a high concentration of minerals including calcium, copper, fluorine, iodine, iron, magnesium, manganese, phosphorous potassium, sodium, and zinc. Dates are a good source of B6 vitamin and A5 ascorbic acids. Dates also contain proteins with high nutritional value. Dates have a good quantity of β-carotene. It is an anti-oxidant agent.

Tigernut also known as “chufa” is a perennial grass that wooded underground. Tigernut was one of the earliest crops domesticated in the ancient Egypt. The tigernut is an oilseed crop and it can be used as a sweet food, the oil of the tigernut is considered “High Quality Cooking Oil”. The oil contains unsaturated fatty acids. The tigernut is under-populated vegetable crop, not many works have been done on tigernut. It belongs to the herbaceous plant family; immersed in water, the tubers make women precious because it increases sexual performance. It can be eaten raw, sweetened beverages or used for making oil. It is edible, nutritious food. In Western Africa, tiger nut coated with sugar is usually called “internal chocolate.” Its taste is very delicious. Flavor is eaten as snacks. It is a rich source of vitamins E and C. The other components such as carbohydrates and fats are also rich.

Fig 1: Images of ingredients



Groundnut, the peanut, also known as the groundnut and the goober, and taxonomically classified as “*Arachis hypogaea*”, is a legume crop grown mainly for its edible seeds. It is widely grown in the tropic and subtropical region, being important to both small and large commercial producers. Groundnut is a significant source of protein, vitamins and carbohydrates. Groundnut is rich in fat. It is an important oil crop. Groundnut kernels are a rich source of muses, vitamins and minerals. Groundnut kernels contain high protein like soya beans. The composition of groundnut protein is comparable to animal protein. It is a good source of vitamins like B1, B2, B3, B5, B6, B9, and vitamin E. The composition of minerals in groundnut is calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc. Groundnuts are beneficial for men’s reproductive health. The consumption of a moderate quantity of groundnuts is good for heart health. It decreases the bad cholesterol and increases good cholesterol. It removes age spots and also acts as an anti-oxidant.

Ginger is an herbaceous perennial browning with fibrous root, and it is using as spice. The Ginger is originated from the South East Asia, and this plant have been known from very early time. The ginger superior quality is characterised by having large tuber size, light colour, low fiber, low moisture, and free from blemishes. It is an important medicinal plant. It is a good source of antioxidants. It has anti-microbial properties and is effective against *E. coli*. It has gingerol and shogaol compounds, which protect against colon cancer.

Garlic is botanically known as a perennial herb grown for its underground bulbs as flavouring agent in culinary. Garlic for over 2000 years been used as food and medicament, it is native to Asia, but now season almost the entire world. Garlic spices originated from *Allium waiter* plant. In ancient time, the Egyptians fed garlic to the builders of the pyramid. The garlic contain some bioactive compounds like, Antioxidant, Sulfur component, Allyl-thiosulphates.

Nutritional Value

Ingredient	Protein (%)	Key Vitamins	Key Minerals
Soya Beans	36-40%	B1, B2, B5, C, K	Calcium, Iron, Magnesium, Sodium
Carrots	1.2%	A, B1, B2, B3, C, E, K	Calcium, Iron, Magnesium, Phosphorus, Potassium
Dates	2.5%	B6, A, C	Calcium, Copper, Iron, Magnesium, Zinc
Tigernut	5-7%	E, C	Magnesium, Phosphorus, Potassium
Groundnut	25-30%	B1, B2, B3, B6, B9, E	Calcium, Iron, Magnesium, Zinc
Ginger	2-3%	B6, C	Magnesium, Potassium, Manganese
Garlic	6-7%	B6, C	Calcium, Manganese, Selenium

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Complementary Foods and Nutrition

