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A Study of the Ascorbic Acid Intake of Children and Aged People in Selected Rural, Sub-urban and Urban Locations in Northern Nigeria

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ABSTRACT

Levels of ascorbic acid intake of 106 subjects during dry and rainy seasons were investigated. These subjects were made up of 41 children of 2–4 years, 40 children of 5–9 years and 25 adults of 55–75 years. Daily ascorbic acid intake was estimated from chemical analysis of food consumed over a period of 14 days in either of the two seasons. The mean ascorbic acid intake for children of 2–4 years old was 33·42 mg/day during the dry season and 48·01 mg/day during the rainy season; for children of 5–9 years old it was 48·96 mg/day in the dry season and 64·44 mg/day during the rainy season while for aged people of 55–75 years the ascorbic acid intake was 38·25 mg/day in the dry season and 52·07 mg/day in the rainy season. Higher levels of ascorbic acid were generally consumed in the rainy season than in the dry season. Children of 5–9 years consumed more ascorbic acid during both seasons than any other age group. Rural subjects had higher ascorbic acid intake than sub-urban and urban subjects. The most common source of ascorbic acid was vegetables. The diets of the subjects under study provided marginal ascorbic acid all year round with maximum supply during the rainy season.

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INTRODUCTION

L-Ascorbic acid (vitamin C) is a substance of great physiological importance in human nutrition. Although many animals are capable of synthesising ascorbic acid and therefore do not require it in their diet, man and other primates and the guinea pig are unable to do so and the vitamin must therefore be added to their diets in order to promote normal connective tissue synthesis. Its prolonged absence from diets causes scurvy, a disease characterised by development of abnormal bone and dental structures, extreme capillary fragility and poor wound healing. As a reducing agent, ascorbic acid is known to maintain prolyl hydroxylase in an active form, probably by keeping its iron atom in the reduced ferrous state. Collagen, synthesised in the absence of ascorbic acid, is insufficiently hydroxylated and hence has a lower melting temperature. Such a collagen cannot properly form fibres and thus causes the skin lesions and blood vessel fragility characteristic of scurvy (Gross, 1973; Tanzer, 1973). Ascorbic acid is known to play an important role in the metabolic reactions of some amino acids and in the synthesis of epinephrine and anti-inflammatory steroids (Peterkofsky & Udenfriend, 1965; Levenson *et al.*, 1971).

Although ascorbic acid has been shown to be abundant in fresh, canned and frozen citrus fruits, and in smaller but important amounts in other fruits, tomatoes, potatoes and leafy vegetables, it is easily destroyed by oxidation and prolonged cooking at high temperatures.

Given the preponderance of vegetables and citrus fruits, but the cooking habits of Nigerians, this study has been undertaken to ascertain the adequacy or otherwise of daily intake of vitamin C in rural, sub-urban and urban centres in northern parts of Nigeria. We report our findings for 106 human subjects ranging from 2 to 75 years in the three centres.

MATERIALS AND METHODS

Preparation of chemicals

Analytical reagent grade metaphosphoric acid (25 g) was dissolved in distilled water to give 6·25% (w/v) metaphosphoric acid solution while 0·205 g of 2,6-dichlorophenolindophenol dye was dissolved in deionised water to give 0·04% (w/v) solution of the dye.

Standard L-ascorbic acid

Ascorbic acid (British Drug House—BDH) (40 mg) was dissolved in 6·25% metaphosphoric acid solution and made up to 100 ml. The container in

which the standard ascorbic acid solution was contained was wrapped with aluminium foil to shield the contents from sunlight. The solution was kept in a refrigerator until when needed and the appropriate quantity removed and used.

Standardisation procedure

Standard L-ascorbic acid solution (5, 10, 15, 20 and 25 ml) was placed in a conical flask and titrated against 2,6-dichlorophenolindophenol dye until a stable deep pink colour persisting for 30 s was obtained. Triplicate readings were taken for each volume of standard L-ascorbic acid. From the readings a standard curve was constructed.

Extraction from food samples and determinations of ascorbic acid content

The method of Moore (1957), as modified by Oke (1966), was used in extracting the ascorbic acid from cooked foods while the method of Keshinro and Ketiku (1972), as modified by Fafunso and Basir (1977), was used for extraction of the vitamin from vegetables and vegetable soups respectively. In all cases, four samples were taken for each season at 6-week intervals and triplicate determinations were made for each sample. The total ascorbic acid of each food sample was determined in accordance with that of Fafunso and Basir (1977). Triplicate determinations were made for each set of samples.

