Proceedings of the 34th Accra Bespoke Multidisciplinary Innovations Conference & the Africa AI Stakeholders Summit
Academic City University College, Accra Ghana
19th – 21st December, 2022
www.isteams.net/accrabespoke2022

Mineral Composition and Sensory Properties of Infant Formulated Food: Alternative Sources of Milk for Infants.

*Lawal, R. A., [1] Musa, H.,[1] Jacob, G.A.[1] & Okebunmi, F.A.[1]
[1]Department of Food Science and Technology, Federal Polytechnic, Bauchi.
*Corresponding author: motherofbelievers54@gmail.com
Phone: +2348055597101

ABSTRACT

This study focused on the possibility of developing and formulating of infant weaning food from locally available, vegetable proteins and cereal to overcome protein malnutrition deficiencies among the children in Sub Sahara Africa. This research investigated the mineral composition and sensory evaluation of infants formulated food produced from cereal-based meal complement with almond milk and soy milk as alternative sources of milk for infants. The raw materials used for this study was procured from local market in Bauchi, Nigeria. The local rice was malted, dried, dry milled, sieve and packaged in cellophane bag. The almond seeds were cleaned, soaked, wet milled, filtered, boiled and packaged as almond milk. The procedure was repeated for soy milk. Then, the carrots were cut into 1cm and blanched, dried, dry milled, sieved and packaged. Also, dry date fruits were cleaned and processed into powder. The weaning diets were formulated by mixing 60grams of powdered malted rice; 5grams of carrot powder and 10gram of date powder with 25ml of almond milk were mixed into slurry (formulated meal I), the mixtures were boiled, served and labeled. The weaning diets II were formulated by mixing 60gram of powdered malted rice; 5gram of carrot powder and 10gram of date powder with 25ml of soy milk were mixed into slurry, boiled into porridge, served and labeled. The mineral composition was evaluated using the atomic absorption spectrophotometer and by comparing the blank to the standard curve and the scores of the sensory was analyzed using analysis of variance (ANOVA) in order to establish the degree of difference. The sensory properties of the formulated porridges were compared with commercial product (control).The mean scores of the attributes evaluated ranging from appearance (6.0 – 7.5), taste (6.0 – 7.2), flavor (7.0 – 7.5), color (6.3 – 7.6), texture (6.3 – 6.8) and general acceptability (6.3 – 7.7) respectively. However, there was significant different ($p>0.05$) in mineral composition between formulated diets and the control. The results showed that the study successfully produced two different formulated diets of rice, carrot, date palm and using soy and almond milk as alternative sources for breast milk with acceptable sensory characteristics as well as excellent nutritional quality.

Keywords: mineral, sensory, infants, formulation and milk.

Proceedings Reference Format
Lawal, R. A., Musa, H., Jacob, G.A. & Okebunmi, F.A. (2022): Mineral Composition and Sensory Properties of Infant Formulated Food: Alternative Sources of Milk for Infants. Proceedings of the 34th Accra Bespoke Multidisciplinary Innovations Conference & The Africa AI Stakeholders Summit. Academic City University College, Accra Ghana, 2022.
Pp 225-233. www.isteams.net/accrabespoke2022.

---

1. INTRODUCTION

The weaning period is the most crucial and vulnerable period for developing children under nutrition. This is because after breastfeeding for six months, additional food and nutrients may be required to continue and maintain the child's growth and development. Unfortunately, during this period, mothers/caregivers give food only to prevent the child from being hungry with little regard to the nutritional quality of the weaning food (WHO/UNICEF, 1998). This situation worsens if economic challenges exist in the family. During this critical period children develop illnesses and multiple deficiencies such as protein, energy and micronutrient deficiencies. The key limiting nutrients identified during the weaning period are iron, zinc, vitamin B6 and, in some populations, riboflavin, niacin, thiamin, calcium, vitamin A, folate and vitamin C. Vitamin D is also of concern in populations with low exposure to sunshine or at high latitudes (WHO, 2006). The highest burden of micro-nutrient malnutrition including vitamin A deficiency (VAD), iron and other diseases associated with hidden hunger among children under five is found in sub Saharan Africa (WHO, 2009).

