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CONCENTRATIONS OF SELECTED MINERAL ELEMENTS IN COMMERCIAL INFANT FORMULAE MARKETED IN ABEOKUTA, OGUN STATE, NIGERIA

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ABSTRACT

Eight different brands of commercial infant formulae marketed in Abeokuta were analyzed for sodium, potassium, calcium and magnesium using a flame photometer. The analytical method subjected to a quality assurance test showed that a 0.25g sample weight give comparable results with a 1.00g sample weight.

The results obtained for the mineral elements ranged from 2.6 to 4.5 mg/g for Na, 4.1 to 8.4 mg/g for K, 1.8 to 6.2 mg/g for Ca and 0.2 to 0.8 mg/g, for Mg. In general the results showed that the formulae are good sources of Na, K and Ca but poor sources of Mg as obtained from the results with a range of 0.24mg/g – 0.79mg/g. A comparison of these results to that of the manufacturer's levels showed statistical differences for the milk brands of Frisolac (for the metals Na, K, Ca and Mg.), Frisocrem (for the metals, Na and Ca,) Cow and Gate (for the metals Na, K, Ca) and Similac (for the metals Na, K, and Mg.) There were notable exceptions as for K and Ca in NAN and for K and Mg in SMA. A general trend of K > Ca > Na > Mg > was obtained for five of the brands.

Keywords:

INTRODUCTION

Infant nutrition during the first year of life is critically important as it has a long term consequence in health and general well-being of a child throughout life (Guthrie, 1986).

Over the years, a lot of attention has been given to the study of specific nutrient requirement for different stages of life, and it has been ascertained that the need for food varies throughout the life cycle (Smith and Ojofeitimi, 1995).

Mineral elements are as equally important as other nutrients in food in that, they are directly associated to needs for obtaining an adequate composition of new tissues, optimal bone mineralization and for maintaining normal plasma mineral levels (Greer, 1989).

For instance, sodium and potassium are principal constituents of extra-cellular and intracellular fluids respectively. Sodium functions mainly to maintain the osmotic pressure of body fluids; potassium exerts an important effect in muscular contractability, whereas calcium is principally combined with magnesium and phosphorous in the body, in the complex formation of bone while magnesium is also vital in carbohydrate metabolism (Krehi, 1975).

Deficiency or over-supply of these elements may result in disease. While excess of sodium

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ions in foods has been associated with rise in blood pressure, potassium deficiency is related to heart muscle degeneration and cellular edema (Taitz, 1977).

Breastfeeding is acknowledged to be the optimal way of feeding and caring for young infants development, including mental development while also providing benefits to the mother, (Lantham, 1997). However, nutritional research, technological advancement and socio-economic structure have been partially responsible for the disease called acquired immune deficiency syndrome (AIDS) which affect infants directly as transmitted via mother's milk and the recommendation by medical practitioners who advise the use of commercial infant formulae for feeding. These factors and the advertisement for such products have helped boost the manufacture and sale of dried milk formulae to meet the requirements of millions of infants.

Quite a number of recent reports in developed countries have compared analytical values of elemental content of infant formulae to that of human milk and the manufacturers levels as indicated on the labels of the containers. (Huffman et. al. 1994, Didd and Ratrani, 1991).

This study aims at determining the levels of Na, K Ca and Mg in infant formulae marketed in Abeokuta and to ascertain if these levels are within the range of the recommended daily dietary allowances for infants.

MATERIAL AND METHODS

Sample Collection

Eight (8) different brands of infant formulae were purchased from Kuto market in Abeokuta The brands purchased were as follows: Frisolac, Cerelac, Similac, NAN, Cow & Gate, Nutrend, SMA and Frisocrem.

The formulae were meant for infants ranging from 0-12 months of age.

The samples were left in their original containers prior to the period of analysis, which did not exceed 24hrs after purchase.