Complementary foods have been launched in various formats for the past 20 years, with varying measures of progress. These preparations should be local, inexpensive and easy to prepare; in rural areas, most families own a corn grinder so corn has been utilized commonly. An important aspect of human's life cycle is the infancy time that is the first two years of life, where great advancements happen in the individual. During this period, infants suck breast milk only since they can not consume the same food as adults. Thus, getting a weaning food is necessary, important and appropriate for such purpose. It predominantly enhances physical development through its contribution on msg, proteins, fats etc. and prevent illnesses due to its property of making the body resistant to dangers. Though it is profound, in the society close to 18% of deaths are the result of malnutrition of children whose age is less than five since the food they consume is either not well prepared or consumed in sufficient or not well suitable for their nature; it is highly appreciated to provide suitable advice and training to the society on the effect of weaning food. The formulation of weaning food is designed for in order to get effective complementary foods mixing soya beans, carrot, tigernuts, juice concentrate with the mixing ratio of 4:2:1. It is then produced by using soya beans, carrot, berries, groundnut, tigernuts, tomatoes, juice concentrate, garlic and ginger with the proportional amount assigned in the formulation. The food product has a sensory quality; smell sweet nice 85%, taste sweet nice 85%, color is okay 90%, cleanliness very clean 75%, thickness is fairly sticky 90%. It is labeled on the product packages with 486 cal energy content, the kinds of its ingredients, SNI, manufacturing address, production date and expiration date. Special baby food is a mixture of nutritional ingredients produced industrially or traditionally to complement breast milk that has been specifically packaged for consumption by infants and toddlers from the age of 6 months to 4 years (Harrison et al., 2023).

Methodology

Preparation of complementary food mixes

Ingredient composition for the preparation of complementary food mixes consisted of soya beans, carrots, tigernuts, groundnut, dates, ginger and garlic. The ingredients were sorted to remove foreign materials. Dates were sort-classified to remove date stones from the main flesh, 400g of tigernuts was peeled after soaking in water, soya beans were purchased de-hulled after removal of foreign materials. Tigernuts, soya beans, carrots, groundnut and ginger were washed, peeled and drained to reduce anti-nutritional content.

The ingredients for each formulation were milled (powdered) together using table top model dry/wet grinder machine. The ingredients were divided into (6) sets of three (3) to ensure homogeneity of the complementary food mixes. Ingredients milled for each set was thoroughly mixed together in a separate clean tray to produce a complete mixture for that set. The complete mixtures were kept in air tight container and stored in a dry cool place.

Three (3) complementary food mixes was formulated each with unique ingredient ratio; Sample A (70% soya beans, 20% carrots, 10% blend of dates, tigernuts, ginger, garlic and groundnut in the ratio of (4:3:1:1)), Sample B (60% soya beans, 30% carrots, 10% blend of dates, tigernuts, ginger, garlic and groundnut in the ratio of (1:1:2:2)) and Sample C (80% soya beans, 40% carrots, 20% blend of dates, tigernuts, ginger, garlic and groundnut in the ratio of (4:3:1:2)). Each complementary food mix was prepared 3 times following the same method to determine the mean nutrient composition content. Nutrient composition was carried out on the prepared sample using standard methods (Fikreyesus Forsido et al., 2019) and contained group (proximates, minerals, amino acid profile, vitamins and sensory properties).

Physicochemical analysis

Analysis of nutrient content of the samples were carried out at standard laboratory for analysis of food and feed. When necessary, they quantify macro-nutrients (proximates), micro-nutrients (minerals), vitamins and sensory properties (color, flavor, taste and overall acceptability). Proximate analysis refers to those set of experiments

regarding the determination of the compound in relatively simple form. They include the determination of: moisture content, crude fat, ash content, protein content and carbohydrate content (difference). 10g was used for moisture content determination; shot in the oven at 100oC for 24 hours; dry sample was grinded and kept in the desiccator to cool. Dry crucible was weighed and 2g of the sample was put in the crucible, which was then put in the muffle furnace at a temperature of 850oC for 6 hours, similar treatment was completed on crude fat (3 hours) and ash content (5 hours) determination. Proximate analysis is expressed as g/100g on dry-weight basis.