Protein-energy malnutrition and micronutrient deficiency among children, especially those living in rural communities, is estimated to be very high. This is because during this period the traditional weaning food (maize porridge, often referred to as ‘Koko’, ‘Akamu’ or ‘Ogi’) given to the child lacks adequate nutrients for growth and development (Treiche *et al.,* 2004). According to the (WFO, 2010), the surface of land for growing rice represents only 11% of the world arable land. But the rice is the first cereal grown in the world, just after wheat and maize (Benkadri, 2010). It also the basic foodstuffs of more than the half of the world population according to Benkadri, 2010.

In Ivory Coast, rice can be grown in every region and precisely in the western, center and south-western side where unfortunately malnutrition raged (EDSCI, 2012).Rice is usually used as powder in infants food to produce complementary food (Laureys and Geeroms, 2002); it is also different from the other cereals because of its high quantity of gluten and less quantity of prolamine. Although rice contains important quantities of micro nutriments and aroma (Laignelet, 1998), it is devoiced of some nutriments useful for the growth such as proteins and it is weak in energy. As the stomach of a child is small (30 ml/kg of his total weight) (Sawadogo *et al.,* 2003), he seems satiated when he eats few quantity but he misses essentials nutriments. The power of rice doesn't correspond to the internationals institutions’ alimentation standard (Bengaly, 2010).

Rice (Oryza sativa) is a major staple food all over the world including Africa. It may be a good carbohydrate alternative in weaning food blends. In Nigeria, though the production of local rice has been increasing lately, patronage of this local rice is, however, low. This is because the inadequate and inappropriate post-harvest practices currently used by farmers and other rice value- chain actors make the quality of the locally milled rice variable. The level of broken grains after milling usually exceeds 30% and the product contains unhusked grains as well as bran and husk fractions (Appiah *et al.,* 2011). This broken rice fraction which otherwise may be used as animal feed or left unused could potentially be an alternative source of carbohydrate for novel infant feed formulations (Appiah *et al.,* 2011).

Soybean (Glycine max) is known for its high quality protein and fat content. Soybeans are the most important plant source because it contains an excellent balance of indispensable anti-nutrient factor such as antigens, lectins, trypsin and oligosaccharide. (Suite, 2007). Its application in weaning formulation improves their protein, fat and iron contents (Goto et al., 1999). An almond (Prunus dulcis) is associated with some positive health benefits such as antioxidant capacities, anticancer and antiatherogenic actions as well as the regulation of immune and inflammatory responses (Rabadan, A., *et al*., 2019). The health benefits of almond are related to the availability of unsaturated fatty acid (Berryman, C., *et al*., 2011) and polyphenols which are known to improve human health (Garrido, I., *et al*., 2008).

In developing countries, one of the greatest problems affecting millions of people, particularly children, is lack of adequate protein intake in term of quality and quantity. As cereals are generally low in protein, supplementation of cereals with locally available legume that is high in protein increases protein content of cereal-legume blends. Childhood nutrition remains a major health problem in Nigeria. Approximately one-third of children less than five years of age in developing countries are stunted (low height – for age), and large proportions are deficient in one or more micronutrients (WHO, 2001).Weaning food supplemented with high protein content, high digestibility and high energy density can be prepared from readily available low cost materials (such as rice, soybeans, coconut, carrot, date palm). This weaning food can be used to meet the needs of growing children (especially those within the age bracket of 6-36 months), thereby reducing malnutrition in developing countries like Nigeria (Satter *et al*., 2013). Therefore, this study aim to investigate the nutritional composition, consumer acceptability with emphasis on protein quality of cereal-based composite porridge complements soybeans almond fruits.

2. MATERIALS AND METHODS

2.1 Sources of raw materials

Local rice, almond, soybeans, carrot, date palm were purchased from Muda lawan market in Bauchi metropolis, Bauchi State, Nigeria.

