ISSN 2348-0319 International Journal of Innovative and Applied Research [2024]
(Volume 12, Issue 09)
20-28

Journal home page: http://www.journalijiar.com

INTERNATIONAL JOURNAL
OF INNOVATIVE AND APPLIED RESEARCH

RESEARCH ARTICLE

Article DOI: 10.58538/IJIAR/2109
DOI URL: *http://dx.doi.org/10.58538/IJIAR/2109*

COMPARATIVE ANALYSIS OF MINERALS AND VITAMINS COMPOSITION IN A DEVELOPED DEPLOYABLE BABY FOOD AND OTHER COMMERCIAL BABY FORMULAS (6-24 MONTHS)

Olayinka J. Omale[1], Godwin I. Adoga[1], Moses A. Daikwo[1] and Jafaru Muhammad Bunza[2]

1. Department of Biochemistry, (Nutrition and Dietetics Division), Bingham University, Karu, Nasarawa State, Nigeria.
2. School of Medical Laboratory Sciences, Usmanu Danfodiyo University Sokoto, Nigeria.

Manuscript Info

Manuscript History
Received: 26 August 2024
Final Accepted: 28 September 2024
Published: September 2024

Keywords:
Complementary Food, Developed Formula, Yellow Maize, Micronutrients, Sensory Evaluation

Abstract

The nutritional adequacy of micronutrients depends on their amount and bioavailability in the complementary foods. The aim of this study is to develop a cost effective, nutritious, homemade homogeneous blend of locally available food ingredients into a complementary baby food for 6-24 months of age that will be acceptable, deployable and prevent malnutrition in this age bracket. Two baby food formulas were developed based on protein contents of available food commodities: DFA (Yellow corn 60%, Soya beans 20%, Groundnut 15% and Crayfish 5%) and DFB (Yellow corn 65%, Soya beans 15%, Groundnut 15% and Crayfish 5%). Standard procedures of the AOAC (2016) and other methods were used to determine the micronutrient contents (minerals and vitamins) of the foods. The mean± standard error of mean for iron, zinc, calcium, sodium, potassium, magnesium and phosphorus contents of the DFA respectively are; (6.73±0.01), (3.24±0.02), (180.72±0.23), (135.74±0.00), (385.65±0.17), (31.51±0.26) and (350.80.37±1.57) while for DFB they are; (6.79±0.17), (3.53±0.01), (150.93±0.34), (132.81±0.05), (365.83±0.03), (32.27±0.16) and (354.37±2.23) respectively which showed a significant difference ($p<0.05$) with the control baby food. Vitamins A, B1, B9, C and E for DFA from the analysis are respectively: (1391.38±3.15), (3.76±0.04), (20.21±0.06), (13.67±0.41) and (4.74±0.10) while for DFB are: (1072.48±7.97), (3.34±0.08), (22.15±0.16), (11.52±0.00) and (3.82±0.11) respectively which also showed significant difference with the control baby food. Samples were also rated using a 9-point hedonic scale range from "like extremely" (9) to "dislike extremely" (1) for sensory evaluation but showed no significant difference statistically with the control baby food. The study revealed that it is possible to prepare nutritionally adequate and acceptable complementary diet (rich in vitamins and minerals) from readily available and affordable food commodities.

***Corresponding Author:-* Olayinka J. Omale,** Department of Biochemistry, (Nutrition and Dietetics Division), Bingham University, Karu, Nasarawa State, Nigeria. yinkuzeobadele19 @ gmail.com +2348031534983