Food samples

The roots and tubers included mainly yams (*Dioscorea rotundata* str.), cassava (*Manihot* species), cocoyams, carrots, sugar-cane and potatoes. Injury-free samples were collected and used. Fruits included oranges, bananas, guava, pawpaw, mango, tangerine, plantains, sorghum, beans and groundnut while vegetables were mainly of the amaranth group. The milk was fresh pasteurised milk while the milk products were mainly yogurt and a native ferment known as *nono*.

RESULTS AND DISCUSSION

Table 1 shows the distribution of the human subjects as well as the spread. Forty-one children of 2–4 years distributed into 17 in rural, 14 in sub-urban and 10 in urban areas were sampled. Forty children aged 5–9 years, distributed into 10 in rural, 18 in sub-urban and 12 in urban areas, were

TABLE 1
Distribution of Human Subjects into Age Groups for Sampling Purposes

Age group (years)	*Sampling location*			*Total subjects*
	Rural	*Sub-urban*	*Urban*	
2–4	17	14	10	41
5–9	10	18	12	40
55–75	7	8	10	25[a]
Total	34	40	32	106

[a] The adults were made up of 12 men (four in each location) and 13 women (four in rural, five in sub-urban and four in urban centres).

examined. A total of 25 adults aged 55–75 years, with seven from rural, eight from sub-urban and 10 from urban locations, were examined. Thus a total of 106 subjects were involved in the study. The human subjects used in this study were medium income earners for each category.

Table 2 groups the various foods, consumed by the human subjects under study and for which analysis was carried out, into four main categories. Results showed that vegetables provided a major portion of the ascorbic acid requirement of individuals and fruits were next in order of importance. Roots and tubers contributed least to the sources of ascorbic acid. Higher levels of ascorbic acid were generally recorded in the rainy season than in the dry season. For the fruits the reverse seemed to be the case. This could be due to the fact that during the dry season some of the endogenous carbohydrates are converted to ascorbic acid.

TABLE 2
Estimation of the Contribution of Ascorbic Acid from the Various Food Groups in the Diet of Subjects under Study

Food group	*Ascorbic acid (% of total intake)*					
	Rural		*Sub-urban*		*Urban*	
	Rainy season	*Dry season*	*Rainy season*	*Dry season*	*Rainy season*	*Dry season*
Roots and tubers	3·01	6·45	3·48	4·02	6·20	7·00
Fruits	5·06	13·61	7·37	12·75	11·17	10·55
Vegetables	86·31	74·80	84·53	74·43	75·57	70·37
Milk and milk products	5·62	5·14	4·62	8·80	7·06	12·08
Total (%)	100	100	100	100	100	100

The daily intake of ascorbic acid by the human subjects in the three locations (rural, sub-urban and urban) in rainy and dry seasons is shown in Table 3. Consumption of ascorbic acid was generally higher in the rainy season than in the dry season in all three locations and in all groups. The daily intake of ascorbic acid in the rainy season ranged from 34·71–61·06 mg with a mean range of 43·90–54·70 mg/day, while in the dry season the daily intake ranged from 28·75–40·56 mg with a mean range of 31·73–34·85 mg/day for children of 2–4 years. The highest intake of ascorbic acid was consistently recorded for subjects in rural locations.

In the case of children of 5–9 years (Table 3), the daily intake of ascorbic acid ranged from 41·04–98·07 mg with a mean range of 53·64–78·14 mg/day in the rainy season as compared to 36·09–81·06 mg/day of ascorbic acid intake with a mean range of 40·93–55·94 mg/day in the dry season.

In aged people (55–75 years), the daily ascorbic acid intake ranged from 25·04–129·7 mg/day with a mean range of 36·90–75·44 mg/day in the rainy season and from 23·18–54·84 mg/day with a mean range of 33·27–44·79 mg/day in the dry season. The subjects in the rural location had consistently higher ascorbic acid intakes than subjects in either the sub-urban or urban locations. This is not very surprising as elderly people are better taken care of in rural areas than sub-urban or urban locations.