2.2 Samples Preparation

2.2.1 Local rice

Processing of malted rice – Sorted clean grains of rice weighing 1000 g were steeped in water (1:3 w/v, grain: water) for 4 h. The steeped grains were then transferred to a wide container with cotton wool to allow for germination at room temperature (30°C) for 3 days. The washed germinated grains were dried in the oven at 35°C for a total of about 10 to 12 h. The grains were then cleaned of sprouts and hulls by hand rubbing and winnowing, after which they were dried in a forced-air oven at 50°C to a uniform colour. The dried grains were ground to fine flour and passed through a 0.5 mm sieve (Elemo *et al.,* 2011).

2.2.2 Preparation of almond milk

Almond seed was prepared using the method described by Preeti *et al*., (2018). Almond seeds were cleaned and soaked in 100ml of distilled water for 12h followed by draining and dehulling to reduce the level of oxalic. The dehulleds almonds were ground with water in a blender.

The obtained slurry was strained through a two layer muslin cloth to obtain filtrate (almond milk). The almond milk was boiled (100℃) for 10mins, package and cooled at temperature 4℃.

2.2.3 Soybeans

Processing of Soybeans milk –using the method described by Nyagaya (2008). The method of soaking, 25g of soybeans was soaked in 100ml of water for 12 hours at room temperature (25 ° C). After draining the soaking water and rinsing with cold water, the beans were ground with 200ml of water using a warring laboratory electric blender and filtered through muslin cloth. The filtrate (soymilk) was boiled in a beaker for 10min.

2.2.4 Preparation of carrot powder

Carrot tubers were prepared using the method described by Mohammed and Hussein (1994). The carrots were trimmed, scrapped, washed and cut into 1cn cube and thoroughly mixed. The carrot cubes were blanched in a water bath (Precision stainless steel, model- 184) at 70^{o}C for 20mins with solution of 2% glycerol, 1% calcium chloride and 0.1% sodium metal bisulphate which were dissolved in distilled water (to prevent loss of carotenoid). Immediately after blanching, the carrot were soaked in distilled water contain ice cubes for 0^{o}C for 15mins to prevent further cooking. The blanched carrot cubes were placed in a stainless pan and dried in oven at 72^{o}C for 48hrs.After drying, the cubes removed and blend with food processor (Cuisinart, Smart powder Duet (R) BFP-703). The powder was later dried in food dehydrator at temperature of 70^{o}C for 15mins. It was dried until moisture content below 0.34%. The powdered carrot was sieved and package in cellophane bag for subsequent used.

2.2.5 Preparation of date powder

The dried date fruits were sorted, graded, cleaning and opened to remove the seeds. The dates were pouring in the stainless pan and dried in the cabinet drier at temperature of 72^{O}C for 48hrs. .After drying, the dates were removed and blend with food processor (Cuisinart, Smart powder Duet (R) BFP-703). The powder was later dried in food dehydrator at temperature of 70^{o}C for 15mins. It was dried until moisture content below 0.34%. The powdered carrot was sieved and package in cellophane bag for subsequent used.

2.2.6 Preparation of composite porridge

2.2.6.1 Formulation composite porridge I: The malted rice meal powder was mixed with dried powder of carrot together with date powder and almond milk was mixed together into slurry. The slurry was boiled at temperature of 100^{O}C for 3-4mins in sauce pan and transfer into serving bowl for further evaluation. The same procedures were repeated for composite porridge II.

2.3 Sensory Evaluation

Sensory evaluation for the 3 samples was carried out. The samples were presented before the panelist who was asked to rate the samples based on the following quality attributes; appearance, taste, flavor, color, texture and general acceptability. The panelists were randomly chosen among the lactating mothers that were familiar with weaning foods. They were to indicate their acting by scoring the samples using the samples using the scores on the nine Hedonic scales presented to them. The scores were analyzed using analysis of variance (ANOVA) in order to establish the degree of difference according to Ihekoronye and Ngoddy, (1985).