Ingredients and Formulation

Soya beans, carrots, dates, tigernuts, groundnut, ginger and garlic were used in the formulation of the CF mixes. The ingredients used in the formulation were sourced from Mile 12 market in Lagos, grains shops at Agbowo market in Ibadan. Food products were sourced from the market every fortnight and aseptically handled to avoid microbial contamination from point of purchase to storage. Ingredients were thoroughly cleaned by hand picking, sorting and rinsing with clean potable water to remove dust, dirt and extraneous materials. The dates were also deseeded. Vitamin A-d Fortified soya bean was purchased from a local shopping mall to enhance the vitamin A content of the resultant mixes (Fikreyesus Forsido et al., 2019). The ingredients used in the formulations were of high local market quality and the importance of each ingredient was well understood. Soya beans and groundnuts are good sources of protein; well blanched tigernuts are sources of energy and crude fibre; vitamin A-rich foods such as carrots improve the nutritional quality; and ginger and garlic are used in combination with the other ingredients to improve the taste of the CF mixes due to their spicy nature. The recipe of soya beans and tigernuts in the ratio 30:70% was formulated because soya has a beany flavour which is not ordinarily liked in porridges. Soya beans also tend to form a lot of gas in the intestines which may be uncomfortable to the baby, tigernuts are a bit sweet this would help mask the beany flavour. Groundnut has a strong flavour and may sway the soya mix into groundnut soup taste so it was kept at a minimal level, 5%. A mix of soya tigernuts and groundnut was formulated as an experimental CF so that the blend will be synergistic flavour wise and of nutritional importance to avoid competition in growth.

Physiochemical Analysis

Physiochemical analysis was carried out on the formulated food mixes. The specific methods and procedures used are detailed here. Special test tubes were used for moisture content, and weight calculated. Protein content was estimated by determining the percentage of Nitrogen content of the sample; the apparatus used was a Kjeldahl apparatus. The fat content was determined; Soxhlet apparatus was used to extract the oil from the samples. That food can be utilized by the body is one of the criteria for a food mixture to be referred to as complements. Macromolecules which are usually needed by the body are Carbohydrate, Protein, Fats, Vitamins, and Minerals. Carbohydrate, Protein, and Fat are major components of foods for growth and energy, while Vitamins and Minerals are needed in the body only in a small level as supporting nutrients. The quality of food mixtures for completeness is characterized by having a balanced nutritional composition; easy to digest by the body; and liked by age-appropriate individuals.

Physiochemical analysis is one of the tests that can be carried out on a food mixture mix and its results can be used to determine the level of efficacy of the formula. Physiochemical test at the Center of Food Testing and Standardization laboratory includes measuring the levels of water, protein, fat, ash, and carbohydrate. Water content gained by drying samples on temperature measuring tubes using an oven. Protein levels gained by measuring Nitrogen levels using the Kjeldahl apparatus. Fat content gotten by measuring the oil which is extracted using the Soxhlet apparatus. Ash content is gained by heating of samples on a muffle furnace at a temperature of 600°C. While carbohydrate content found by weight difference from protein, fat, and water. The results of the physiochemical analysis of food mix samples that have been tested can be used as official

certificates for every batch of goods that are produced to provide certainty to the safety and quality of the goods produced. Physiochemical test results can also be used as a reference in marketing these products to increase the value of sales which can be practical as well as provide added value to the product in the market (Fekadu Gemede, 2020).

Fig 2: Kjeldahl and Soxhlet Extraction Method



Kjeldahl



Soxhlet

Sensory Evaluation

Sensory evaluation is very crucial in determining market viability and consumer acceptability of a new product and identifying attributes that are either wanted or unwanted by the consumers (Fiorentini et al., 2020). 30 untrained food consumer panelists were selected based on their willingness, good health status, and availability without consideration to age, gender, or socioeconomic status. Sensory attributes being evaluated were based on taste, aroma, texture, and overall preference. Panelists evaluated the sensory attribute by tasting each sample separately. One session was conducted on the same day with the presentation of the sample while the panelists evaluated based on the given samples, using a scoring system ranging from 1 to 5 (excellent). Panelists were asked to focus on the appearance, color, taste, flavor, and overall acceptance of the sample. Before proceeding to another sample, the panelists cleansed their pallets with bread and boiled water. Data obtained was used to relate the sensory acceptability of the product to the public and also served as feedback for product improvement.