Introduction:-

Breast milk alone can be used as a proper food for an infant in the first six months of life (exclusive breast feeding), and from then on, complimentary feeding becomes necessary (Cristina et al., 2004). It contains all the nutrient and immunological factors an infant requires to maintain optimal health and growth. At 6 months which is a formative period, the supply of energy, protein and some nutrients from breast milk is no longer adequate to meet an infant's needs. Malnutrition during this period of life, leads to permanent stunting in growth (Onis et al., 1997). Therefore, complementary foods are introduced. Complementary foods are foods giving to infants other than breast milk or infant formula (semisolids, solids, and liquids) to provide both macro and micronutrients (Kleinman et al., 2004). To ensure adequate growth, prevent malnutrition, stunting and anaemia when breast milk nutrients become inadequate for their energy and growth needs, complementary foods must be nutritious. Poor complementary feeding is the immediate direct cause of malnutrition leading to growth faltering and high rate of infections during infancy and early childhood (Peter, 2010). It is vital that malnutrition is addressed in children as its manifestations and symptoms begin to appear in the first 2 years of life (Shrimpton et al, 2001). Coinciding with the mental development and growth periods in children, protein energy malnutrition (PEM) is said to be a problem at ages 6 months to 2 years. Thus, this age period is considered a window period during which it is essential to prevent and/or manage acute and chronic malnutrition manifestations (Benson et al, 2008). Several factors determine the introduction of complementary foods, amongst the factors are the age of the child, the health of the mother and child, existing taboos , the vocation or occupation of the mother and the caregiver (Ikujenlola and Fashakin,2005).In most developing countries, complementary diets are derived mainly from local foods and staples such as cereals and tuber, with animal proteins which are expensive. Attempts have been made to identify alternative source of protein, especially from plants (Metwal et al., 2011). Due to the fact that infants are very vulnerable nutritionally during complementary feeding, introduction of semi-solid foods at the expenses of breast milk must provide adequate nutrients for the rapid phase of growth and development (WHO 1998).

Complementary foods are expected to be high in energy density, containing all essential amino acid, required vitamins and minerals and safe level of anti-nutritional components while retaining the quality of palatability (Abeshu et al., 2016).

In many developing countries, cereals or starchy roots and tubers are usually prepared as thin gruels, and as a result, their energy and micronutrient content and density are likely to be low, but their content of phytic acid, polyphenols, and/or dietary fibre can be relatively high, all components that can inhibit absorption of certain micronutrients. In Nigeria, traditional complementary foods are usually produced from staple cereals and legumes prepared either individually or as composite gruels (Walker, 1990). Cereal grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins, minerals and fibre for people in developing countries. However, the nutritional quality of cereals and sensorial properties of their products are sometimes inferior or poor in comparison with milk and milk products. This is because cereal is deficient in certain essential amino acids (i.e., lysine and tryptophan), and additionally is characterized by low starch availability, presence of anti-nutrients (phytic acid, tannins and polyphenols) and the coarse nature of the grains (Vasal, 2001).

In the light of the above, this study was aimed to fill the gap of providing an acceptable cost-effective homemade, micronutrient rich complementary food that would supply the basic nutrients needed for proper growth and development of the child in the right quantity to prevent malnutrition and as well be low in anti-nutrients due to the process of formulation. The nutritional contents were also compared with other available baby formulas and sensory attributes were evaluated.

Materials and Methods:-

Sources of food materials

The food materials used (yellow corn, soya beans, groundnut and crayfish) for developed formulas were obtained from Kubwa village market in Bwari Area Council, Abuja, Nigeria in January, 2024 and were taken to the herbarium of National Institute for Pharmaceutical and Research Development (NIPRD) Abuja for taxonomical identification before use. Control food (imported baby formula) was purchased from a reputable supermarket within Kubwa, Bwari Area Council, Abuja. Commercial Formula A (CFA) was purchased within Abuja, FCT while Commercial Formula B (CFB) was purchased from Lafia in Nasarawa state, Nigeria.