Samples Preparation and Digestion

0.25g sample of each formulae was weighed in duplicate. To each weighed sample in a conical flask was added 5ml of HNO_3 and 1.5ml H_2SO_4. The mixture was then carefully heated on a hot plate at a regulated temperature of 140°C. It was observed that in the process of heating, brown fumes of NO_2 were given off. After heating, the contents in the flask was allowed to cool for 2 minutes using an airgun. The digestion was then completed by addition of another 5ml of HNO_3 and heated until no more evolution of brown fumes of NO_2 was observed. The solution was cooled, and filtered. The filtrate was transferred into a 50ml standard flask and made up to mark with distilled water. (Kashlam et.al 1991).

Analytical Quality Assurance

In order to ascertain the reproducibility of the digestion process and variation in weight of samples taken for analysis, ten (10) replicate samples of 1.0g weight of Frisolac brand were analyzed according to the digestion process described above. Similarly eight (8) replicate samples of 0.25g weight of Frisolac brand were also analyzed.

Blank Determination

For the blank determination, all the reagents used for the digestion process were transferred to a conical flask and the digestion process carried out without the presence of any infant formulae (absence of sample), then made up to mark in a 50ml standard flask

Quantification of Samples

The digests were subjected to flame photometry for quantitative determination of the analytes using spectro AA 30 Varian Techtron.

Data Analysis

This was carried out by the analysis of variance (ANOVA) after which the F-test statistics was used for variance comparison

RESULTS AND DISCUSSION

The results of the analysis are presented in Tables 1,2 3 and 4.

The analytical quality assurance in Table 1 showed that for the 0.25g weight sample of Frisolac formulae analyzed, the mineral elements ranged from 10.51 – 11.83mg/g for Na, 9.65 – 10.23mg/g for K, 9.59 – 10.23mg/g for Ca and 9.09 – 10.73mg/g for Mg, while in using the 1.0g weight of Frisolac the following ranges were obtained 11.91 – 13.31 mg/g for Na, 12.16 – 12.74mg/g for K,

TABLE 1: % Concentrations of Na, K, Ca and Mg for Frisolac formulae for 1.0g and 0.25 g sample weight

CODE No.	At 1.0g Weight of Sample				CODE No.	At 0.25g Weight of Sample			
	Na	K	Ca	Mg		Na	K	Ca	Mg
FL 11	11.91	12.74	12.33	12.41	FL 11	10.51	10.09	10.25	10.23
FL 12	13.00	12.16	12.58	12.06	FL 12	10.93	9.88	9.59	9.09
FL 13	12.44	12.20	12.40	11.72	FL 13	11.83	10.02	10.04	9.47
FL 14	12.67	12.46	12.45	12.76	FL 14	11.45	9.92	10.13	10.61
FL 15	12.04	10.49	12.84	13.22	FL 15	10.96	10.16	10.58	9.47
FL 16	10.07	12.35	12.33	11.95	FL 16	10.68	9.65	10.06	10.35
FL 17	12.49	12.60	12.47	14.10	FL 17	11.20	10.16	10.04	9.97
FL 18	13.37	12.53	12.76	11.76	FL 18	11.69	9.78	9.69	9.60
					FL 19	10.75	10.09	9.73	10.48
					FL 20	11.34	10.23	9.90	10.73
Ovarall Mean (x)	12.50	12.44	12.50	12.50	Ovarall Mean (x)	11.30	10.00	10.01	10.00
STD DEV. (SD)	0.50	0.19	0.17	0.83	STD DEV. (SD)	0.19	0.19	0.29	0.56
(x ±SD)	12.50±0.50	12.44±0.19	12.50±0.17	12.50±0.83	((x ±SD)	11.13±0.44	10.00±0.19	10.01±0.29	10.00± 0.21
RANGE (%)	11.91-13.17	12.16-12.74	12.33-12.84	12.33-12.84	RANGE (%)	10.51-11.83	9.65-10.23	9.59-10.23	9.09-1073