TABLE 3
Estimation of Total Ascorbic Acid Intake by Individuals in Various Age Groups by Chemical Analysis of Food Items

Location		*Daily ascorbic acid intake (mg)*				
		Rainy season			*Dry season*	
		Range	*Mean*	*SD*	*Range*	*Mean* *SD*
Rural	(A)	48·60–61·06	54·70	± 1·63	32·54–39·87	34·85 ± 3·28
	(B)	59·03–98·07	78·14	± 14·08	36·09–45·83	40·93 ± 3·62
	(C)	59·90–129·7	75·44	± 28·00	37·01–50·09	44·79 ± 5·74
Sub-urban	(A)	37·50–50·43	43·90	± 5·70	28·75–33·70	31·73 ± 0·75
	(B)	41·04–71·06	61·54	± 10·94	42·48–81·06	55·94 ± 13·07
	(C)	38·26–47·08	44·08	± 2·40	23·18–54·84	36·70 ± 10·07
Urban	(A)	34·71–53·06	45·45	± 1·70	30·55–40·56	33·69 ± 3·84
	(B)	43·08–60·95	53·64	± 5·70	39·06–48·84	44·05 ± 4·07
	(C)	25·04–48·90	36·90	± 8·69	24·85–43·00	33·27 ± 6·50

(A)—Intake for children of 2–4 years.
(B)—Intake for children of 5–9 years.
(C)—Intake for adults of 55–75 years.
SD—Standard deviation.

TABLE 4
Summary of Mean Ascorbic Acid Intake of Children and Aged People Compared with Recommended Dietary Allowance (RDA)

Ascorbic acid intake (mg/day)	*Season*	*Age group (years)*		
		2–4	*5–9*	*55–75*
RDA	All seasons	35	35·40	30
Rural	Rainy season	54·70	78·14	75·44
	Dry season	34·85	40·90	44·79
Sub-urban	Rainy season	43·90	61·54	44·08
	Dry season	31·73	55·94	36·70
Urban	Rainy season	45·45	53·64	36·69
	Dry season	33·69	44·05	33·27

Table 4 gives a summary of the daily intake of ascorbic acid for the various age groups under rainy and dry conditions in rural, sub-urban and urban centres. These values have been compared with what has been accepted generally as the recommended daily allowance (RDA). Although the requirement of ascorbic acid in infancy and early childhood is not known precisely, the infant's ascorbic acid need appears to be met satisfactorily by the level provided by the milk of adequately fed mothers (40–45 mg/litre) and, since the breast-fed infant consumes approximately 850 ml of milk (NAS, 1974), 35 mg has been recommended for infants. For children up to 11 years, about 40 mg has been recommended (Baker, 1967). A daily intake of 30 mg of ascorbic acid has been considered adequate for a healthy normal adult.

Based on the above recommended daily allowance (RDA), all the subjects in the various age groups met their daily ascorbic acid intake during the rainy season in the rural, sub-urban and urban centres. Children of 2–4 years in rural areas marginally met their daily ascorbic acid intake (average intake of 34·85 mg/day) in the dry season but those in sub-urban and urban areas fell below their daily requirement. Children of 5–9 years all met their requirement for daily intake. However, if they must maintain an adequate body pool of 1500 mg (Baker *et al.*, 1971), then they require a daily intake of 45 mg of ascorbic acid (Levenson *et al.*, 1971). In that case, the levels recorded in this group of children are only marginal. That children in this group were able to meet the minimal daily intake requirement can be attributed to the fact that children in this category are more active and mobile than those in the group of 2–4 year olds. The adults of 55–75 years in

all three locations (rural, sub-urban and urban), on face value, would appear to be taking adequate quantities of ascorbic acid since their daily requirement is 30 mg/day (Baker, 1967; NAS, 1974). However, this is only so in normal healthy adult individuals and 30 mg/day may not be satisfactory for the maintenance of optimal health over long periods of time (Baker *et al.*, 1969; Hodges *et al.*, 1971). The inclusion of women in this study was not likely to change the picture since none of the women in this group was either pregnant or lactating.

CONCLUSION

The results showed that the foods contained reasonable levels of ascorbic acid to meet the daily intake requirement at marginal levels for each category of subjects under study. While the levels of daily intake appeared adequate for healthy individuals during the rainy season, the levels of daily intake during the dry season require supplementation.

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