Equipment:
Milling machine, oven, weighing balance, muslin cloth, sieve

Food Processing
Fermentation of Soya Beans (Glycine max (Linn.) Merrill)
50 g of dry soya beans was picked and impurities sorted out. Soya beans were soaked for 24 hours. Thereafter, it was washed thoroughly and tied in a bag (a muslin bag to allows water drain) for another 24 hours to allow sprouting. Soya beans were dehulled manually by washing under running tap water and using hands to peel the back. Boiled for 45 minutes using an electric cooker and dehydrated using a laboratory oven (MODEL NO. DHG-9053A Searchtech Instruments British Standard) for 24 hours at 60° C. Toasting of soya beans in a frying pan on fire was done until it turned golden brown. Soya beans were later grinded with other ingredients, then stored/packaged in an air tight container.

Yellow Corn (Zea mays Linn.)
Yellow corn was well picked with stones and foreign particles removed. It was then washed under running water and allowed to sun-dry for 72 hours. Toasting was done mildly till it turned brown/gold. It was allowed to cool and grinded with other ingredients into powdered form.

Groundnut (Arachis hypogaea Linn.)
Groundnut was sorted out to remove impurities and toasted in an empty pot. Allowed to cool and the back peeled and sorted out. Clean groundnut was grinded with other ingredients as the last ingredient added during grinding to avoid rancidity.

Cray Fish
Cray fish was sorted out to discard impurities. It was dried further under sunlight to reduce the moisture content before been grinded with other ingredients.

Food Formulation
The food samples were formulated with reference to CODEX (2013) protein requirement of infants (15%) to obtain the following blends for two different ratios of the sample mix:
Ratio 1 (DFA) Yellow corn (60%), Soya beans (20%), Groundnut (15%) and Cray fish (5%)
Ratio 2 (DFB) Yellow corn (65%), Soya beans (15%), Groundnut (15%) and Cray fish (5%).

Table 1:- Quantities of Ingredients in DFA and DFB:

S/N	Ingredients	DFA	DFB
1)	Yellow corn	90g	98g
2)	Soya beans	9g	7g
3)	Groundnut	10g	10g
4)	Cray fish	4g	4g

DFA= Developed formula A, DFB= Developed formula B

Mineral Analysis
Determination of Calcium and Magnessium:
The developed and commercial baby foods were analyzed using the Versanale- EDTA Complexometric Titration method as adopted by AOAC (2016).

Determination of Potassium and Sodium:
Potassium (K) and sodium (Na) in the sample were determined by flame photometry using the method of analysis adopted by AOAC (2016).

Determination of Iron and Zinc:
The developed and commercial baby foods were analyzed by Atomic Absorption Spectrophotometer (AAS) as adopted by Okwakpam et al. (2023).

Determination of phosphorus was using Ultra Violent-Visible Spectrophotometer at 470 nm wavelength as adopted by Okwakpam et al. (2023).

Vitamins Analysis

Vitamin A (Beta carotene) determination:

The analysis was done using the method adopted by Rodriguez-Amaya and Kimura (2004)

Vitamin B1 (Thiamine) Determination:

The vitamin B1 determination was carried out by HPLC method as adopted by Aslam et al. (2008).

Vitamin B9 (Folic acid) Determination:

The vitamin B9 determination was carried out by HPLC method as adopted by Aslam et al. (2008).

Vitamin C Determination:

The ascorbic acid determination was carried out by iodine titration method as adopted by Ikewuchi and Ikewuchi (2011).

Vitamin E Determination:

The concentration of vitamin E was determined using UV spectrophotometer method as adopted by Okwakpam et al. (2023).

Sensory Evaluation

DFA and DFB were made into light gruels, using about 20 g of the sample and 60 ml of water. The reconstituted blends were cooked in a pot on the fire until well cooked and dished hot. Evaluation was done along with the control food (imported baby food). Sensory evaluation was conducted on the reconstituted samples which were coded and presented to 20 untrained panelists (i.e., nursing mothers) who were familiar with the control food sample but was coded. The sensory evaluation was conducted in a standard sensory laboratory of a Primary Health Care Centre in Kubwa, Abuja. The samples were rated on the following attributes: Colour, Taste, Smell, Texture and Overall Acceptability using a 9-point hedonic scale range from “like extremely” (9) to “dislike extremely” (1) as described by Ruston et al. (1996).

