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COMPARATIVE ANALYSIS OF THE NUTRITIONAL AND ANTI-NUTRITIONAL COMPOSITION OF A DEVELOPED DEPLOYABLE BABY FOOD AND OTHER COMMERCIAL BABY FORMULAS (6-24 MONTHS)

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Abstract

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. The nutritional and anti-nutritional values of the formulated foods were compared with imported baby food and two locally available baby formulas. 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 proximate, phytochemicals and anti-nutrient properties of the foods. The mean± standard error of mean for moisture, ash, crude protein, crude fibre, crude fat and carbohydrate contents of the DFA respectively are; (4.08±0.04), (2.27±0.14), (15.19±0.08), (0.95±0.04), (10.14±0.10) and (67.37±0.27) while for DFB they are; (4.09±0.19), (1.76±0.03), (15.96±0.20), (0.69±0.02), (14.50±0.2) and (62.99±0.03) respectively. The overall results indicated that the proximate parameters and energy contents of the developed homogeneous blends were similar, lower or higher than values in the control formula but all within the acceptable limits. Samples were also rated using a 9-point hedonic scale range from “like extremely” (9) to “dislike extremely” (1) for sensory evaluation. Conclusively, it is believed that complementary foods from locally available food commodities have great potential in providing nutrients aimed at combating the problem of malnutrition among infants and toddlers between the ages of 6 to 24 months.

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Introduction:-

Scientific study has proven that breast milk is the best food for the infant during the first six months of life. It contains all the nutrients and immunological factors an infant requires to maintain optimal health and growth (Amira et al., 2018; UNICEF, 1999). Good nutrition is the bedrock of every child's survival, growth and development. Well-nourished children are better able to learn, play and participate in their communities. They are also more resilient to illnesses and crisis. Breastfeeding is the optimal way of feeding babies, offering them the nutrients they need in the right balance, as well as offering protection against disease. Adequate nutrition during infancy and early childhood is essential to ensure the growth, health and development of children to their full potential. The World Health Organization (2001) recommends that babies should be exclusively breastfed for the first six months of life, followed by introduction of nutritionally adequate and safe complementary foods and continued breastfeeding up to two years old or beyond. Nutritious complementary foods are introduced – also known as weaning foods – to cover the period of six to twenty four months of age in most developing countries (WHO/OMS, 2000). Complementary food is a food either liquid or solid that can be given to infant and toddlers (6–24 months) along with breast milk (WHO, 2001). Therefore, timely provision of appropriate complementary foods during infancy is paramount for child growth (nutritional and developmental) says Kamchan et al. (2004), but the quality of complementary foods to meet the required essential nutrient for children is very essential.

Since 2000, the world has reduced the proportion of children under 5 suffering from stunting by one third and the number of children who are stunted by 55 million. This remarkable achievement proves that positive change for nutrition is possible and is happening at scale. But there is more work to be done. Complementary feeding period is the time when malnutrition starts in many infants, contributing significantly to the high prevalence of malnutrition in children less than 5 years of age worldwide (Daelmans & Saadeh, 2003). Today, many children are not getting the nutrition they need to survive and thrive. This is especially true for the most vulnerable children: the youngest, the poorest and those trapped by humanitarian crises. At least, one in three children under 5 is affected by malnutrition in its most visible forms: undernutrition- both stunting and wasting- and overweight. Therefore, nutritious complementary foods are needed to cub malnutrition. The complementary food is often associated with low energy density and other essential nutrients; and in many parts of developing countries, it is usually given too earlier or late in insufficient amounts to meet the nutritional needs of infant (Onyango, 2003; Muhimbula et al., 2011). Scientific research has reported that timely introduction of appropriate complementary foods promotes good nutritional status and growth in infants and young children (Michaelsen et al., 2000; Domellof et al., 2002). The nutritional adequacy of complementary foods is essential for the prevention of infant morbidity and mortality, including malnutrition and overweight.

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 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).

