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Original Article

NITRATE, NITRITE AND ASCORBIC ACID CONTENT OF COMMERCIAL AND HOME - PREPARED COMPLEMENTARY, INFANT FOODS

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The contents of nitrate, nitrite and ascorbic acid were determined in four samples of commercial and fifteen samples of home - prepared complementary infant foods common in Nigeria. The nitrate and nitrite values of the commercial food samples ranged from 3.1 – 3.9mgNO_3- N/100g and 5.0 - 16.0ug $N0_2$ - N/100g respectively while the ascorbic acid content ranged from 6.0 – 13/lmg 1100g. The nitrate and nitrite content of the home prepared complementary infant foods varied considerably according to recipes with maximum values found in foods containing vegetables and legumes. The highest levels of nitrate were found in yam and vegetable pottage (25.1mg $N0_3$ - N/100g), followed by soybean moin-moin (16.3mgNO_3 -N/100g) and that of nitrite in pureed spinach vegetable (72.0mgNO_2 -N/100g). The ascorbic acid content of the home - prepared complementary foods were very low. Therefore these foods should be-supplemented with vitamin C. However, the nitrate and nitrite levels of these complementary infant food as well as the estimated possible intake from meal per day were well below tolerance levels and these foods do not pose any health problem for infants.

Key words: Nitrate, Nitrite, Ascorbic acid, Complementary Infant Foods.

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INTRODUCTION

The first year of life is crucial in laying the foundation of good health and improving the quality of life (Shanti, 1979). For the first four to six months of life, it is recommended that infants receive no food or liquid other than breast milk (Murray, 1997). From the age of six months onwards infants should continue to receive breast milk and in addition, should be fed safe and adequate amounts of complementary foods appropriate for them (Caulfield *et al,* 1999). Complementary foods therefore are the first foods introduced into an infant's diet in addition to breast milk [Brown and Lutter, 2000]. These special transitional food according to Derwey *et al* (1999) may be either centrally processed or prepared at home from family foods that are mashed such as beans, rice and others or otherwise specially prepared for infants consumption.

Diet has been considered to be the major source of human intake of both nitrate and nitrite (Gangolli *et al,* 1994; Meah *et al*, 1994). The concentration of these chemicals have been found to vary considerably within each food category and many investigators have observed that nitrate level is often high in plant materials since it is the plant's primary source of nitrogen. (Stopes *et al,* 1998, Ketiku *et al*, 2000). Thus nitrate and nitrite have been shown to be a natural constituent of many foods both of plant and animal origins (Philips, 1968; Baranova *et al*, 1994). Roots, tubers, leaves, and stems have been reported to contain high amount of nitrate. (Abo-Bakr, 1986)

Exposure to high doses of nitrate and nitrite has been associated with a variety of adverse health effects in human such as cancer (National Academy of Sciences 1981); birth defects (Scragg *et al,* 1982); cardiovascular effects (Morton,

1971) and hypertrophy of the thyroid (Vanmaanen, 1994). The major adverse health effect on infants is methemoglobinemia (Menzer, 1993; Finan *et al,* 1998). This involves the oxidation of hemoglobin to the ferric form, methemoglobin, which does not reversibly bind oxygen, resulting in difficulties in the oxygen transport system of the blood. The reduced oxygen transport becomes clinically manifest at methemoglobin concentrations of 10% and above. Symptoms are cyanosis and at higher concentration, asphyxia. Cases numbering in thousands have been reported mostly involving poisoning in infants (Menzer, 1993).

The primary aim of the study was to determine the levels of nitrate, nitrite and ascorbic acid in commercial and home-prepared complementary infant food, thereby assessing the possible contribution of these foods to the daily intake of nitrate, nitrite and ascorbic acid. This will also help to determine the safety of these food products that are meant for consumption by infants who show great sensitivity to toxicity of nitrite and nitrate. Vitaniin C, is a remarkable antioxidant which has been shown to be a strong reducing agent that is capable of inhibiting or reversing methemoglobin formation. (Shuval and Gruener, 1972). Determination of its levels in foods that contain nitrate and nitrite is therefore desirable particularly as such data are scanty in Nigeria.

