

Nigerian Bread Contribute One Half of Recommended Vitamin a Intake in Poor-Urban Lagosian Preschoolers

Florence Uchendu, and Tola Atinmo

Abstract—Nigerian bread is baked with vitamin A fortified wheat flour. Study aimed at determining its contribution to preschoolers' vitamin A nutriture. A cross-sectional/experimental study was carried out in four poor-urban Local Government Areas (LGAs) of Metropolitan Lagos, Nigeria. A pretested food frequency questionnaire was administered to randomly selected mothers of 1600 preschoolers (24-59 months). Retinyl Palmitate content of fourteen bread samples randomly collected from bakeries in all LGAs was analyzed at 0 and 5 days at 25°C using High Performance Liquid Chromatography. Data analysis was done at $p < .05$. Mean total intake of vitamin A from bread was 220.40 μ gRAE (733.94 \pm 775.68i.u). Bread contributed 6.5–178.4% of preschoolers RDA (1333i.u/400 μ gRAE). Mean contribution to vitamin A intake was 55.06 \pm 58.18%. Strong statistical significant relationship existed between total vitamin A intake and % RDA which was directly proportional ($p < .01$). Result indicates that bread made an important contribution towards vitamin A intake in poor-urban Lagosian preschoolers.

Keywords—Bread, dietary intake, Lagos metropolis, preschoolers.

I. INTRODUCTION

VITAMIN A deficiency (VAD) is a global public health problem in 118 countries, especially in Africa and South-East Asia [1]. Vitamin A deficiency (VAD) is a major public health nutrition problem, affecting an estimated 190 million (approximately 33%) pre-school-aged children and 19 million pregnant and lactating women globally [2]. Thirty six million children are vitamin A deficient in Sub-Saharan Africa out of which 17.4 million live in Western and Central Africa [3]. The prevalence of vitamin A deficiency in Nigerian children is 25% [4], [5]. It has been suggested that a prevalence of 20% for VAD constitutes a public health problem [1].

A common cause of vitamin A deficiency might be a shift in the local diet to imported and ready-to-eat foods [6]. Strategies used towards virtual elimination of VAD are vitamin A supplementation, food fortification, nutrition education, dietary diversification and recently biofortification. Food fortification is a long-term strategy, preventive, cost effective and resolves the many issues of equity and access

because it is population based [7].

Food fortification is the addition of a nutrient to a food, whether or not is normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups [8]-[9].

Currently, 10 low- and low middle –income countries and two upper-middle-income countries are fortifying or proposing to fortify wheat flour and/or maize flour with vitamin A [2], [10]. Wheat and maize flour fortification is a preventive food-based approach to improve micronutrient status of populations over time that can be integrated with other interventions in the efforts to reduce vitamin and mineral deficiencies when identified as public health problems [11].

Effectiveness studies determine how well the general population or a large segment of the population benefits from flour fortification [12]. Fortified food intake has become a routine, however, little quantitative information on the intake of these foods is available [13]. Although experience is accumulating that a fortification approach is effective in some developing country settings, there remain several countries, especially in Africa and South Asia, where effectiveness is yet to be demonstrated [14]-[15], [2].

Historically, food fortification programs were often undertaken with little attention to issues such as micronutrient bioavailability, optimal levels of addition, efficacy or to monitoring impact on nutritional status, health, and human function [16].

Ensuring product quality and monitoring for effectiveness are essential for fortification to maximize its potential for the preventive health consequences of vitamin and mineral deficiencies [17]. Another reason for hesitancy to invest in food fortification is the concern that some fortified foods do not reach the target populations notably, the poor [18]. The contribution made by fortified food products to total vitamin A intake needs to be assessed.

A study carried out in East Java, Indonesia showed that some fortified products do not contribute substantially to the total vitamin A intake of the poorest segments of society [19].

