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An Investigation of the Safety and Nutritional Adequacy of Infant Formulas Found in Nigeria

[1]Hemba, Andrea Eyikomisan ; [2]Ochigbo, Susan Eloyi
Department of Home Economics Education,
Federal College of Education, Pankshin P.M.B 1027 Pankshin - Plateau State

Abstract:-

- ***Introduction***

Human breast milk is most recommended for the feeding of infants. Infant formulas could be introduced due to a number of reasons relating to the health of the mother or of the baby.

- ***Objective***

To assess the nutritional adequacy and safety of commonly sold infant formula milk brands in the Nigerian market.

- ***Method***

An observational study was conducted in Plateau State Nigeria around the months of February – April 2023 where five (5) different brand of infant formulas where compared. These were chosen because they were the most commonly available formulas in the market. Macro and micronutrient content of each formula milk was carefully collected from the cans and documented. Also, a comparison was made between the selected infant formulas and the European Society for Gastroenterology, Hepatology and Nutrient (ESPGHAN) guidelines.

- ***Results***

All included infant formula brands (SMA, Peak Baby, My Boy, NAN, and Lactogen) have their content within the optimal range as specified by the ESPGHAN. However, some formulas did not contain elements as fluoride and Niacin. Others are Aracidonic acid (AA), Docosahexaenoic acid (DNA) and Nucleotides.

- ***Discussion***

Findings from this study revealed that all the included infant formula brands could be considered safe but not all are nutritionally adequate for infant feeding.

- ***Conclusion***

There is a need re-evaluate the composition of infant formula brands commonly sold on the Nigerian market. This is necessary since the commonly available brands were not nutritionally adequate.

Keywords:- *Infant formula, Breast milk, Nutrition , Ingredients, Feeding.*

I. INTRODUCTION

The nutrition of a newborn should consist primarily of breast milk. This highly nutritious substance produced by nursing mothers is known to be capable of supplying all of the nutritional requirements of an infant both macro and micro, from birth until six months when complementary foods are introduced. In addition, it has been suggested that mothers breastfeed their children exclusively for the first six months of their babies' lives and subsequently, in addition to supplemental foods till the child is two years old, given the many benefits this practice offers (Ahern et al., 2019; Blanchard et al., 2013; Eriksen et al., 2018; World Health Organization, 2013). The human breast is also contains a wide range of bioactive compounds and elements that are critical to the baby's proper growth and development, including hormones, antimicrobials, digestive enzymes, and agents that promote the maturation of the gastrointestinal tract. (Falcão & Zamberlan, 2021).

Despite the fact that breastfeeding is the best method of providing nutrition for infants (McFadden et al., 2016), certain situations may make it necessary to give a newborn formula. Several factors could contribute to the choice to formula feed the infant such as the mother's failure to make enough milk to nurse her baby, or a newborn's metabolism is altered and the child is unable to breastfeed, it can also be due to a communicable disease, sore around the nipples or as a result of maternal death. In such situations, formula feeding becomes the next best alternative (Ahern et al., 2019). In Nigeria, breastfeeding is a common practice. But exclusive breastfeeding is still uncommon and is on the decline (Adewuyi & Adefemi, 2016). For a variety of reasons, the majority of working-class mothers start formula feeding their babies at a fairly young age. A study conducted by Ezechi et al., (2021) revealed that although mothers in Nigeria had some knowledge of breastfeeding, they had a more positive attitude towards infant formula feeding than breast feeding. 62.3% in the study asserted that infant formulas were as nutritious as breastmilk, 80.7% and 56.9% declared that infant formulas were necessary if a nursing mother wished to resume her job and for convenience respectively.

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Infant formula is an artificial substitute for human breast milk that is used in the feeding of infants with the purpose of giving these kids with the same level of potential for growth and development that is attainable by breastfed children. (Blanchard et al., 2013). The purpose of this study was to assess the safety and nutritional adequacy of some of the most patronized infant formulas on the Nigerian market.

II. METHODOLOGY

An observational study was conducted in Plateau state Nigeria around the months of February-April 2023. A total of 5 different brands of (non-specially designed) cow's milk based infant formulas (SMA, Peak Baby, My Boy, NAN and Lactogen) were selected for this study. The formulas were considered for this study because they were the most commonly available in all the markets and stores visited and they were the most patronized. The nutrition facts of each of the included formulas were carefully collected from the manufacturer's written information each of the formula cans. These were entered into a Microsoft word 2010 document. Macro and micronutrient content of each of the infant formulas which included energy, protein, fat, carbohydrates, vitamin, and mineral content of the infant formulas were expressed as the amount per 100kcal of formula milk. These were then compared with the global standard requirement for the composition of infant formula milk as recommended by the European Society for Paediatric, Gastroenterology, Hepatology, and Nutrition (ESPGHAN).