In 2008, 8.8 million global deaths in children less than 5 years old were due to underweight, of which 93% occurred in Africa and Asia. Approximately one in every seven children faces mortality before their fifth birthday in sub Saharan Africa (SSA) due to malnutrition (Walton, 2011). Malnutrition is not just a health issue but also affects the global burden of malnutrition socially, economically, developmentally and medically, affecting individuals, their families and communities with serious and long lasting consequences (WHO, 2019).

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 fiber 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).

The use of local foods formulated at home as complementary food should be guided by the following principles says Dewey & Brown, 2003; Pelto et al., 2003.

1. high nutritional value to complement breastfeeding

2. acceptability by the child
3. low price/ affordability
4. locally available food materials

In the light of the above, this study was aimed to fill the gap of providing an acceptable cost-effective homemade, nutritious complementary food that would supply the basic nutrients needed for proper growth and development of the child in the right quantity to alleviate malnutrition and as well be low in anti-nutrients as a result of good processing methods. 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 that 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 12 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 (dried) 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

Analytical Methods:-

Proximate Analysis:

Nutrient composition of the food samples was determined using the standard procedures, all analysis were done in triplicates. Powdered samples were used for moisture content in a hot-air circulating oven (Lab. oven model no. DHG-9053A Searchtech Instruments British Standard) using the gravimetric method as adopted by Onwuka (2018). Ash was determined by the muffle furnace (PEC Medical USA SX-2.5-12) incineration gravimetric method at 550°C adopted by Onwuka (2018) for 5 hours. Crude fat was determined by soxhlet solvent extraction method adopted by Onwuka (2018). Crude protein was determined by the Kjeldahl method in which the nitrogen content was determined and multiplied by 6.25 to obtain the protein content (Onwuka, 2018). Crude fibre was determined by the gravimetric method adopted by Onwuka (2018). The carbohydrate content was determined by difference using the method adopted by Onwuka (2018). Addition of all the percentages of moisture, fat, crude protein, ash and crude fibre was subtracted from 100%. This gave the amount of nitrogen free extract otherwise known as carbohydrate:

Percentage (%) carbohydrate=100 - (%Moisture+%Fat+%Ash+% Crude fibre+%Crude protein). The energy content of the baby food samples were determined by calculating the amount of protein, fat and carbohydrate of respective food items and by using the following equation as adopted by Onwuka (2018). Energy = (Protein × 4.1) + (Fat × 9.3) + (Carbohydrate × 4.1).

Anti-Nutrients and Phytochemicals Analysis

Phytate was determined according to the gravimetric method as adopted by Owheruo et al. (2019).

Oxalate in the samples was determined using titration method elucidated as adopted by Onwuka (2018).

Tannin in the samples was determined using spectrophotometric method as adopted by Onwuka (2018).

Alkaloids content was determined according to the gravimetric method as adopted by Nimyel and Lori (2022).

Flavonoids Content was determined according to the spectrophotometric method as adopted by Onwuka (2018).

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 obtained from Bwari Area Council, 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 nutritional and anti-nutritional contents (proximate composition, anti-nutrients and phytochemicals) 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:-

The data for chemical composition i.e. moisture, ash, crude protein, crude fat, crude fibre, carbohydrate and energy have been presented in the following manner. All the analysis was performed in triplicates and the values are used in mean ± standard error of the mean.

Proximate analysis of developed complementary food samples in comparison with other baby formulas.
The proximate composition of yellow corn, soya beans, groundnut and crayfish homogenous blends in two different ratios called Developed Formula A (DFA) and Developed Formula B (DFB) are presented in Table 2.