Ethical Approval

Ethical permission for sensory evaluation was granted at Bwari Area Council of Abuja, (Reference number BAC/HSS/23/422) to use 20 nursing mothers with children within the ages of 6 to 24 months who visit the Byazhin Primary Health Care Centre, Kubwa, Abuja, (FCT).

Statistical Analysis

The data generated was analysed using SPSS version 25.0. The triplicate results of the data which followed normal distribution were presented as mean±standard error of the mean of minerals, vitamins and sensory attributes in the baby food formulations. The groups mean comparison between the contents of respective baby food formulations were made using One way-analysis of variance (ANOVA), followed by Least Significant Difference (LSD) post hoc test to analyse any significant difference. Level of significance was set at 95% confidence interval ($p<0.05$).

Results:-

Minerals analysis of developed complementary food samples in comparison with other baby formulas shown in Table 2.

The mean Iron content (mg/100g) of the DFA, DFB and CFB showed no significant difference ($p >0.05$), however, were significantly higher than that of CFA ($p<0.05$) and lower than that of the Control baby food ($p<0.05$). The mean Zinc (mg/100g) in DFA and DFB showed no significant difference however, were significantly lower than that of Control, CFA and CFB ($p<0.05$). There was no significant difference between the values in CFA and CFB ($p >0.05$); however, the values were lower than those in the Control food ($p<0.05$). The mean Calcium (mg/100g) in DFA, and CFB showed no significant difference however, were significantly higher than that of DFB and CFA. CFA and CFB showed no significant difference ($p>0.05$). The values in the Control food however, were significantly higher than those of the other formulations ($p<0.05$). The mean Sodium (mg/100g) in DFA, DFB and CFB showed no significant difference ($p>0.05$); however, were significantly higher than that of Control and CFA ($p<0.05$). CFA was significantly lower than the Control. The mean Potassium (mg/100g) across the formulations showed significant difference ($p<0.05$). Control showed significantly highest value as see on the table, followed by DFA, DFB, CFA and CFB respectively. The mean Magnesium content (mg/100g) in DFA, DFB, Control, CFA showed no significant difference ($p>0.05$). However, CFB was significantly higher than DFA, Control and CFA

ISSN 2348-0319 International Journal of Innovative and Applied Research [2024]
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(p>0.05) but similar to DFB. The mean Phosphorus (mg/100g) in DFA and DFB showed no significant difference however, significantly higher than CFA and CFB (p<0.05). The mean value in the Control food was higher than the other baby food formulations analysed (p<0.05).

Vitamins analysis of developed complementary food samples in comparison with other baby formulas shown in Table 3.
The mean Vitamin A content (IU/100g) in DFA was significantly higher than DFB and CFB however, it was significantly lower than Control and CFA. No significant difference between Control and CFA. The mean Vitamin B1 (mg/100g) in DFA was significantly higher than DFB, Control, CFA and CFB (p<0.05). However, DFB was significantly higher than the Control, CFA and CFB (p<0.05) while CFA and CFB showed no significant difference (p>0.05) but significantly higher than Control (p<0.05). The mean Vitamin B9 (µg/100g) in DFA showed no significant difference with CFA however, it was significantly lower than the values in DFB and Control (p <0.05) but higher than that of CFB. The mean Vitamin C (mg/100g) in DFA was significantly higher than those of DFB, CFA and CFB (p<0.05). The value in the Control was significantly higher than those in the other formulations analysed (p<0.05). DFB, CFA and CFB showed no significant difference (p>0.05). The mean Vitamin E (IU/100g) in DFA and CFB showed no significant difference (p>0.05) however, it was significantly higher than the values in DFB and CFA (p<0.05). The values in the Control were significantly higher than those in the other formulations analysed (p<0.05). DFB and CFA showed no significant difference (p>0.05).