III. RESULTS

Tables 1-4 shows that all the included formula brands (SMA, Peak Baby, My Boy, NAN and Lactogen) with all the included macro and micronutrients and the optional ingredients added to each formula brand. Table 5 presents all the mandatory elements included in the selected infant formulas.

Table 1. Macronutrient Content of the Selected Infant Formula Brands Compared with the ESPGHAN Guidelines.

Parameter	SMA	Peak Baby	My Boy	NAN	Lactogen	ESPGHAN Guidelines
Energy (kcal/dl)	66	74	67	67	67	60-70
Protein (g/100 kcal)	1.9	4.0	2.1	1.8	1.8	1.8-3
Lipid						
Total fat (g/100 kcal)	5.4	3.7	5.4	5.2	5.4	4.4-6
Linoleic acid (mg/100 kcal)	0.57	0.44	0.66	0.53	0.53	0.3-1.2
α-linoleic acid (mg/100 kcal)	74	61	93	88	100	50-NS
carbohydrates						
Total carbohydrates (g/100 kcal)	11	15	11	11	11	9-14

Abbreviations: ESPGHAN, European Society for Paediatric and Gastroenterology Hepatology and Nutrition.
NS, Not Specified

Table 2. Mineral Contents of the Selected Infant Formulas Compared with the ESPGHAN Guidelines.

Parameter	SMA	Peak Baby	My Boy	NAN	Lactogen	ESPGHAN Guidelines
Ca(mg/100 kcal)	55	141	75	63	66	50-140
Ph(mg/100 kcal	30	114	45	34		25-90
Mg(mg/100 kcal)	7	12	9	7		5-15
Na(mg/100 kcal)	25	46	30	34		20-60
K(mg/100 kcal)	97	183	97	123		60-160
Cl(mg/100 kcal)	61	114	63			50-160
Zn(mg/100 kcal)	0.9	0.7	0.9			0.5-1.3
Fe(mg/100 kcal)	1.2	1.8	1.1			0.3-1-3
Cu(µg/100 kcal)	66	43	75			35-80
Mn(µg/100 kcal)	11	25	25	17	17	1-50
I(µg/100 kcal)	1.2	30	15			10-50
Se(µg/100 kcal)	24	2.7	3.75	2.85	1.95	Up to 9
Flouride(µg/100 kcal)	-	-	-	-	-	NS-60

Abbreviations: ESPGHAN, European Society for Paediatric, Gastroenterology, Hepatology and Nutrition
NS: Not stated

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Table 3. Vitamin Content of the Selected Infant Formulas Compared with the ESPGHAN Standards

Parameter	SMA	Peak baby	My Boy	NAN	Lactogen	ESPGHAN Guidelines
A (µg/100kcal)	99	96	105	87	87	60-80
D(µg/100kcal)	1.8	1.5	1.8	1.5	1.3	1-1.5
E(mg/100kcal)	1.1	2.7	1.9	2.1	1.5	0.5-5
K(µg/100kcal)	10	6.9	7.6	7.8	8.2	4-25
C(mg/100kcal)	14	28	13	15	17	8-30
B_1(µg/100kcal)	150	117	88	106	106	60-300
B_2(µg/100kcal)	165	127.5	136	154	150	80-400
B_6(µg/100kcal)	82.5	58.5	58.5	64.5	61.5	35-175
B_{12}(µg/100kcal)	0.2	0.3	0.3	0.2	0.3	0.1-0.5
Niacin(µg/100kcal)	750	-	705	-	-	300-1500
Pantothenic acid(µg/100kcal)	525	480	490	945	780	400-2000
Folic acid(µg/100kcal)	16	18	15	12	12	10-50
Biotin(µg/100kcal)	3	3.9	2.1	2.7	2.7	1.5-7.5

Abbreviation: ESPGHAN European Society for Paediatric Gastroenterology Hepatology and Nutrition.