The mean Moisture (%) content of DFA and DFB were significantly higher than that of the Control but lower than that of CFA and CFB. There is no significant difference between DFA and DFB and between CFA and CFB also. The mean Ash (%) content of DFA and CFB showed no significant difference however, they are significantly higher than the values in DFB and CFA. The mean value in the Control is significantly higher than the other groups. The mean Crude Protein content (%) in DFA, DFB and Control showed no significant difference; however, they are significantly lower than the values in CFA and CFB. The values in CFA are significantly lower than those in CFB. The Fat content (%) in DFA was significantly lower than that of DFB, CFA and CFB. It is however, higher than that of Control. There is no significant difference between CFA and CFB. The Crude Fibre content (%) in DFA was significantly higher than that of DFB. DFA and DFB, however, were significantly lower than the Control, CFA and CFB. The value in the Control food was significantly higher than those in CFA and CFB. The Carbohydrate (%) in DFA, DFB and Control showed no significant difference. However, they were significantly higher than those in CFA and CFB. CFA was significantly higher than CFB.

Anti-nutrients analysis of developed complementary food samples in comparison with other baby formulas shown in Table 3.
The mean Oxalate (%) in DFA and DFB showed no significant difference. However, it was significantly lower than those in Control food, CFA and CFB. The mean values in CFB were significantly higher than those in DFA, DFB, Control and CFA. The mean Phytate (%) in DFA, DFB and the Control showed no significant difference. However, they were significantly lower than those in CFA and CFB. The mean value in CFB was significantly higher than that of CFA. The mean Tannin (%) in DFA was significantly higher than those in DFB, Control, CFA and CFB. The values in DFB and CFB were significantly higher than those in the Control food and CFA. No significant difference between DFB and CFB.

Phytochemicals analysis of developed complementary food samples in comparison with other baby formulas shown in Table 4.
The mean Alkaloids (%) in DFA was significantly lower than those in DFB, Control, CFA and CFB. The values in DFB and CFA showed no significant difference but were significantly lower than the value in DFB. The mean Flavanoids (mg/100g) in DFA was significantly lower than those in DFB, Control food, CFA and CFB. The mean Flavanoids values in DFB and CFA showed no significant difference. However, they were significantly lower than the values in Control and DFB. The mean values in the Control baby food and CFB showed no significant difference.

Sensory evaluations
The sensory parameters of the two ratios of formulated baby food and control food showed the mean±S.E.M. 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 on figure 1 below.

Table 2:- The mean comparison of Moisture, Ash, Crude Protein, Fat, Crude Fibre and Carbohydrate contents of the baby food formulations analysed in the study.

Baby Formula	Moisture %	Ash %	Crude Protein %	Fat Content %	Crude Fibre %	Carbohydrate %	Energy (Kcal)
DFA	4.08±0.04[a]	2.27±0.14[a]	15.19±0.08[a]	10.14±0.10[a]	0.95±0.04[a]	67.37±0.27[a]	433
DFB	4.09±0.19[a]	1.76±0.03[b]	15.96±0.20[a]	14.50±0.2[b]	0.69±0.02[b]	62.99±0.03[a]	459
Control	2.28±0.33[b]	3.86±0.03[c]	16.22±0.05[a]	8.38±0.14[c]	4.82±0.17[c]	64.45±0.19[a]	409
CFA	5.51±0.12[c]	1.96±0.04[b]	19.66±0.58[b]	17.22±0.21[d]	1.24±0.03[d]	54.41±0.59[b]	464
CFB	5.37±0.08[c]	2.59±0.03[a]	31.71±0.38[c]	17.30±0.21[d]	2.16±0.01[e]	40.87±0.39[c]	458
CODEX standard*	<5	<3	15	10-25	<5	60-75	400-425

DFA= Developed Formula A, DFB= Developed Formula B, Control= Maize with milk, CFA= Commercial Formula A, CFB= Commercial Formula B. Values are mean±S.E.M. of Moisture, Ash, Crude Protein, Fat, Crude Fibre and Carbohydrate contents. Values with different superscripts in a column are significantly different at $p<0.05$. *CODEX Alimentarius Commission (2013).