Some of the factors to guide a decision to fortify flour with vitamin A include population intake distributions of flour products, the dietary vitamin A intake required, and the associated costs [2]. Large gaps persist in knowledge of these factors, which are needed to enable evidence-based fortification in most countries, leaving most decisions to

F. Uchendu is with the Department of Health Sciences, School of Science and Technology, National Open University of Nigeria, Victoria Island, Lagos, Nigeria (phone: +2348037065874; e-mail: Uchendu_flo@yahoo.com).

T. Atinmo is with the Department of Human Nutrition, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria.

fortify guided by assumptions [2].

The purpose of this study is to determine vitamin A content of bread, consumption pattern and contribution to vitamin A Recommended Dietary Allowance of poor-urban Lagos metropolitan preschool children.

II. MATERIALS AND METHODS

A. Study Design

This study is a descriptive, cross-sectional and experimental study.

Instruments used for data collection in the study were quantitative food frequency questionnaire and retinyl palmitate analysis. Retinyl palmitate analysis of fourteen samples of bread (sliced and unsliced) was done using High Performance Liquid Chromatography (HPLC). The survey was done between June, 2008 and May, 2012.

B. Study Area

This study was carried out in four Local Government Areas (LGAs) in Metropolitan Lagos, Nigeria namely Oshodi/Isolo, Agege, Mushin and Lagos Island LGAs representing the poor-urban communities. Lagos is a Mega city located in Southwest of Nigeria. The State covers an area of approximately 3568.61 km² and lies between Latitude 6° 35' N and Longitude 3°45' E. It borders the Atlantic Ocean to the South, Ogun State to the North and the East, and the Republic of Benin to the West [20]. It is located in the central district of Lagos State in South Western Nigeria (Fig. 1). At the 2006 Census it had a population of 9 million people [21].

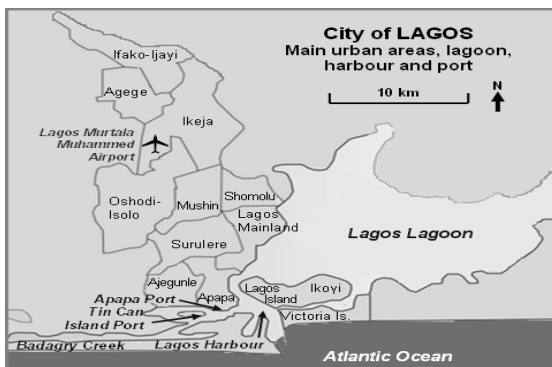


Fig. 1 Map of Lagos State (Wikipedia, 2008/9)

C. Ethical Considerations

At some of the Local Government headquarters, permission were obtained for the study and relevant information about the Local Government Areas were collected. The protocol of the study was approved by the Department of Human Nutrition and University of Ibadan/University College Hospital (UI/UCH) Health Research Ethics Committee, Institute of Advanced Medical Research and Training (IMRAT), College of Medicine, University of Ibadan, Ibadan, Nigeria (UI/IRC/07/0095). On-the-spot written voluntary informed consent was obtained from mothers willing to participate in the survey. The mother signed an informed consent form before she and her child were included in the study. Mothers,

who were unable to sign their signatures, thumb printed. The respondents were interviewed individually.

D. Study Population

The unit of study was the household. The study population included children aged 24-59 months and their mothers. This age group was targeted because this stage of development is considered to be one of the most vulnerable groups to vitamin A deficiency [22].

E. Selection of Local Government Areas (LGAs)

A random sampling method was used to select the LGAs. A list of all the sixteen Local Government Areas (LGAs) in Lagos Metropolis was obtained. Out of every four LGAs, a LGA was chosen until it was exhausted.

F. Determination of Sample Size (n)

A minimum sample size (n) of 320 (in each of the 4 LGAs) households were derived using a statistical sample size formula: $n = Z^2pq/d^2(d \text{ squared})$. 10% non-response (NR) was assumed [9]. Balanced group was used for the 4 LGAs.