2.3 Mineral Composition

The mineral content of all the samples was analyzed using the method of Fasakin and Ogunsola (1982). Exactly 0.5 g of the sample was transferred into a 75ml digestion tube. About 5 ml of the digestion mixture was added, swirled, and placed in a fume cupboard; digestion was made for 2 h at 150 °C. These were removed from the digester, cooled for 10 min., and then 3ml of 6 M HCl was added to each tube. These mixtures were digested for another 1 h 30 mins. They were then removed from the digester, cooled, and 50 ml of distilled water was added to each tube and stirred vigorously using a vortex mixer. The mineral content was analyzed using the atomic absorption spectrophotometer and by comparing the blank to the standard curve.

Statistical Analysis

Data were analyzed using analysis of variance (ANOVA), standard deviation and percentages. All chemical analysis on the samples was done in triplicate.

Table 1: Formulation Table for Weaning Food from 6-36 Months

MATERIALS	FORMULATION I	FORMULATION II
LOCAL RICE	60g	60g
ALMNOD MILK	25ml	-
SOYBEANS MILK	-	25ml
CARROT	5g	5g
DATE PALM	10g	10g

3. RESULT AND DISCUSSION

Table 2: Organoleptic properties of cereal-based composite porridge

Parameters	Control	RCC	RCS
Appearance	7.5±0.02	6.3±0.18	6.0± 0.09
Taste	7.2±0.14	6.0±0.04	6.3±0.01
Flavor	7.5±0.04	7.0±0.03	7.3±0.04
Color	7.6±0.08	6.3±0.10	7.0±0.03
Texture	6.8±0.01	6.3±0.02	6.5± 0.07
General Acceptability	7.7±0.05	6.3±0.16	6.5±0.01

KEY
Control – Cerelac
RCC – Rice, carrot, date palm with almond milk
RCS – Rice, carrot, date palm with soybeans milk

Table 2 shows the sensory properties of all the samples with respect to appearance, taste, flavor, color, texture and general acceptability using a 9-point hedonic scale. The sensory properties of the formulated and commercial products (Control) indicate that all the complementary food formulations were significantly different ($p<0.05$) from the Control in all the sensory attributes.

The sensory properties of the formulated and commercial product shows the mean scores of the attributes evaluated ranging from appearance (6.0 – 7.5), taste (6.0 – 7.2), flavor (7.0 – 7.5), color (6.3 – 7.6), texture (6.3 – 6.8) and general acceptability (6.3 – 7.7). Color has a prominent effect on sensory scores of complementary foods (Chukwu et al., 2000) as shown in table 4.7. The color of the formulated diets were not different ($p>0.05$) from each other while the color of the Control was significantly different ($p<0.05$) from the formulated diets. The major complaint of the mothers was the light brown color of the formulated diet after reconstitution which was quite glaring when compared to the control which had a milky color. This was so because mothers are accustomed to the milky color of the commercial complementary foods and so it was not strange that they were hesitant to score high a product with a different color (Chukwu et al., 2000).

The product might be appealing and having high energy density but without good taste, such a product is likely to be unacceptable. Sample RCC received the lowest mean score while the control received the highest score. The formulated diets were significantly different ($p>0.05$) from the control. The inclusion of legume flour with a characteristic beany flavor may have informed the panelists' decision to return lower scores for the formulated diets. The favorable taste of the formulated diets was probably enhanced by the addition of date palm. The flavor of the formulated diets were not significantly different ($p>0.05$) from each other while the flavor of the control was significantly different ($p<0.05$) from the formulated diets. This may be due to the similar flour composition of the formulated diets and additional flavoring added to the control (Nzeagwu and Nwaejike, 2005).

The disparity between flavor of the control and formulated diets may be attributed to the characteristic beany aroma of the legume (Ijarotimi and Famurewa, 2003). The sensory scores of texture revealed that no significant differences ($p>0.05$) were observed in mouth-feel by all panelists between the formulated diets but there was a significant difference ($p<0.05$) between the formulated diets and the control. The mean score for the texture was above average indicating that from this test parameter, the formulated diets were liked moderately by the panelists.