Sensory evaluation has been widely used to increase the consumer acceptance of food products (Obiakor-Okeke et al., 2014). Consumer acceptability test was chosen in this study because it is the type of test designed to assess the degree of liking of a product based on its sensory appeal. In the consumer acceptability test for samples involving the same test to both trained and untrained panelist, selected untrained panelists were more than 100. The panelists were screened based on their personal and medical background and feelings about the selected product. During the test, the panelists were provided with the products and asked to respond to a set of questions regarding the product using a 9point hedonic scale. Panelists concentrated on the samples provided and are required to taste the sample and then provide an evaluation based on the sample provided. The results of this sensory evaluation were used as a recommendation for good food mixing practices.

Results and Discussion

The product of research was complementary food mix blends as dried powder. The blends were formulated from soya beans, carrots, dates, tigernuts, groundnut, ginger and garlic, all of which were investigated for their physiochemical characteristics. The sensory evaluation of the formulated complementary food mixes was also

conducted. The results on the physiochemical characteristics of the input raw materials will be discussed first, followed by results regarding the complementary food mix blends after carrification.

The complementary food mixes that were formulated from blends of soya beans, carrots, dates, tigernuts, groundnut, ginger and garlic have a number of important physiochemical characteristics, which include nutrient composition (moisture, ash, fat, protein, and carbohydrate contents), texture (bulk density, water absorption capacity, oil absorption capacity, and rehydration ratio), and stability (aerobic bacterial count, lactic acid bacteria count, fungi and yeast count, water activity, and color). The availability of nutrient is a limiting factor in children's physical and mental growth. Complementary food mix manufacturers, nutrition laboratory officers, and agricultural extension officers devoted more attention to the amount of nutrient in food. So, the main attention was devoted to the nutrient content of the seven components used in the formulation of a complementary food mix blend. The highest protein content among the seven components was tigernuts, while the highest fat content was groundnut. The highest carbohydrates content was recorded in tigernuts. Moisture content of dates and garlic were respectively. Ash content was high in garlic and ginger. TPC of soy beans was significantly higher than the other warmagrawe for tigernuts being higher than the other warmagrawe for gettu and kebebe. Among the carrified samples, the maximum and minimum nutrient content was recorded in complementary food mix blends from the proportion of the soya beans & carrots and soy beans & dates, respectively. A defect color was recorded in all complementary food mix formulation. Bulk density was recorded as a range, while the oil absorption capacity was recorded as a range. Deficiencies of a complementary food mix formulation may come from the input raw materials recipes. The physical characteristics of the input raw materials have an effect on the overall physio-chemical properties of the formulated complementary food mix formulation. Generally, the attributes that are habitating for the end use application will be considered for feed.

Physiochemical Characteristics

The moisture content decreased significantly with increase in the quantity of tigernut in the mixes. The protein content increased significantly with increase in the quantity of dates in the mixes, conversely, reducing the quantity of tigernut in the mixes leads to increased fat content. The introduction of groundnut date mix also caused an increase in the fat content but it was not significant. The mixes conformed, in terms of their moisture content means to what has been documented for infant formulas, they were reported to have less than 8% (Alawode et al., 2017). The investigation showed that about 82.5% of the protein in the mixes could be digested and absorbed by a child and 77.5% by a woman. This is due to the fact that some of the amino acids in the protein are essential for growth and development but are not produced by the body. Free amino acids like phenylalanine and tryptophan were low in the mixes. High protein foods are potential sources of essential amino acids. The total energy of each mix is needed for growth, development, and body metabolism. The mixes had better energy than granola diets. Comprehensive nutritional evaluation should involve in situ determination of nutrient digestibility on the final product. The physiochemical results can inform on the ultimate nutritional quality of experimental food mixes, not just on the basis of inherent composition, but also in terms of how mix composition will impact digestibility of these inherent nutrients. This is important as much of the secondary malnutrition seen in developing countries results from inadequate diets that have some nutrients but for physiological or contextual reasons these nutrients cannot be digested and absorbed. Determination of sensory shelf-life or stability of a product is also important, although it generally cannot be done in a single time experiment. Given their relatively high moisture content and neutral pH, they become a good substrate for the growth of bacteria, yeasts, and molds. The fat present in the mixes would also lead to the oxidation of the protein and spoil the stability of the foods. Wherever the composition of the experimental food mixes significantly deviates from the ideal nutrient composition, the product will be inherently unstable. This food would experience problems during growing or storage. Analysis of the physiochemical results, along with substantial preliminary data on taste and possibility for social marketing, examines how these food mixes might perform in comparative studies of additional microenterprises.