Table 4. Optional and Other Ingredients Content in the Selected Formula Brands Compared with ESPGHAN Standards

Parameter	SMA	Peak baby	My Boy	NAN	Lactogen	ESPGHAN guidelines
AA(mg/100kcal)	18	9.3	-	12	-	Should be at least equal to DHA content
DHA (mg/100kcal)	18	10	-	12	-	0%-0.5% of total fat
Taurine(mg/100kcal)	7	13	9	6	6	0-12
Inositol(mg/100kcal)	6	16	5	13	11	4-40
L-Carnitine(mg/100kcal)	1.5	1.3	2.8	1.9	1.5	1.2-NS
Choline(mg/100kcal)	24	24	21	50	16	7-50
Nucleotide equivqlent(mg/100kcal)	3.9	-	4.8	2.25	-	0-5mg

Abbreviations: ESPGHAN, European Society for Paediatric, Gastroenterology, Hepatology, and Nutrition
NS, Not Stated
DHA, Docosahexanoic Acid
AA, Arachidonic Acid

Table 5: Mandatory Elements in Each of the Selected Infant Formulas

Parameter	SMA	Peak Baby	My Boy	NAN	Lactogen
Protein	Whey Alpha-lactalbumin	Whey	Whey	Whey	Whey
Fat	LA ALA AA DHA	LA ALA AA DHA Monounsaturated fatty acid Polyunsaturated fatty acid Saturated fat	LA ALA	LA ALA AA A DHA	LA ALA
Carbohydrates	Lactose	Lactose Maltodextrin Galactoologosaccharides	Lactose Maltodextrin	Lactose	Lactose

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On table 1, the macronutrient content of all the selected infant formula brands is presented. The most common type of protein in all the studied formulas was whey protein. Only SMA contained Alpha- lactalbumin in addition to whey protein. Regarding fat, all the formula brands in this study had vegetable fat as the most dominant source of fat. However, NAN and Peak Baby formula brands included a mix of vegetable and animal fat. Fungal oil was also included in NAN infant formula. All the formulas have linoleic acid and α-linoleic acid included in their formula. Peak Baby have monounsaturated, polyunsaturated and saturated fatty acids added in it.

The main carbohydrate source in all the included formulas was lactose. In addition, Peak Baby formula included maltodextrin and galacto-oligosaccharides together with lactose. While My Boy infant formula have a mix of lactose and maltodextrin.

SMA formula had all the elements except fluoride that was not included. While NAN did not include fluoride and niacin. The following ingredients were not documented for Peak Baby formula: fluoride, niacin, L-carnitine and nucleotides. Both My Boy and Lactogen infant formulas did not document the following ingredients: fluoride, arachidonic acid (AA) and docosahexanoic acid (DHA) in their formulas. Niacin and nucleotides were not included in Lactogen infant formula.

IV. DISCUSSION

The ESPGHAN has set standards for the addition of macro and micronutrients that are to be added to infant formula so as to achieve a formula that closely simulate the human breast milk. Findings from the study conducted revealed that the selected formulas for this study were all lacking in fluoride. When compared with ingredients found in the ESPGHAN guidelines, 6 elements were lacking in some of the formulas. They include niacin, arachidonic acid, docosahexaenoic acid, L-carnitine and nucleotides.

A. Protein

This study showed that four of the selected infant formulas in this study (SMA, My Boy, NAN and Lactogen) had their protein energy ratios in line with the ESPGHAN guidelines. However, Peak Baby formula was found to have its protein ratio exceeding the maximum margin set by the ESPGHAN as seen in table 1. While adequate protein intake supports the normal functioning of the human system, an excess of it from dairy products have been associated with high weight gain and could lead to overweight and obesity in later life (Tang, 2018). All included formulas have whey protein obtained from cow's milk as their main protein source. Two (2) main protein groups are found in milk, whey and casein proteins. Whey dominant proteins are easily digestible and tolerated by infants making it a preferred choice for the feeding of infants. Casein proteins are more difficult to digest compared to whey protein. According to a study by (Wood et al., 2021), formula acceptance and preference are affected when the whey: casein ratio is changed from 20:80 to 60:40, with the whey-enhanced milk being more willingly taken. Only SMA infant formula contains α-lactalbumin in addition to whey (Table 5).