G. Selection of Houses on the Local Government Areas

Simple random sampling method was used to select the houses in the four Local Development Areas. Every 9th house was selected. The validity of the sampling was increased by trying to approximate random selection and by eliminating bias.

H. Selection of Households

The households were selected using the age of the child. To be eligible, the child in the household must be between 24-59 months. The respondent was the mother. Until children have reached the developmental stage when they are able to give account of their food intake and can begin to conceptualize (approximately 7-8 years), the onus for dietary reporting is on the parents [23]. According to [23], in a dietary recall studies which compared the results of direct observation of children's food intake with 24-hour recalls by parents, the evidence suggests that parents can be reliable reporters of their children's food intake in the home setting. This finding agrees with another result which stated that in any dietary survey, the respondent is usually the mother or the housewife who is involved in the preparation of the food for the family [24]. A total of 1600 households were selected.

I. Selection of Mother and Child

Mothers were visited at their homes similar to that done by [25]. A pair comprising of mother and child between 2-5 years old was selected from the identified household. If there was more than one child between 2-5 years old, the youngest child was selected [18], [6], [26].

Again, when there was more than one wife in the household, the youngest wife was selected with her youngest child. If there was no suitable mother-child pair in the selected household, another household was selected as done by [26]. The same applied if the mother refused to participate in the survey.

J. Assessment of Dietary Intake

Dietary intake of pre-school children was recorded using diet history method comprising of food frequency questionnaire and quantitative 2 days 24-hr dietary recall. A detailed quantitative food frequency questionnaire appropriate to local conditions was developed similar to that used by [27] and [6].

The overall eating pattern of the children both at mealtimes and in-between meals were obtained similar to that of [28] and [29]. The questionnaire was pre-tested and 8 trained indigenous interviewers helped to distribute them. The questionnaire was modified to give quantitative data on the amount of bread consumed in the standard package from producers as they are sold or consumed e.g. in Naira (N) and slices. Mothers were asked to state the quantity the children consumed in slices or the amount consumed at each eating similar to that done by [30]. Price (N) of bread eaten was used to quantify the weight of bread. The recall consisted of asking the respondent to name all foods the child ate during the 2 days 24-hour recall periods, beginning from the time she or he woke up on each day before the interview as done by [18].

K. Food Analysis

1. Inclusion Criteria

Samples were selected for inclusion based on percentage of the population reporting the food. Only samples consumed by at least 5% of the total population in each LGA were considered as commonly consumed as done by [31]. This is designed to maximize statistical reliability of estimates for individual age groups. Foods were also considered as commonly consumed if they were consumed 3 or more times per week during various meal times per day [32].

L. Vitamin A Determination:

Randomly selected fourteen samples of fresh bread from bakeries in four LGAs were taken to the food laboratories. Homogenized portions were analyzed to get their Retinyl palmitate contents. The remaining samples were stored under room temperature wrapped in cellophane nylons as purchased and analyzed after 5 days. Results were expressed in i.u/kg (μgRAE). Direct and saponification methods were used to analyze samples using High-Performance Liquid Chromatography, UV detector, reverse phase C-18 column (Shimadzu Corporation, Kyoto, Japan) as described in [33], [34], [35]. The direct method has already been described elsewhere [36].

M. Vitamin A Extraction and Quantification

Vitamin A was de-proteinized from 10-20g sample using 2.0% of sodium ascorbate solution (HPLC grade) until moist and heated in a steam bath for 5mins. About 0.1% Butylated Hydroxyl-Toluene (BHT) and 3mls of potassium hydroxide (17M) was measured and added to each of the samples and vortexed for 2 minutes. Flask was connected to air condenser and refluxed for 30 minutes with frequent shaking. Samples were cooled with ice-blocks.

Vitamin A extraction was done using 3% sodium sulphate

solution and ether. The ether extract was transferred to 250mls round bottom flask and evaporated to dryness under reflux using steam water bath at a temperature $< 40^\circ\text{C}$. The extract was washed with Milli-Q Water (4 x 50mls) until neutral. The concentrated vitamin A extract was then dissolved with acetonitrile and injected into the HPLC using 100 μL micro volumetric injector.