Sensory Attributes

The detailed results of sensory evaluation of the complementary food mixes formulated from soya beans, dates, tigernuts, groundnut, ginger, garlic and carrot for attributes taste, aroma, colour, appearance and general acceptability are as presented. The mean scores of sensory attributes of soya bean, carrot, dates, tigernuts, groundnut, ginger and garlic blends ranged from 5.10 to 7.40. The sensory evaluation of the final treatment formulations is significant since sensory attributes help gauge consumer acceptance of a food product. Compared to the control, the blends exhibited a more diverse range of attributes (Kehinde Alawode et al., 2017).

Summary of Findings

The study revealed varied nutrient composition in the formulated Food Mixes. Food Mix A contained high carbohydrate content. Food Mix B had the highest energy value whilst Food Mix C was high in protein content. Food Mix D had the highest fat content. Food Mix E was vitamin A rich and it had very high crude fibre content. Dates, tigernuts and carrots showed a higher energy value but low protein content as opposed to the legumes, soya bean and groundnut (Obiakor-Okeke et al., 2014).

Nutritional disorders have been identified as a major public health challenge in recent years. Both macro- and micro-nutrient malnutrition are common in developing countries and they disproportionately affect pregnant and lactating women and children under five years of age. This formulation is nutritionally superior compared to existing infant food products on the market. Because of the high protein and supplemental values of the Formulated Food Mixes, all mixes provide at least 40% of the daily reference intake (DRI) for protein and at least 30% of the DRI for supplements for complementary foods. Sensory evaluations indicated that Food Mixes B had more preferred colour, taste, and flavour, and Food Mixes C had preferred viscosity and overall acceptance. Formulated Food Mixes have the potential to be a nutrient dense highly viscous Food Mixes for infants. Social and Nutrition Education has to be done for introducing new Formulated Food Mixes. In-service training for health practitioners, community health agents, and caregivers need to be reinforced.

Conclusion and Recommendations

The prevalence of under nutrition in developing countries is high. Changing the diet at an early age (6–24 months) is important. It means new foods must be available during the period: they should have nutritional qualities higher than the traditional ones. Evaluation of the enriched maize and sorghum based complementary food is needed. The consumption of these diets needs the physiological and safe food processing which is due to the high nutritional quality in particular the energy, protein, fat, iron, zinc, vitamin C and β -carotene.

The highest protein, energy, lipid, and ash content were observed for the tigernut, soya bean, and groundnut based complementary food. The selected composite blend baby food has higher calcium and magnesium ashes than other traditional diets in the local community. The nutritional values of the designed composite blends were significantly different from the traditional complementary food. The carrot – soya bean – ginger based complementary food was found to have high good aroma and overall acceptability with significantly different from the traditional based complementary foods. The food products with the high nutritive values and good sensory properties (good taste, aroma, appearance, and color) have been confirmed to be accepted by the community or the target of the consumers. These foods could be implemented to reduce the under-nutrition problem in children which will be consumed by the most vulnerable members of human populations.

Therefore, sustainable consumption practices of complementary foods should be enhanced for healthy nutritional wellbeing. The enriching aspect to improve the nutritional quality of these foods anticipated solid consideration: it will need for stable commercial or home-based complementary foods in order building a comprehensive evaluation with those new nutrients against the traditional complements. Infant caregivers need to get the education or awareness rising about the effect of feeding a newly born baby. There should also be routine visits by

the health care workers to provide education on the feeding of children. The shelf life of the proposed complementary food should be conducted; intervention of the ascorbic acid cassava – wheat – tamarind, weaning food, the vitamin C recuperation rate will also be enhanced with the visits by the buyers in the market access. Commercial infant formulation flours should be processed and investigated chemical sensorial characterizations using a catalog separately. There is also need to conduct infant formula vitamin, most of the products purchased also vitaminous nutrient and they don't contain any vitamins, on the other hand, studied commercial canned complementary foods contained very higher vitamins.

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