Table 3:- The mean comparison of Oxalate, Phytate and Tannin of the baby food formulations analysed in the study

Baby Formula	Oxalate mg/100g	Phytate %	Tannin %
DFA	0.35±00[a]	0.28±0.02[a]	0.6±0.11[a]
DFB	0.29±0.01[a]	0.26±0.01[a]	0.25±0.01[b]
Control	0.65±0.09[b]	0.36±0.01[a]	0.09±0.01[c]
CFA	0.80±0.06[c]	0.84±0.01[b]	0.14±0.01[d]
CFB	1.02±0.01[d]	1.29±0.14[c]	0.22±0.02[b]
*Codex standard	25mg/100g	200mg/100g	1mg/kg

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 Oxalate, Phytate and Tannin contents. Values with different superscripts in a column are significantly different at $p<0.05$. *CODEX Alimentarius (2015).

Table 4:- The mean comparison of Alkaloids and Flavanoids of the baby food formulations analysed in the study.

Baby Formula	Alkaloids %	Flavanoids mg/100g
DFA	3.34±0.06[a]	10.45±0.26[a]
DFB	4.56±0.07[b]	12.59±00[b]
Control	5.13±0.06[c]	14.40±0.10[c]
CFA	4.09±0.02[b]	12.27±0.03[b]
CFB	6.04±0.03[e]	14.92±0.06[c]

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 Alkaloids and Flavanoids contents. Values with different superscripts in a column are significantly different at $p<0.05$.

Discussion:-

The weaning period is the most critical phase of an infant's life which is the period after the recommended 6 months of exclusive breast feeding, when complementary foods are introduced (Giulia et al., 2022). During this period, the mother's milk is not generally adequate to cover the nutritional requirements of the child and cannot support body growth effectively. World Health Organization (2013) recommends that infants be on exclusive breast milk for the first six months of life beyond which additional meals be introduced. For the rapidly growing infant, the available diets are not able to meet their nutritional demands, hence the need for complementary foods. However most of the imported baby foods are expensive. Complementary foods are generally introduced between the ages of six months to 24 months of age as breastfeeding is discontinued. A complementary food should be accessible to the child and adequate in protein, fat, carbohydrates, vitamins and minerals to alleviate protein-energy malnutrition. It is an essential element in the care of infants and toddlers especially in developing countries where malnutrition is prevalent (IYCF, 2023).

In view of the above, DFA and DFB were formulated to meet the required daily allowances of the dietary needs of these children using the locally available ingredients around us which are affordable, making them into a homogenous blend of nutritious baby food for children between six to 24 months old.