Sensory Evaluations
The sensory parameters of the two ratios of formulated baby food and control food showed the mean±SEM for colour, taste, smell, texture and overall acceptability.

The mean Color of DFA, DFB and Control baby food showed no significant difference statistically.

The mean Taste of DFA, DFB and Control baby food showed no significant difference.

The mean Smell of DFA, DFB and Control baby food showed no significant difference.

The mean Texture of DFA, DFB and Control baby food showed no significant difference.

The mean Overall acceptability of DFA, DFB and Control baby food showed no significant difference.

The sensory evaluation results (colour, taste, smell, texture and overall acceptability) of the three baby formulas showed that DFA and DFB were lower than the imported baby formula used as control but were not statistically significantly different as seen in table 4 below.

Table 2:- The mean comparison of the Iron, Zinc, Calcium, Sodium, Potassium Magnesium and Phosphorus of the baby food formulations analysed in the study.

Baby Formula	Iron mg/100g	Zinc mg/100g	Calcium mg/100g	Sodium mg/100g	Potassium mg/100g	Magnesium mg/100g	Phosphorus mg/100g
DFA	6.73±0.01^{a}	3.24±0.02^{a}	180.72±0.23^{a}	135.74±0.00^{a}	385.65±0.17^{a}	31.51±0.26^{a}	350.80±1.57^{a}
DFB	6.79±0.17^{a}	3.53±0.01^{a}	150.93±0.34^{b}	132.81±0.05^{a}	365.83±0.03^{b}	32.27±0.16^{ab}	354.37±2.23^{a}
Control	12.92±0.61^{b}	8.75±0.18^{b}	235.89±27.39^{c}	120.02±0.06^{b}	417.46±1.45^{c}	30.06±0.61^{a}	551.82±14.07^{b}
CFA	5.57±0.04^{c}	6.15±0.52^{c}	150.48±0.24^{b}	111.55±0.20^{c}	165.83±0.03^{d}	29.68±0.91^{a}	296.73±1.18^{c}
CFB CODEX standard *	7.25±0.18^{a} 16	6.40±0.09^{c} 3.2	173.01±1.56^{ab} 250	130.32±0.36^{a} 296	185.65±0.17^{e} 516	35.52±0.64^{b} 32	309.87±0.25^{c} 356

DFA= Developed Formula A, DFB= Developed Formula B, Control= Maize with milk, CFA= Commercial Formula A, CFB= Commercial Formula B. Values are mean±SEM of Iron, Zinc, Calcium, Sodium, Potassium, Magnesium and Phosphorus. Values with different superscripts in a column are significantly different at $p<0.05$. *CODEX Alimentarius Commission (2013).

Table 3:- The mean comparison of Vitamin A, Vitamin B1, Vitamin B9, Vitamin C and Vitamin E of the baby food formulations analysed in the study.

Baby Formula	Vitamin A IU/100g	Vitamin B1 mg/100g	Vitamin B9 µg/100g	Vitamin C mg/100g	Vitamin E IU/100g
DFA	1391.38±3.15[a]	3.76±0.04[a]	20.21±0.06[a]	13.67±0.41[a]	4.74±0.10[a]
DFB	1072.48±7.97[b]	3.34±0.08[b]	22.15±0.16[b]	11.52±0.00[b]	3.82±0.11[b]
Control	1621.10±36.23[c]	0.83±0.05[c]	24.14±0.14[c]	58.95±0.06[c]	5.94±0.63[c]
CFA	1639.9±72.25[c]	2.91±0.04[d]	19.20±0.06[a]	9.67±0.17[b]	3.80±0.09[b]
CFB	1197.73±11.06[d]	3.09±0.05[d]	11.89±0.2[d]	10.55±00[b]	4.43±0.27[a]

DFA= Developed Formula A, DFB= Developed Formula B, Control= Maize with milk, CFA= Commercial Formula A, CFB= Commercial Formula B. Values are mean±SEM of Vitamin A, Vitamin B1, Vitamin B9, Vitamin C and Vitamin E. Values with different superscripts in a column are significantly different at $p<0.05$.