TABLE 2: Mean Concentration of Mineral Elements in Infant Formulae Marketed in Abeokuta (mg/g)

FORMULAR	Na	K	Ca	Mg
FRISOLAC	3.22±0.06	7.04±0.11	4.27±0.05	0.79±0.04
NAN	2.63±0.03	5.31±0.09	4.36±0.09	0.24±0.02
SMA	4.23±0.10	5.76±1.17	1.83±0.03	0.34±0.03
SIMILAC	2.84±0.05	8.31±0.27	4.25±0.03	0.53±0.01
COW & GATE	4.54±0.04	8.38±0.05	7.34±0.20	0.43±0.04
CERELAC	3.82±0.06	4.09±0.08	6.21±0.22	0.35±0.03
NUTREND	2.99±0.08	4.24±0.10	5.86±0.09	0.44±0.02
FRISOCREM	3.09±0.05	6.13±0.06	7.40±0.05	0.37±0.03

TABLE 3: Comparison of Survey results with Manufacturer's levels (mg/g)

Brand	SURVEY RESULT				MANUFACTURER'S LEVEL			
	Na	K	Ca	Mg	Na	K	Ca	Mg
Frisolac	3.2	7.0	4.3	0.8	1.1	4.2	3.5	0.4
NAN	2.6	5.3	4.6	0.2	13	5.7	4.0	0.4
SMA	4.2	6.5	1.8	0.3	2.0	7.4	5.6	0.4
Similac	2.8	8.3	4.3	0.5	1.8	6.1	4.2	0.3
Cow & Gate	4.5	8.4	7.3	0.4	2.0	7.4	5.3	0.5
Cerelac	3.8	4.1	6.2	0.4	1.9	4.4	3.2	-
Nutrend	3.0	4.2	5.9	0.4	0.9	5.7	-	-
Frisocrem	3.1	6.1	5.2	0.4	1.8	-	5.0	-

TABLE 4: F-Test statistics of Survey results with Manufacturer's level

FORMULA	Na	K	Ca	Mg
FRISOLAC	991	464	147	268
NAN	75	5.8	8.033	96
SMA	556	5.6	603	9.8
SIMILAC	44	100	1.8	158
COW & GATE	1029	68	113	3.8
CERELAC	150	11.8	456	-
NUTREND	357	80	-	-
FRISOCRE	68	-	403	-

12.33 – 12.84mg/g for Ca and 11.72 – 14.10mg/g for Mg.

Statistical analysis (t-test) of the means of the determinations (0.25g and 1.0g) showed that at the 95% confidence limit there was no significant difference between the mean concentrations of both weights, indication that the use of either weight does not in any appreciable manner affect the analyte concentration determined. The analytical method of Kashlam et. al (1991) as used for this digestion, recommended the use of 1.0g sample of formulae, however in following this procedure, the final digest would be colourless. This was achieved using a 0.25g sample weight. This is why an analytical quality assurance test was carried out to ascertain if indeed there were any significant differences in using either the 1.0g sample weight recommended in the produre or the 0.25g sample weight which represented a modification of the procedure of Kashlam et. al (1991).

The results of the analysis (Table 2) showed that the levels of elements ranged as follows Na (2.6-4.5mg/g), K (4.1-8.5mg/g), Ca (1.8-6.2mg/g), and Mg (0.2-0.8mg/g).
For all the sample analyzed, potassium had the highest concentration while Mg also consistently had the lowest concentration. The levels obtained in this study compares favourably with that reported previously in literature by Dodd and Ratrani (1991) and Wharton (1990).

Furthermore, it had also been reported by the American Academy of Paediatrics (1976) that the concentration of potassium in infant formulae is often higher than all the other normal elements and that for a balanced infant formulae which can actually serves as substitute for human milk, the Na : K ratio should not exceed 1:1. The only exception to this trend was the Similac formulae, in which a ratio of Na : K was 1:3. This same ratio was similarly observed in respect of the manufacturer levels (Na, 1.8mg/g, K, 6.1mg/g). All other infant formulae in this class and analyzed in this study did not deviate from the recommended 1:1 ratio of Na to K as had been reported by Fatoki and Bamiro (1990).