MATERIALS AND METHODS

MATERIALS: Two sets of samples were analysed. Four commercial complementary foods purchased at a popular market in Ibadan while 15 home-prepared complementary foods were prepared with locally available foodstuffs using the weaning diet recipes compiled by the Nutrition unit of the Federal Ministry of Health (1986). Also analyzed in the study were samples of tap water used in the preparation of these food samples.

METHODS: The-moisture content of all the samples was determined by the air oven method (AOAC, 1990). The method of extraction of nitrate and nitrates of Stopes *et al* (1998) was used. 40g each of the homogenized samples was blended with 200ml hot distilled water. The extract was kept in a refrigerator for 12 hours and then filtered through Whatman no. 1 filter paper and the filtrate used for nitrate and nitrite determinations.

Nitrate Determination: The filtrates as well as the water sample were analyzed for nitrate using the phenoldisulphonic acid method (Taras, 1950). 20ml of each sample was pipetted into a conical flask and the content evaporated to dryness. The residue was thoroughly wetted with 2ml phenoldisulphonic acid reagent to ensure dissolution of all solids. It was then diluted with 20ml distilled water and 6ml concentrated ammonium hydroxide was added with stirring. Optical densities were read at 410nm using a spectrophotometer against a blank prepared with distilled water. A standard nitrate curve was prepared using sodium nitrate and sample concentrations were computed directly from the curve.

Nitrite Determination: The diazotisation method of the American Public Health Association (1995) was used in the determination of nitrite. 25ml of each sample filterate was pipetted into well-washed conical flask. 0.5ml sulphanllic acid reagent was added to each flask and left to stand for between 2 and 8 minutes. 0.5mls α- naphthylamine was then added and allowed to stand for about 2 hours for the full development of the characteristic pinkish - red color. The optical densities were measured at a wavelength of 543nm on a spectrophotometer against distilled water blank. A standard curve was prepared and sample nitrite concentrations were computed directly from the curve.

Determination of Ascorbic Acid Content: The ascorbic acid content of the commercial and home prepared complementary foods were determined on fresh samples of foods prepared as

are normally fed to the infants. The 2,6, dichlorophenol indophenol visual titration method was used for its determination.

RESULTS AND DISCUSSION

Nitrate and nitrite have been observed by several researchers to occur widely in foods of animal and plant origin as well as community water supplies. The results revealed the nitrate, nitrite and ascorbic acid levels of foods destined for consumption by infants. Table I shows the nitrate and nitrite content as well as the estimated possible intake from meals per day from the commercial complementary foods.

The commercial complementary foods evaluated in the study were cereal based with milk Soymilk and Soybean mixes. These commercial complementary foods have the potential to play an important role in the diets of infants mostly due to the fact that levels of female employment, disposable income and use of purchased foodstuff are growing in concert with urbanization.

The values of nitrate obtained from these commercial food products ranged from 3.1 - 3.9 mgNO_3-N/100g while the nitrite values ranged from 5.0 - 16.0ugNO_2-N/100g. Frisocrem® had the highest levels of nitrate and nitrite which might be chiefly due to its wheat component. The other products are made up of maize as the principal energy source. This agrees with what was reported by Ketiku *et al* (2000) showing the nitrate and nitrite levels of wheat to be higher than that of maize. The home prepared complementary foods included foods made from different foodstuffs, most of which are based on the most popular weaning food which is thin cereal gruel called pap.

Other protein food ingredients such as egg, crayfish, groundnut, melon were added to this maize to enrich the meal. Legumes and tubers are introduced much later to the infant diet. All these foods have been noted to be satisfactorily used as complementary infant foods (Onofiok and Nnanyelugo, 1998).

The nitrate and nitrite content of the home - prepared complementary foods as presented in Table 2 varied considerably. The highest value of nitrate was obtained in yam and vegetable pottage (25.1 mgNO_3-N/100g) while that of nitrite was found in pureed spinach vegetable (72.OugNO_2-N/100g).

Leafy vegetable especially spinach have been shown to contain high amounts of nitrate and nitrite (Hardison *et al*, 1996; Ketiku *et al*, 2000). Also shown to contain high amounts of nitrates and nitrites in this study were soyabean moi-moi, yam and beans pottage, 'Gbegiri' soup and 'Ekuru".