Table 4:- The mean comparison of Color, Taste, Smell, Texture and Overall acceptability of the baby food formulations analysed in the study.

Baby Formula	N	Color	Taste	Smell	Texture	Overall Acceptability
DFA	20	8.10±0.33	7.40±0.43	7.50±0.43	7.10±0.55	7.53±0.39
DFB	20	7.80±0.35	7.95±0.45	7.55±0.44	7.25±0.42	7.64±0.37
Control	20	8.40±0.11	8.30±0.19	8.00±0.22	7.95±0.25	8.16±0.15

DFA= Developed Formula A, DFB= Developed Formula B, Control= Maize with milk, Values are mean±SEM of Color, Taste, Smell, Texture and Overall acceptability.

Discussion:-

Formulating diets for infants and toddlers using the locally available food materials especially in developing countries where there is hunger to alleviate micronutrients malnutrition is a welcome idea and should be encouraged. Mineral elements play important roles in health and disease states of humans and domestic animals. The current study formulated the baby foods DFA and DFB and compared them with Control, CFA and CFB (Table 3) for the Iron, Zinc, Calcium, Sodium, Potassium Magnesium and Phosphorus contents. From this study, the mineral content of the developed formulas were found to be inadequate in some minerals (iron, calcium, potassium, sodium,) compared to the CODEX (2013) standard but adequate in others such as zinc, magnesium and phosphorus. Iron content of developed formulas ranged from (6.73 g - 6.79mg/100 g) for DFA and DFB respectively. Iron has been reported to be an important component of the red blood cells (Agbon et al., 2009), while its deficiency is believed to affect 20-50% of the world population, making it the most common micro nutrient deficiency in the world (Onabanjo, 2007). The values of Iron obtained in this study were lower than the control diet (12.92mg/100 g) and all were lower to the nutritional requirement for iron (16mg/100g CODEX, 2013). DFA and DFB were lower when compared to the values reported by other workers (Asma et al., 2006; Onabanjo et al., 2008), which contained iron less than or equal to 0.01g (10mg). The values of Zinc (3.24-3.53mg/100g) for developed formulas were slightly higher than the nutritional requirement of 3.2 mg/100g prescribed by the CODEX (2013). According to Onabanjo (2007), Zinc is an integral component of almost 100 different enzymes, vital to about 200 different enzymes and appears to play an essential role in all the major metabolic pathways. Zinc content of all the complementary formulas were higher than the RDA value (3.2 mg/100g) recommended by the Codex Alimentarius Guidelines for formulated supplementary foods for older infants and young children (FAO/WHO, 2013), and compared to Oluseye and Olamide work which is 0.02 g/kg (Oluseye and Olamide 2016). Calcium content of the complementary food samples ranged from (150-180mg/100g) for DFB and DFA respectively. The values of calcium obtained in this study were lower to the control (235mg/100) but higher when compared to the formulated baby food by (Rashida et al., 2014) which is 0.50 g/kg. All foods were lower (including control) when compared to CODEX (2013) standard of 250mg/100g. The significant differences ($p<0.05$) observed between the control and the homogenous blends in their calcium content could be attributed to the type of raw materials used as a base especially the milk added to the control food. Calcium is an essential micro nutrient in infants and young children for building bones and teeth, functioning of muscles and nerves, blood clotting and for immune defence (Rashida et al., 2014). The sodium concentration of DFA and DFB ranged from (132-135 mg/100g) and the values were higher when compared to the control (120 mg/100g). None of the values for the five complementary foods were adequate when compared to the nutritional requirement for sodium (296mg/100g) CODEX (2013). Potassium, just like Sodium, is an electrolyte essential in the homeostatic balance of body fluids. The concentration of potassium in the control food was 417mg/100g, whereas 365mg/100g and 385mg/100g in the developed formulas. The nutritional requirement for potassium is 516mg/100g (CODEX 2013) which is higher when compared to DFA and DFB but DFA and DFB are higher in potassium when compared to the complementary food produced by Akinsola which is 0.6g/kg (Akinsola et al., 2017). Phosphorus ranged from (350-354mg/100g) for DFA and DFB respectively which were lower to the control (551mg/100g) but considerable to the CODEX standard (2013) of 356mg/100g. There was no significant differences ($p>0.05$) in the values of Magnesium obtained in the study.