The current study formulated the baby foods DFA and DFB and compared them with a Control food, CFA and CFB (Table 2) for Moisture, Ash, Crude Protein, Fat, Crude Fibre and Carbohydrate contents. The mean Moisture (%) of DFA and DFB were significantly higher compared to that of Control but lower than CFA and CFB. The high values of moisture content of DFA and DFB shows that they will have a lesser shelf life compared to the control baby food with a lesser moisture content but higher moisture content when compared to CFA and CFB. The more the moisture content, the more susceptible to microbial attack during storage (Isengard, 2001) which shortens the period of time the food sample can stay before getting unfit for human consumption. However, the moisture content of DFA and DFB still falls within the expected value of <5 as stated by Codex standard (2013). The mean Ash (%) of DFA and CFB showed no significant difference however, they are significantly higher than the values in DFB and CFA. The mean value in Control food is significantly higher than the other groups. Ash content gives an indication of the mineral composition preserved in the food materials (Omotoso, 2005; Nnamani et al., 2009). Higher ash content indicates a higher mineral content. The ash content of DFA was higher than that of DFB and infants feeding on DFA will not suffer mineral deficiency even though the ash content in the control is higher. The expected value of ash content according to Codex standard (2013) is <3g/100g. The mean Crude Protein (%) in DFA, DFB and Control showed no significant difference however, they are significantly lower than the values in CFA and CFB. The Codex standard (2013) for protein in complementary foods is 15% as shown on table 2. The protein content of DFA is within the expected value even though lower than the control which makes it an accurate protein diet to alleviate protein energy malnutrition in infants and toddlers. Effionge et al. (2009) stated that any plant food that provides about 12 % of the caloric value from protein is considered a good source of protein. Therefore, the homogenous blend of DFA and DFB meets this requirement. The Fat content (%) in DFA was significantly lower than that of DFB, CFA and CFB. It is however, higher than that of Control. The fat content of DFB is higher than the 10% recommended by FAO, (1996) for weaning food formulation but within the range of 10-25% recommended by Codex Alimentarius Commission (2013). This high content implies that the storage life of the flour blends may decrease due to their high-fat content resulting in high susceptibility to oxidative rancidity (Ihekoronye & Ngoddy, 1985). Dietary fats function in the increase of palatability of food by absorbing and retaining flavours (Antia et al., 2006). The fat content of the control is lower than that of DFA which meets the fat requirement of baby foods. The Crude Fibre (%) in DFA was significantly higher than DFB. The DFA and DFB, however, were significantly lower than Control, CFA and CFB. The fibre content of DFA and DFB were lower than that of the control but found to be within recommended limits. The Codex standard of fat content is <3 and all the baby food formulations are within the standard range except for the control which is a little higher. Carbohydrate content contributes to the bulk of energy of the formulation. The Carbohydrate (%) in DFA, DFB and Control showed no significant difference however, were significantly higher than those in CFA and CFB. The high carbohydrate yield of DFA and DFB makes them ideal for babies since they require energy for their rapid growth. The Codex standard for carbohydrate is stated as 60-75%. CFA and CFB are not up to the Codex standard for carbohydrate, while DFA, DFB and Control food are within the standard range. The expected energy value in Kcal/100g as stated by Codex Alimentarius Commission (2013) is 400-425KCal.

The current study formulated the baby foods DFA and DFB and compared them with a Control food, CFA and CFB (Table 3) for the Oxalate, Phytate and Tannin contents. The mean Oxalate (%) in DFA and DFB showed no significant difference however, it was significantly lower than those in Control, CFA and CFB. The mean values in CFB were significantly higher than those in DFA, DFB, Control and CFA. The permissible limit for Oxalate according to CODEX ALIMENTARIUS (2015) is 25mg/100g which indicates that DFA and DFB are eligible for consumption. The mean Phytate (%) in Developed Formula A, DFB and Control showed no significant difference however, they were significantly lower than those in CFA and CFB. The mean values in CFB significantly higher than that of CFA. The permissible limit for Phytate according to CODEX ALIMENTARIUS (2015) is 200mg/100g. The five baby food formulations fall within the permissible limit of the antinutrient. The mean Tannin (%) in DFA was significantly higher than those in DFB, Control, CFA and CFB. The values in DFB and CFB were significantly higher than those in the Control and CFA. No significant difference between DFB and CFB. The permissible limit for Tannins according to CODEX ALIMENTARIUS (2015) is 1mg/kg and all baby food formulations fall within the permissible limits.

The current study formulated the baby foods DFA and DFB and compared them with a Control baby food, CFA and CFB (Table 4) for the Alkaloids and Flavanoids contents. The mean Alkaloids (%) in Developed Formula A was significantly lower than those in DFB, Control, CFA and CFB. The value in DFB and CFA showed no significant difference but was significantly lower than the values in DFB. The mean Flavanoids (mg/100g) in DFA was significantly lower than those in DFB, Control, CFA and CFB. The mean Flavanoids values in DFB and CFA showed no significant difference however significantly lower than the values in Control and DFB. The mean values in Control and CFB showed no significant difference. Phytochemicals have antioxidant properties and offer protection that deceases the risk of many diseases, says Vijaya Surampudi (2023), a physician nutrition specialist at UCLA Health. They help in neutralizing free radicals, which can damage the DNA. As such, no specific range is stated.