Table 1:
Nitrate and Nitrite Contents of the Commercial Complementary Infant Foods.

Name of Sample (Age Group)	% Moisture Content (g,/100g	Nitrate Content (mgNO_3-N/100g)	Nitrite Content (mgNO_2-N/100g)	Recommended intake of meal per day (g)*	Expected *Nitrate* intake from meal per day (mgNO_3-N/100g)	Expected Nitrite intake from meal per day (mgNO_2-N/100g)
'CERELAC® 4 - 6 Months > 6 Months	86.6 ± 0.30	3.8 ± 0.4	5.0 ± 0.4	 175.0 220.0	 6.7 8.4	 8.8 11.0
'NUTREND'® 4 - 6 Months > 6 Months	88.2 ± 0.12	3.1 ± 0.2	6.0 ± 0.8	 175.0 220.0	 5.4 6.8	 10.5 13.2
'SOY-OGI'® 4 - 6 Months 6 - 9 Months 9 – 12 Months	87.2 ± 0.04	3.4 ± 0.2	13.0 ± 0.5	 145.0 160.0 180.0	 4.9 5.4 6.1	 18.9 20.8 23.4
'FRISOCREAM'® 4 - 6 Months 8 – 12 Months	88.4 ± 0.25	3.9 ± 0.6	16.0 ± 0.4	 175.0 220.0	 6.8 8.6	 28.0 35.2

**As indicated on nutrition label*

Table 2: Nitrate and Nitrite Content of the home-prepared Complementary Infant Foods.

Age group consuming the foods	Name of infant food	% Moisture Content (g,/100g	Nitrate Content ($mgNO_3$-N/100g)	Nitrite Content ($mgNO_2$-N/100g)	Recommended intake of meal per day (g)*	Expected *Nitrate* intake from meal per day ($mgNO_3$-N/100g)	Expected Nitrite intake from meal per day ($mgNO_2$-N/100g)
4 – 6 months	Pap with Milk	85.9 ± 0.06	4.5 ±0.6	6.0 ± 0.8	*155.0*	7.0	9.3
	Pap with Egg	89.7 ± 0.02	2.5 ± 0.2	9.0 ± 1.4	180.0	*4.5*	16.2
	Pap with Crayfish	85.3 ± 0.01	2.9 ± 0.4	9.0 ± 0.2	166.0	4.8	14.9
	Egg Custard	84.5 ± 0.01	3.2 ± 0.4	14.0 *± 0.5*	80.0	2.6	19.2
	Pureed Spinach Vegetable	91.6 ± 0.14	14.4 ± 1.7	72.0 ± 2.7	*35.0*	*5.0*	25.2
6 – 9 months	Pap with Groundnut	79.5 ± 0.02	2.9 ± 0.8	*15.9* ± 1.2	180.0	5.2	27.0
	Pap with Melon	79.6 ± 0.11	3.6 ± 1.0	14.0 ±2.7	180.0	6.5	*43.2*
	Rice Pudding	83.5 ± 0.03	4.1 ± 0.4	16.0 ± 2.8	*115.0*	4.7	18.4
	Garri Pudding	89.8 ± 0.01	2.9 ± *0.5*	21.0 ± 1.2	*155.0*	*4.5*	32.6
	Alapa	68.2 *± 0.05*	8.7 ± 0.3	9.0 ±1.4	125.0	10.9	11.3
	Ekuru	83.5 ± 0.08	11.0 ± 0.5	14.0 ± 0.8	75.0	8.3	*10.5*
	Gbegiri Soup	74.9 ± 0.02	16.2 ± 0.6	11.0 ± 1.4	*150.0*	24.3	*16.5*
	Soyabean Moi moi	81.1 ± 0.11	16.3 ± 0.1	37.0 ± 1.4	100.0	16.3	37.0
9– 12 months	Yam and Beans Pottage	71.8 ± 0.04	19.5 ± 0.2	37.0 ± 2.2	125.0	24.4	46.3
	Yam and Vegetable Pottage	74.6 ± 0.08	25.1 ± 0.4	*56.0* ± 2.8	100.0	25.1	56.0