B. Fat

The present study showed that the fat source in all the included infant formulas was of vegetable origin. NAN and Peak Baby infant formula have a combination of vegetable and animal fats. While My Boy, Lactogen and SMA have their main fats source from vegetable oils since these are cheaper when compared with cow's milk fat. NAN's fat sources include palm olein, palm kernel oil, low erucic rapeseed oil, corn oil, sunflower oil, fungal oil and fish oil from tuna. My Boy includes palm oil, palm kernel oil, canola oil and sunflower oil. SMA includes palm oil, soybean oil, high oleic sunflower oil, and coconut oil. Lactogen includes palm oil, low erucic rapeseed oil, palm kernel oil and corn oil. Peak Baby includes palm oil, canola oil (low erucic type), palm kernel oil, sunflower oil, fish oil and single cell oil. All the infant formulas included in this study have palmitate in their vegetable oil content. Palm oil has been included in infant formula to mimic the palmitic acid levels found in human breast milk; however, clinical trials show that infant formulae containing palm oil result in lower levels of development (weight accretion), fat, DHA, palmitate, and calcium absorption, as well as bone mineralization and soft stools (Padial-Jaudenes et al., 2020). Two of the infant formulae studied (My Boy and Lactogen) lacked arachidonic acid (AA) and docosahexaenoic acid (DHA). Those that contain AA and DHA have content levels that are consistent with the ESPGHAN guidelines for their addition. Studies suggest that consumption of DHA and ARA in infancy improves cognition, brain connection, and allergies in early childhood, implying that these fatty acids regulate cognitive and immunological development (Carlson & Colombo, 2016). A review of research in infants and children up to 24 months of age indicated that omega-6 and/or omega-3 fatty acid supplementation improved growth, visual, and motor development in developing countries (Simmer et al., 2008). Supplementing infant formula with omega-3 fatty acids, particularly DHA and AA, is expected to be pertinent during early childhood as this may lead to increased development scores in malnourished babies, as demonstrated in research from Pakistan (El-khayat et al., 2007).

C. Carbohydrates

Carbohydrates are an essential source of energy for the growing infant. The recommended types of carbohydrates to be used in infant formula include lactose, maltose, sucrose, maltodextrins, glucose syrup or dried glucose syrup, precooked starch and gelatinized starch which are naturally gluten free (Raiten et al., 1998).

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All the infant formulas included in the present study had lactose as the main carbohydrate source. However, Peak Baby have a combination of maltodextrin and galactooligosaccharides in addition to lactose and My Boy infant formula have maltodextrin added to lactose as the source of carbohydrates.

The U.S. Food and Drug Administration (FDA) classifies maltodextrin as a GRAS (Generally Recognized as Safe) food ingredient, however, a study among preterm pigs fed a maltodextrin based formula had a higher risk of intestinal inflammation (necrotizing enterocolitis) and slower growth rates as compared to those that were fed a lactose based formula (Buddington et al., 2018). Consequently, caution must be exercise when adding maltodextrin to baby formula because consuming too much of it can result in health issues such as gastrointestinal conditions.

D. Vitamins

Vitamin content were within the optimal range as recommended by the ESPGHAN in all the selected infant formulas as seen in Table 3. Peak Baby, NAN and Lactogen has not included niacin in their formula.

E. Minerals

All the infant formulas in the present study were enriched with the necessary minerals. However, fluoride was found to be lacking in all the studied formulas. Fluoride is necessary for the prevention and control of tooth decay though a minimum of zero was recommended for fluoride content in infant formula by an expert committee (Almazrooy et al., 2017).

V. LIMITATIONS

In conducting this study, only 5 formula brands were selected although other formula brands were in the market. These formula brands were selected because they were the commonly available brands and quite affordable. Secondly, the nutritional content of the included formula brands were assessed based on the declared content by the manufacturer without any laboratory analysis of these claims. Therefore, it is recommended that further studies be conducted to ascertain the claims of the manufacturers of these infant formulas and also follow-up studies on the health impact of formulas lacking some of the elements like fluoride to the child.

VI. CONCLUSION

Infancy is a critical stage of development and to achieve optimal health for the infant, their nutrition should provide the necessary nutrients for growth. There is a need for the Nigerian Government through the Association of Nigerian Nurses and Midwives to re-evaluate the composition of infant formula brands commonly sold on the Nigerian market this is necessary since the commonly available brands could be considered safe but not nutritionally adequate.

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REFERENCES

[1]. Adewuyi, E., & Adefemi, K. (2016). Breastfeeding in Nigeria: A systematic review. *International Journal of Community Medicine and Public Health*, 385–396. https://doi.org/10.18203/2394-6040.ijcmph20160421

[2]. Ahern, G. J., Hennessy, A. A., Ryan, C. A., Ross, R. P., & Stanton, C. (2019). Advances in Infant Formula Science. *Annual Review of Food Science and Technology*, *10*(1), 75–102. https://doi.org/10.1146/annurev-food-081318-104308

[3]. Almazrooy, A. H., Alturki, A. M., Aljohani, A. M., Alraddadi, A., & Allogmani, A. M. (2017). Comparison of the nutritional values of infant formulas available in Saudi Arabia. *Global Pediatric Health*, *4*, 2333794X17731037.