The low texture (compared to the control) might be presumably due to the processing method of the commercial brand that involved drum drying with improved the texture and also taste of the product (Okafor *et al.*, 2008). The lower ratings of the formulated diets samples in terms of color, taste, flavor, texture and general acceptability compared with the control could also be attributed to the familiarity of the panel of judges to the taste, flavor, and color of the control and also because the control was industrially prepared with additional sweetener and flavoring.

Table 3: Mineral analysis of samples (mg/kg)

Constituents	Control	RCC(mg/kg)	RCS (mg/kg)
Zinc (Zn)	5.00±0.00	1.80±0.32	1.09±0.15
Iron (Fe)	7.50±0.01	5.10±0.40	5.89±0.30
Calcium (Ca/P)	1.50±0.01	0.95±0.01	1.71±0.01
Magnesium (Mg)	0.00	31.44±0.90	34.91±0.10
Sodium (Na/K)	0.23±0.02	1.15±0.02	0.71±0.01

KEY
Control – Cerelac
RCC – Rice, carrot, date palm with almond milk
RCS – Rice, carrot, date palm with soybeans milk

Table 3, showed the analysis of the mineral composition on the samples. There was a great significance difference in the zinc content of the control (5.00mg/kg) and other samples (RCC-1.80mg/kg, RCS-1.09mg/kg). The value of iron ranged from 5.10mg/kg for RCC, 5.89mg/kg for RCS and 7.50mg/kg for the control sample. Calcium (Ca/P) ranged from 0.95 for RCC, 1.17 for RCS and 1.50 for control. Also, magnesium was not determined due to low concentration but RCC has 31.44mg/kg while RCS has 34.91mg/kg. The sodium (Na/K) content of RCC was higher (1.15mg/kg) and RCC (0.71mg/kg), control (0.23mg/kg) respectively.

Mineral content in the formulated diet as shown in table 3 were comparatively lower than that in the control (cerelac). The lower mineral content observed in the formulated diet when compared with the control could be attributed to the fact that the control, a commercial complementary food was fortified with micro-nutrients during its production and such was not applied to the formulated diet. To compensate for lost of macro-nutrients and micro-nutrients in processed foods, a number of researchers have advocated for food fortification, particularly infant foods during the production process (Rosalind *et al.,* 2000). In the observation, it showed that the formulated sample met the recommended value of calcium (>2.0) and sodium (>1.0) according to FAO/WHO (1991) which indicates that formulated diet would support bone and teeth formation in children and also would not pose any danger to the heart of the infant whenever taken as a complementary food.

4. CONCLUSION

The possibility of occurring PEM (Protein Energy Malnutrition) during this transitional phase when children are weaned from liquid to semi-solid or fully adult foods where the growing body of children needs nutritionally balanced and calorie-dense supplementary food such as weaning foods in addition to mother's milk. All other samples were generally accepted by sensory panelists. It is therefore recommended that, soy milk can be treated with $NaH(CO)_3$ salt during the production in other to lessen the "beany" flavor in soy milk. All these milks have several benefits but it can't be substituted for breast milk. The mineral compositions of all the formulated and commercial weaning products were varied significantly.