The current study compared DFA and DFB with Control, CFA and CFB (Table 4) for Vitamin A, Vitamin B1, Vitamin B9, Vitamin C and Vitamin E contents. The mean Vitamin A (IU/100g) in DFA was significantly higher than DFB and CFB however, it was significantly lower than Control and CFA. The developed formulas meet the nutritional requirement for vitamin A which is 400µg/day (FAO/WHO/UNU 1985). The equivalence of 400µg is 1,333 IU/100g and DFA (1,391 IU/100g) was higher than that. The control food was also higher while DFB was a little lower than the standard. The mean Vitamin B1 (mg/100g) in DFA was significantly higher than DFB, Control, CFA and CFB however, DFB was significantly higher than the Control, CFA and CFB while CFA and CFB showed no significant difference between then but significantly higher than Control. DFA is a good source of thiamine in complementary baby foods. The mean Vitamin B9 (µg/100g) in DFA showed no significant difference with CFA however, it was significantly lower than the values in DFB and control food but higher than that of CFB. 10-30µg/100kcal was recommended by Codex Alimentarius standard (FAO/WHO, 1991), which is equivalent to 15-45µg/100g. DFA, DFB and the control falls within the given range which shows that the developed foods are rich in folic acid. The mean Vitamin C (mg/100g) in DFA was significantly higher than those of DFB, CFA and CFB. The values in Control (58.95) were significantly higher than those in the other formulations analysed. DFB, CFA and CFB showed no significant difference. The Codex Alimentarius standard (FAO/WHO, 1991), is 13.34mg/100g which shows that DFA is adequate in vitamin C. The values of the formulated foods and control were higher when compared to Oluseye and Olamide work of 6.93mg (Oluseye and Olamide, 2016). The mean Vitamin E (IU/100g) in DFA and CFB showed no significant difference however, it was significantly higher than the values in DFB and CFA. The values in the Control were significantly higher than those in the other formulations analysed. DFB and CFA showed no significant difference. DFA and DFB still provides adequate vitamin E contents in complementary baby foods.

Sensory parameters: The current study formulated the baby foods DFA and DFB and compared them with Control (Table 4) for Color, Taste, Smell, Texture and Overall Acceptability. The results showed that the sensory parameters of the three baby food formulas (DFA, DFB and Control) were not statistically significantly different from each other when compared even though the control food had slightly higher values. DFA and DFB in comparison with the control food were palatable and acceptable by the 20 member panel of nursing mothers and as such can be deployed for commercial purposes for babies between 6-24 months of age.

Conclusion:-

DFA has the highest values in micronutrients (vitamins and minerals) contents between the two food ratios. This study shows that the development of complementary baby food from properly selected local household food commodities can be used to formulate nutritious homemade complementary foods for children between 6-24 months old. It is an available and affordable means of providing complementary food that can help in alleviating some economic (cost effective) and time related constraints faced in child feeding practices. Therefore, it can serve as an alternative to imported baby foods, meeting the micronutrient requirements of infants.

Recommendation:-

More research can be carried out on other available grains and cereals to analyze their nutritional composition for homemade complementary foods for infants and toddlers in rural and urban areas. Also, further studies will be done on the DFA and DFB for functional properties (water absorption capacity, swelling capacity, solubility, etc), amino acid composition and shelf life.

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