Reading was taken at 325nm with a flow rate of 1.0ml/min and injection volume of 100 μl . The Mobile Phase used were Acetonitrile/Water (60%/40%); Methanol 98%, Water 2%. An BFRL column LC-18, 5micron (Dimensions 4.6mm x 150mm) and SY-8100 UV/VIS Detector was used. Vitamin A was quantified using peak area.

The Retinyl acetate, Sigma grade, type IV was used as internal standard. Standard was treated like sample. The minimum required quantity for this assay was 30 i.u/g. Vitamin content in the sample was calculated using the following formula as done by [35].

$$A \times I \times C \times E \times F \times H \times 1000 \times 1000 / B \times D \times 100 \times 250 \times G \quad [35]$$

where

A = Peak Area of sample

B = Peak Area of standard

C = Weight of standard (g)

D = Weight of sample (g)

E = ml of ether used

F = dilution factor for sample

G = dilution factor for standard

H = % purity of standard

N. Estimation of Vitamin A Contribution of Bread to Recommended Dietary Allowance (RDA) of Pre-school Children

The amount of vitamin A in the quantity of bread consumed were expressed as percentage of total vitamin A content and recommended dietary allowance (RDA) using the vitamin A contents of fresh and 5 days old bread similar to that of [37].

O. Calculation of Median Dietary Intake:

Median dietary intake = Total vitamin A intake divided by total number of children

P. Calculation of Percentage RDA:

The percentage contribution of each sample to RDA was calculated using the following formula:

% RDA = Median dietary intake / RDA of age group (1333 i.u or 400RAE) x 100

Q. Statistical Analysis:

Data were presented in tables, frequencies, percentages, mean, and standard deviation. Analysis was done at 5% significance using the statistical package for the Social Scientists Version 10.0 (SPSS Inc., Chicago, IL, USA).

III. RESULTS AND DISCUSSION

Table I presents the characteristics of the study group. The children were mainly males (52%) and between 23–35 months old (54%). Most of the mothers were in their early thirties.

TABLE I
CHARACTERISTICS OF STUDY POPULATION

Characteristics	Frequency (%)
<i>CHILD</i>	
Gender: Male	631(52)
Female	585(48)
<i>Age group (months)</i>	
23 – 35	658(54)
35 – 47	271(22)
47 – 59	287(24)
<i>Mother's Age (years)</i>	
18 – 29	412(34)
30 – 39	660(54)
40 – above	144(12)
<i>Level of Education (years)</i>	
None	62 (5)
Drop out	56 (5)
1 – 6	149(12)
7 – 12	446(37)
12 – above	502(41)
<i>Location of residence</i>	
Oshodi/Isolo	304(25)
Mushin	304(25)
Agege	304(25)
Lagos Island	304(25)

Table II shows the consumption of bread across the four LGAs in Lagos Metropolis. Unsliced and sliced bread samples A, B, C, and D were consumed by more than 5% of children.

Unsliced bread was the most frequently consumed white bread across the LGAs. More than half ate unsliced bread 220 ± 31.6 (71.4% \pm 9.7) while about 94 (29%) ate white sliced bread.

TABLE II
REPORTED USUAL BRANDS OF WHITE BREAD CONSUMED BY PRESCHOOL CHILDREN

Bread Brand	LGAs			
	Osho/Isolo F (%)	Agege F (%)	Mushin F (%)	Lagos Island F (%)
None	3(0.9)	-	-	-
Unsliced	210(69.1)	250(82.2)	236(77.6)	180(59.2)
<i>Sliced:</i>				
A	32(10.5)	20(6.6)	68(22.4)	11(3.6)
B	27(8.9)	13(4.3)	0(0.0)	15(4.9)
C	11(3.6)	0(0.0)	0(0.0)	60(19.7)
D	10 (3.3)	17(5.6)	0(0.0)	15(4.9)
E	0(0.0)	-	-	14(4.6)
F	6 (2.0)	4(1.3)	0(0.0)	0(0.0)
G	5 (1.7)	0(0.0)	0(0.0)	9(3.0)
Total	304 (100)	304(100)	304(100)	304(100)