REFERENCES

1. Bengaly D., (2010). ''Cours de physiologie de la nutrition. Licence Technologie Alimentaire et Nutrition Humaine''. 43p.
2. Benkadri. 2010. Contribution à la diversification de l'alimentation pour enfants coeliaques : fabrication de farines-biscuits sans gluten. Universite Mentouri de Constantine. Mémoire deMAGISTER en Sciences Alimentaires. 106p
3. Berryman, C., Preston, A., Karmally, w., DecklbaumR., Kris-Etherton, P.,(2011). Effects of almond consumption on the reduction of LDL-cholesterol: Adiscussion of potential mechanisms and future research dirctions.
4. Chukwu, U., Olorunda, A.O., Adeniji, T.A., Amos, N. and Ferris, R.B.S. (2000). Development, Production, Properties and Acceptability of Snacks and Weaning Food made from Extruded Cooking Banana (ABB). African Journal of Biotechnology, 8:120-131.
5. Elemo GN, Elemo BO, Okafor JNC (2011). Preparation and nutritional composition of a complementary food formulated from germinated sorghum (Sorghum bicolor) and steam cooked cowpea (Vigna unguiculata Walp). Am. J. Food Technol. 6(5):413-421.
6. FAO/WHO, (1991). CODEX CAC/GL 08, 1991. Codex Alimentarius: Guidelines on Formulated Supplementary Foods for Older Infants and Young Children, 4, 144.
7. Fashakin, J. B. and Ogunsola, F. (1982): The Utilization of Local foods in the Formulation of Complementary foods. J. Trop. Pediatri 28, 93-96.
8. Garrido,I., Monagas, N., GONEZ-Cordoves, C., Bartolome, B.(2008).Polyphenols and antioxidant properties of almond skins: Influence of industrial processing. *J.Food Sci.*
9. Gotto, A.M., LaRosa, J.C., Maroni, J., Barter, P., Szarek, M., Grundy, S.M., Kastelein, J.J.P. and Bittner, V. (2007) HDL Cholesterol, Very Low Levels of LDL Cholesterol, and Cardio vascular Events. New England Journal of Medicine, 357, 1301-1310. http://dx.doi.org/10.1056/NEJMoa064278
10. Ihekoronye, A.I and Ngoddy, P.O. (1985) Integrated Food Science and Technology for the Tropics, Macmillan publishers London.Pp 345.
11. Ijarotimi S.O., Keshiro O.O. (2012) Protein quality, haematological properties and nutrtitional status of albino rats fed complementary foods with fermented popcorn, African locust beans.
12. Laignelet B. (1997). Appréciation de la qualité technologique du riz. In, GODON B., LOISEL W. Guide pratique d'analyse dans les industries des céréales. Lavoisier. Tec et Doc/Apria. Paris : 728-743. 819 p.
13. Laureys C. et Geeroms J., (2002). New insights in the unique characteristics of rice
14. derivatives. Remy Industries N. V. Wijgmaal. 21 p
15. Mohammed,S., and Husseein, R., (1994). Effect of low temperature blanching, cysteine-HCL, N-acetyl-L-Cysteine, Na metasulphite and drying temperatureon the firmness and nutrient content of dried carrots. *Journal of Food Preservation.* 18(4) :343-348.
16. Nzeagwu, O.C. and Nwaejike, N.J. (2005). Nutrients Composition, Functional and Organoleptic Properties of Complementary Food Formulated from Sorghum, Groundnut and Crayfish. Proceedings of the 37th Conference of Nutrition Society of Nigeria.
17. Okafor, J.N.C., Ozumba, A.U., Osibanjo, T., Onu, L.I., Dauda, A.M., and Olatunji, O. (2008). Chemical, Microbial and Sensory Properties of Weaning Fods Formulated from Blens of Nigrian Foodstuffs, Journal of Tech. and Indust. Res., 2:31-35.

18. Preeti Kundu, Jyotika Dhankhar, Asha Sharma, (2018). Development of Non Dairy Milk Alternative Using Soymilk and Almond Milk. *Journal of Nutrition and Science.*
19. Rabadan, A., Alvarez-orti, M., Pardo, J.A. (2019). Comparison of the effect of genotype and weather conditions on the nutritional composition of most important commercial nuts. *Sci. Horti*.
20. Sawadogo P., Prevel M., Savy M., Kameli Y., Traore A., (2003). Pratiques d'alimentation du nourrisson en zone rurale au Burkina Faso: description et conséquences nutritionnelles 2èmeAtelier International sur les voies alimentaires d'amélioration des situations nutritionnelles, Ouagadougou, Saris
21. Treche S., Benoit B., Benbouzid D., Delpeuch F., 1995. Techniques pour augmenter la densité énergétique des bouillies. In ORSTOM editions. Paris : 123-146. 392 p.
22. UNICEF/WHO (2011). Turning the tide of malnutrition: responding to the challenge of the 21st century. *World Health Organization.*