The current study formulated the baby foods DFA and DFB and compared them with the Control baby food (Figure 1) 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. DFA and DFB in comparison with the control food were fit 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.

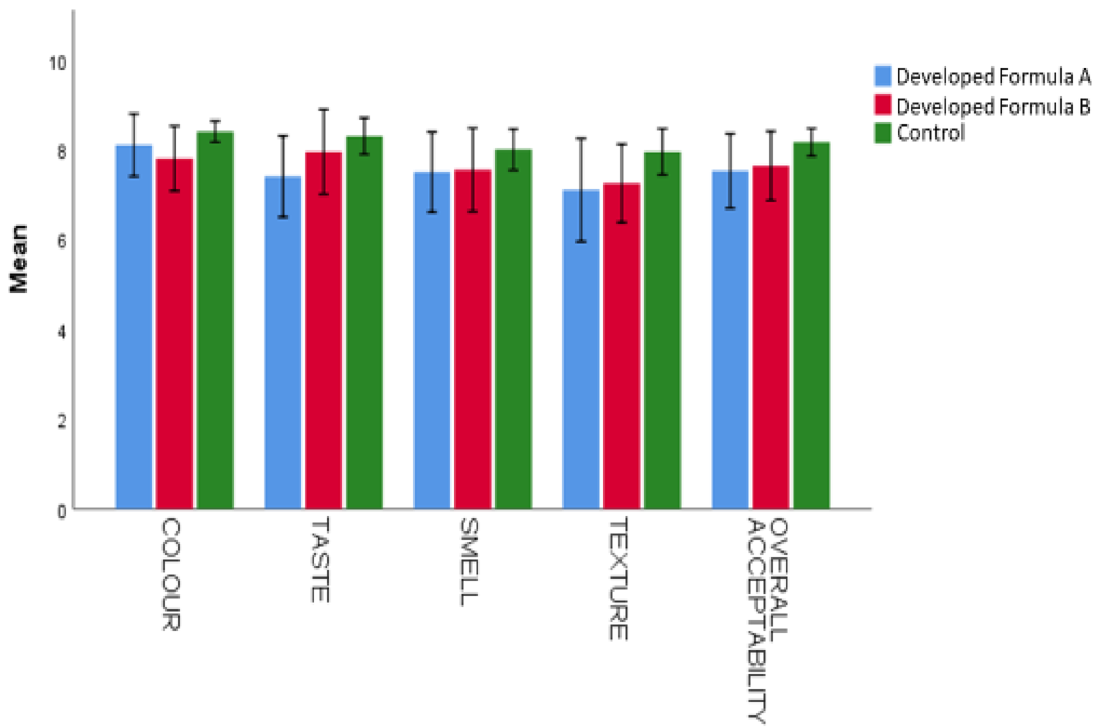

Figure 1:- The mean±S.E.M. of Color, Taste, Smell, Texture and Overall Acceptability of Developed Formula A, Developed Formula B and Control analysed in the study. Bars showed no significant difference at p>0.05.

Conclusion:-

This study revealed that the homogenous blend of developed formulas from locally available food commodities meets the recommended macronutrient requirements of infants and toddlers, and is highly nutritious when compared to the control. Among the formulated baby foods, DFA was ranked best when compared with other formulated food samples (DFB, CFA and CFB). However, the other three food samples were good sources of high quality protein and energy values. Thus, the developed formulas A and B are considered safe as the anti-nutrients were destroyed during processing and values are within recommendation by FAO and WHO 2004. The procedure for the processing is equally easy and energy saving. Nutritionally, DFA when compared to the control baby food in terms of proximate composition, antinutrients and phytochemicals stood out and conclusively can serve as an alternative to imported baby foods in order to meet the nutritional requirements of infants (6-24 months).

Recommendation:-

Homogenous blends (DFA especially) formulated from this research work can be recommended to mothers in rural and urban areas with children within 6 to 24 months as a complementary food.

Further studies can be carried out 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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