TABLE III
CONSUMPTION GRAMMES OF WHITE BREAD BY PRESCHOOL CHILDREN IN 2-DAYS-24HR RECALL

Bread brand	Bread consumption (g)			
	0g/day	<75g/d	75-149g/d	150-300g/d
<i>LGAs</i>				
Oshodi/Isolo	197(65)*	4(1)	76(25)	27(9)
Agege	198(65)	-	79(26)	27(9)
Mushin	270(89)	-	31(10)	3(1)
Lagos Island	236(78)	9(3)	47(16)	12(4)

* Figures in bracket are in percentages

Table III indicates the quantity of bread consumed by the preschoolers. Majority of the children consumed 75-149g of bread per day. Mean consumption of unsliced bread was 123.39 ± 15.75 g while that of sliced bread was 93.96 ± 6.62 g. Total mean consumption of bread was 108.67 ± 19.30 g.

A. Vitamin A Content of Fresh Bread

Out of fourteen samples of fresh bread analyzed, half (50%) had vitamin A content while half had zero vitamin A (Table IV). Mean vitamin A content of bread samples was $4,121.62 \pm 6712.33$ i.u/kg. Most of the sliced bread had zero vitamin A contents.

TABLE IV
VITAMIN A (RETINYL PALMITATE) CONTENT OF FRESH WHITE BREAD

Bread Sample	Vitamin A content i.u/kg (μ gRAE)	
	Fresh bread	5 (days old)
<i>UNSLICED (A)</i>		
1*	3, 434.0 (1, 031.23)	0.0
2*	12, 597.0 (3, 782.88)	0.0
3*	0.0	0.0
4**	18, 239.0(5, 477.18)	6,344.0(1, 905.11)
5**	0.0	0.0
6***	17, 472.0(5, 246.85)	0.0
7***	5, 615.0(1, 686.18)	0.0
8****	998.7(299.91)	678.8(203.84)
9****	3,438.1(1, 032.46)	2221.8(667.21)
<i>SLICED</i>		
10A*	0.0	0.0
11B**	0.0	0.0
12C***	0.0	0.0
13D****	0.0	0.0
14D****	1, 524.0(1, 032.46)	869.7(261.17)

Mean = $4,121.62 \pm 6712.33$ (1, 236.49 \pm 2, 013.7 μ gRE)

*Agege LGA, **Mushin LGA, ***Lagos Island LGA, **** Oshodi/Isolo LGA

B. Contribution of Bread to Vitamin A Intake of Preschoolers

Table V presents vitamin A contribution of bread to recommended dietary allowance (RDA) of preschool children at different shelf ages (fresh and 5 days old) they were consumed in two days 24-hour recall.

The contribution of bread to preschoolers' vitamin A nutriture ranged from 6-178%. Mean total vitamin A intake was 733.94 ± 775.68 i.u/day (220.40 μ gRE) and this is very close to the level recommended by FAO/WHO (1333i.u/d or 400 μ gRE/d). Mean contribution to vitamin A requirement was 55.06 ± 58.18 %.

Bread therefore contributed one-half of recommended vitamin A intake in poor-urban Lagosian preschoolers. This result indicates that bread makes a very important contribution towards vitamin A nutriture in this study group. The result is similar to that obtained by [18]. It also agrees with that obtained in Bangladesh chapattis, 35-55% [38].