The low level of Mg in this study is also reflective of the low recommended daily intake (Wharton, 1990). Furthermore infant formulae had been recommended to have a minimum of 0.4mg/g (Tanner 1982), which is reportedly much lower for values obtained in this study with a range of 0.2mg/g to 0.8mg/g. Inspite of the lower valves of Mg in this study than the recommended daily intake the results in this study were similar to levels reported in the work of Gunshin et. al (1998) and showed that samples would not have adverse effects in children's health (Jelliffe and Jelliffe) (1990).
A comparison of the results in this study and manufacturer's levels are presented in Table 3.

The trend of the concentration of mineral element showed K > Ca > Na > Mg in the manufacturer levels while for this study, though this similar trend was followed, there were three notable exceptions for Cerelac (K < Ca), Nutrend (K < Ca) and SMA (N < Ca). On a comparative basis, the results from this study were in most cases higher than the manufacturers levels e.g. for Frisolac, in this study the level was 3.2mg/g while that of the manufacturers level was 11mg/g. This same trend was obtained for concentration of Na, K, Ca and Mg with values of 7.0/42mg/g, 4.3/3.5mg/g and 0.8/0.4mg/g respectively for this study as against manufacturer's values.

A statistical analysis, using the F-test showed significant differences between the metal levels obtained in this study as compared to that of the manufacturer's claims.
Testing at F (3,95%) with an F value of 7.71 it showed that for the Frisolac milk brand that all the metals analysid Na, K, Ca and Mg showed significant differences from that of the manufacturers. There was no other milk brand analyzed, that showed significant differences for all the metals analysed.
The milk brands NAN, Similac and Cow and Gate showed no significant differences for the metals K, Ca and Ca respectively.
In general for all the milk brands analyzed, of the eight different formulae, at least 50% showed no significant differences for the level of K for this study and that of the manufacturers claim. Inspite of the significant differences observed as to the method of analysis which may be attributed to systemic errors, the results in this study and that of the manufacturer's showed positive correlation at $P < 0.01$ for both surveys.
In general the results showed that the formulae are good sources of Na, K and Ca but poor sources of Mg according to the recommended Daily allowances (RDA). The RDAs for calcium

is 360mg for infants while that for magnesium is 50mg. No RDAs are established for sodium and potassium but it has been recommended of potassium intake to counteract the effect of Na in raising blood pressure with a suggestion of 1.87 – 5.6g Na as safe and adequate (Bosco 1980). The differences observed between the results in this study and the manufacturer's specification may be attributed to systemic errors, yet in spite of these differences, the levels lie within recommended dietary allowance. That the levels of Mg were not indicated by the manufacturers for Cerelac, Nutrend and Frisolac may be attributed to the fact that the brands do not contain any Mg and if that be the case, calcium may have substituted for the roles of Mg in the formulae as shown by the trends, of which Cerelac and Nutrend Ca concentrations were greater than K concentrations, whereas for the other formulae in which Mg was present, the K concentration was greater than of Ca.

Calcium is a suitable substitute for magnesium since Ca and Mg are both responsible for healthy bone mineralization. (Huffman et. al., 1994).

CONCLUSION

This study has shown that infant formulae contains high amounts of sodium, potassium and calcium with relatively low amount of magnesium which falls below the dietary requirement of infants. Furthermore, the concentration of potassium was higher than that of all the other elements but the ratio of Na: K as recommended for a balanced infant formula which can actually serve as substitute for human milk of 1:1 was observed. The differences observed between the results in this study and that of the manufacturer's claims may be attributed to systemic errors, yet inspite of these difference the levels lie within the recommended dietary allowance.

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