Table 3: Ascorbic Acid *Content of* the Commercial Complementary Infant foods

Name of Sample (Age Group)	% Moisture Content (g/100g)	Ascorbic acid Content (mg/100g)	Recommended intake of meal per day (g)	Expected intake from meal per day (mg)
'CERELAC®	86.6 ± 0.30	6.0 ± 0.08		
4 - 6 Months			175.0	10.5
> 6 Months			220.0	13.5
'NUTREND'®	88.2 ± 0.30	13.1 ± 0.2		
4 - 6 Months			175.0	22.9
> 6 Months			220.0	28.8
'SOY-OGI'®	87.2 ± 0.04	4.6 ± 0.12		
4 - 6 Months			145.0	6.7
6 - 9 Months			160.0	7.4
9 – 12 Months			180.0	8.3
'FRISOCREAM'®	88.4 ± 0.25	8.3 ± 0.01		
4 - 6 Months			175.0	14.5
8 – 12 Months			220.0	18.3

Table 4: Ascorbic Acid Content of the Home - prepared complementary Infant foods.

Age group consuming the foods	Name of infant food	% Moisture Content (g,/100g	Ascorbic acid Content (mg/100g)	Recommended intake of meal per day (g)	Expected intake from meal per day (mg)
4 – 6 months	Pap with Milk	85.9 ± 0.06	3.6 ± 0.2	155	5.6
	Pap with Egg	89.7 ± 0.02	2.4 ± 0.1	180	4.3
	Pap with Crayfish	85.3 ± 0.01	2.4 ± 0.1	166	4.0
	Egg Custard	84.5 ± 0.01	3.6 ± 0.1	80	2.9
	Pureed Spinach Vegetable	91.6± 0.14	16.7 ± 0.2	35	5.8
6 – 9 months	Pap with Groundnut	79.5 ± 0.02	3.6 ± 0.2	180	6.5
	Pap with Melon	79.6 ± 0.11	2.4 ± 0.3	180	4.3
	Rice Pudding	83.5 ± 0.03	2.4 ± 0.5	115	2.8
	Garri Pudding	89.8 ± 0.01	2.4 ± 0.1	155	3.7
	Alapa	68.2 ± *0.05*	3.6 ± 0.2	125	4.5
	Ekuru	83.5 ± 0.08	2.4 ± 0.1	75	1.8
	Gbegiri Soup	74.9 ± 0.02	3.6 ± 0.1	150	5.4
	Soyabean Moi moi	81.1 ± 0.11	3.6 ± 0.1	100	3.6
9– 12 months	Yam and Beans Pottage	71.8 ± 0.04	4.8 ± 0.3	125	6.0
	Yam and Vegetable Pottage	74.6 ± 0.08	4.8 ± 0.2	100	4.8

Another important dietary source of nitrate and nitrite especially for bottle fed infants is water (Archer, 1982).

However, the tap water used in the preparation of both the commercial and home - prepared complementary foods were observed to be low in nitrate (0.4 ± 0.02mgNO_3-N/100ml) and nitrite (4.1 ± 0.8ugNO_2-N/I00ml) compared with what was obtained in some other studies (USEPA, 1987; Mbanugo *et al,* 1990;)

The ascorbic acid content of the commercial complementary foods as shown in Table 3 ranged from 4.6 - 13.1mg/100g. These relatively high amounts of ascorbic acid could be attributed to the fortification of the commercial products with C. Ascorbic acid level and the estimated intakes from the home prepared complemetary foods (Table 4) are lower than the corresponding data for commercial complementary foods. The levels of Vitamin C in these foods are far below the the recommended intake of vitamin C per day (Food and Nutrition Board, 1986). Therefore, consumption of fruits such as oranges that are rich in C should be encouraged.

Conclusion: This study has shown that the complementary infant foods based on vegetables and legumes contain high amounts of nitrate and nitrite compared to cereal based complementary foods. However, the estimated intakes of nitrates and nitrite from these meals would not pose any health risk to the infants under normal conditions. Also, the tap water used for the preparation of these complementary foods was found to be low in nitrate and nitrite. Such water is recommended for the preparation of complementary infant foods.

Mothers should be encouraged to continue breastfeeding their infants frequently beyond the first year of life so these foods could serve as complements and not replacements to breastmilk. Breastmilk itself has been shown to contain low levels of nitrate and nitrite (National Academy of Sciences, 1981).

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