Some of the contribution by individual bread (32-33%) was similar to values obtained in Philippine pandesal, 33% [2]. But it disagrees with the report from East Java, Indonesia, that some fortified products do not contribute substantially to the total vitamin A intake of the poorest segments of society [19]. It will also disabuse the minds of some stakeholders who

hesitate to invest in food fortification because of concern that some fortified foods do not reach the target populations notably, the poor [18].

Nigerian bread therefore qualifies to be called fortified food. Its contribution to dietary intake of preschool children is double [39] or triple [40] the standard. Codex Alimentarius specification says that food with nutritional equivalence is food to which a minimum of 5% of the RDA was added to the portion. Reconstituted food is that to which 10% to 30% of the RDA was added while fortified food is the responsibility of the authorities of each country [13].

Vitamin levels used in food fortification are normally within the safe range of 15% - 25% of the RDA per serving [39]. Another lower level states that fortified foods contribute at least one-third (10-15%) of the children's vitamin A RDA [40]. Never-the-less, a closer look at those bread samples that contributed above 100% vitamin A to this study group might spark a little worry for consumers from affluent homes who have access to animal sources of vitamin A and also consume bread regularly.

They might stand a risk of over-consumption of vitamin A. This is due to the unusually high level of vitamin A fortification of wheat flour in Nigeria. Nigeria started requiring the addition of vitamin A to flour at a very high level of 9 mg/kg in 2002 [41]. Of all the countries reported to be fortifying wheat flour with vitamin A, Nigeria has the highest fortification level [2].

TABLE V
CONTRIBUTION OF BREAD TO VITAMIN A INTAKE OF PRESCHOOLERS

Bread	Vit.A content iu/g(μ gRAE/g)	Total vit. A μ gRAE/d	% Contribution to RDA
Sample 1 Fresh	3.43(1.03)	134.39 \pm 13.4	33.55 \pm 3.32
Sample 2 Fresh	12.60(3.78)	484.9 \pm 43.6	121.1 \pm 10.89
Sample 4 Fresh	18.24(5.48)	546.96 \pm 0.72	136.64 \pm 0.21
5days	6.34(1.90)	190.68 \pm 0.35	47.64 \pm 0.09
Sample 6 Fresh	17.47(5.25)	713.98 \pm 113.41	178.35 \pm 28.36
Sample 7 Fresh	5.62(1.69)	229.45 \pm 36.45	57.33 \pm 9.09
Sample 8 Fresh	1.00(0.3)	37.96 \pm 0.69	9.5 \pm 0.14
5days	0.68(0.2)	25.80 \pm 0.48	6.45 \pm 0.07
Sample 9 Fresh	3.44(1.03)	130.83 \pm 2.34	32.65 \pm .64
5days	2.22(0.67)	84.43 \pm 1.51	21.10 \pm .42
Sliced Sample 14 Fresh	1.52(0.46)	41.68 \pm 5.5	10.45 \pm 1.34
5days	0.87(0.26)	23.78 \pm 3.12	5.95 \pm 0.8
Mean		220.40 \pm 232.7	55.06 \pm 58.18

RAE, Retinol activity equivalent

RDA, Recommended Dietary Allowance

^aRDA = 1333 I.U/ 400 RAE

^b1 RAE = 1 RE = 3.33 i.u for fortified foods or vitamin A activity from retinol.

1 I.U = 0.3 μ g RE

The aim of fortification is to add vitamin A to a regular dietary constituent (food or condiment) in an amount (e.g. one-third of existing dietary deficiency) in target groups without posing significant risks of overdosing in those who habitually consume the largest quantity of the fortified product [42]. It is encouraged to review the vitamin A fortification level since over-consumption of vitamin A is toxic.

IV. CONCLUSION

The result indicates that bread made a very important contribution towards vitamin A dietary intake of Lagos Metropolitan preschool children. However, monitoring the quality of premix used and quantity added will help to ensure there is vitamin A in all bread samples and that they all will contribute to vitamin A intake of preschoolers.