[4]. Blanchard, E., Zhu, P., & Schuck, P. (2013). 18—Infant formula powders. In B. Bhandari, N. Bansal, M. Zhang, & P. Schuck (Eds.), *Handbook of Food Powders* (pp. 465–483). Woodhead Publishing. https://doi.org/10.1533/9780857098672.3.465

[5]. Buddington, R. K., Davis, S. L., & Buddington, K. K. (2018). The Risk of Necrotizing Enterocolitis Differs Among Preterm Pigs Fed Formulas With Either Lactose or Maltodextrin. *Journal of Pediatric Gastroenterology and Nutrition*, *66*(3), e61–e66. https://doi.org/10.1097/MPG.0000000000001707

[6]. Carlson, S. E., & Colombo, J. (2016). Docosahexaenoic Acid and Arachidonic Acid Nutrition in Early Development. *Advances in Pediatrics*, *63*(1), 453–471. https://doi.org/10.1016/j.yapd.2016.04.011

[7]. El-khayat, H., Shaaban, S., Emam, E. K., & Elwakkad, A. (2007). Cognitive functions in protein-energy malnutrition: In relation to long chain-polyunsaturated fatty acids. *Pakistan Journal of Biological Sciences: PJBS*, *10*(11), 1773–1781. https://doi.org/10.3923/pjbs.2007.1773.1781

[8]. Eriksen, K. G., Christensen, S. H., Lind, M. V., & Michaelsen, K. F. (2018). Human milk composition and infant growth. *Current Opinion in Clinical Nutrition and Metabolic Care*, *21*(3), 200–206.

[9]. Ezechi, L. O., Otobo, V., Mbah, P. E., & Ezechi, O. C. (2021). Breastfeeding knowledge and attitudes of Nigerian mothers assessed by the Iowa infant feeding attitudes scale. *International Journal Of Community Medicine And Public Health*, *8*(12), 5722. https://doi.org/10.18203/2394-6040.ijcmph20214558

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24FEB1706

[10]. Falcão, M. C., & Zamberlan, P. (2021). Infant Formulas: A Long Story. *International Journal of Nutrology*, *14*(2), e61–e70. https://doi.org/10.1055/s-0041-1735640
[11]. McFadden, A., Mason, F., Baker, J., Begin, F., Dykes, F., Grummer-Strawn, L., Kenney-Muir, N., Whitford, H., Zehner, E., & Renfrew, M. J. (2016). Spotlight on infant formula: Coordinated global action needed. *The Lancet*, *387*(10017), 413–415. https://doi.org/10.1016/S0140-6736(16)00103-3
[12]. Padial-Jaudenes, M., Castanys-Munoz, E., Ramirez, M., & Lasekan, J. (2020). Physiological Impact of Palm Olein or Palm Oil in Infant Formulas: A Review of Clinical Evidence. *Nutrients*, *12*(12), Article 12. https://doi.org/10.3390/nu12123676
[13]. Raiten, D. J., Talbot, J. M., & Waters, J. H. (1998). LSRO report: Assessment of nutrient requirements for infant formulas. *J Nutr*, *128*(11), 2059S-293S.
[14]. Simmer, K., Patole, S. K., & Rao, S. C. (2008). Long-chain polyunsaturated fatty acid supplementation in infants born at term. *The Cochrane Database of Systematic Reviews*, *1*, CD000376. https://doi.org/10.1002/14651858.CD000376.pub2
[15]. Tang, M. (2018). Protein Intake during the First Two Years of Life and Its Association with Growth and Risk of Overweight. *International Journal of Environmental Research and Public Health*, *15*(8), 1742. https://doi.org/10.3390/ijerph15081742
[16]. Wood, E. L., Christian, D. G., Arafat, M., McColl, L. K., Prosser, C. G., Carpenter, E. A., Levine, A. S., Klockars, A., & Olszewski, P. K. (2021). Adjustment of Whey:Casein Ratio from 20:80 to 60:40 in Milk Formulation Affects Food Intake and Brainstem and Hypothalamic Neuronal Activation and Gene Expression in Laboratory Mice. *Foods (Basel, Switzerland)*, *10*(3), 658. https://doi.org/10.3390/foods10030658
[17]. World Health Organization. (2013). *Country implementation of the international code of marketing of breast-milk substitutes: Status report 2011*.