ACKNOWLEDGMENT

We thank the managements of Standards Organization of Nigeria (SON) and BATO Chemical Laboratories Limited for subsidizing the cost of the research work. The researchers are also grateful to the management of Honeywell Flour Mills for giving us full access to their laboratory and HPLC equipment. We appreciate the staff of these three organizations for their help in making sure the analysis was completed.

REFERENCES

- [1] O. N Rostami, A R Farsar, N Shiva, "Prevalence of sub-clinical vitamin A deficiency in 2-5-year-old children in Tehran." WHO EMRO Eastern Med. Health J. vol. 13 No. 2 March-April: 1-6. 2007
- [2] R D W Klemm, K P West Jr., A C Palmer, Q Johnson, P Randall, P Ranum, and C Northrop-Clewes "Vitamin A fortification of wheat flour: Considerations and current recommendations." Food and Nutr.Bull. vol. 31, no. 1 (Supplement). Pp S47-S61. 2010
- [3] Micronutrient Initiative. In: Begin and Greig 2001. F Begin and Greig, Food fortification in West Africa Assessment of Opportunities and Strategies. Micronutrient Initiative, Pp.1- 17. October 2001.
- [4] UNICEF/M.I., Vitamin and mineral deficiency: A challenge to media Professionals 2006.
- [5] F N Uchendu and T Atinmo, "The silent and neglected crisis of malnutrition: scientific evidence for taking decisive action." Global J.of Health Sci., Canada. Vol. 3, No. 1, April 2011. Online link: www.ccsenet.org/journal/index.php/gjhs/article/download/...www.doaj.org/doi?func=openurl&genre=journal&issn=
- [6] L Englberger, G Marks, M Fitzgerald, and J Timothy, "Vitamin A intake and factors influencing it among children and caretakers in Kosral, Micronesia. Eco. Food and Nutr. 44:307-338. 2005
- [7] Sph.Emory.edu, Elimination of malnutrition: Food fortification approaches.2006 <http://www.sph.emory.edu/PAMM/IH52/Jan28fortification/index.html> 14/3/2006
- [8] FAO. Annex 4 – Micronutrient fortification of food: Technology and quality control. 1996.<http://www.fao.org/docrep/w2840e/w2840eob.htm>. Accessed 7/1/07
- [9] WHO/FAO. Guidelines on food fortification with micronutrients. (L Allen, de Benoist, O Dary, and R Hurrell, eds.) 2006. P. 3-117.
- [10] WHO, FAO, UNICEF, GAIN, MI, & FFI. "Recommendations on wheat and flour fortification." Meeting Report: Interim Consensus Statement. Geneva. World Health Organization, 2009.http://www.who.int/nutrition/publications/micronutrients/wheat_m_aize_fort.pdf. Accessed 6/8/2011.
- [11] World Health Organization (WHO). Global prevalence of vitamin A deficiency in populations at risk 1995-2005; WHO Global Database on Vitamin A Deficiency, Geneva: WHO, 2009.
- [12] J Gwirtz and G Gleason . The flour millers' toolkit on fortification.2007.

- [13] S Liberato and H Pinheiro-SentAna. 2006. Fortification of industrialized foods with vitamins Rev. Nutr. V. 19 n. 2 Campinas mar./abr: 1-23.2006.
- [14] B A Underwood. Dietary approaches to the control of Vitamin A deficiency: An introduction and overview. Food. and Nutr. Bull. Vol.21. no. 2. PP.117-123. 2006
- [15] D Omar and J O Mora. Food fortification to reduce Vitamin A deficiency: International Vitamin A Consultative Recommendations J. Nutr. 132: 2927S – 2933S, Sept. 2002.
- [16] L Allen. New approaches for designing and evaluating food fortification programs. J. Nutri. 136: 1055-1058. 2006.
- [17] Food Fortification Initiative (FFI). "Harmonization workshop for wheat and maize flour fortification Nairobi, Kenya, Meeting Summary 19-22 April, 2010." 2008. <http://www.fortaf.org/fortification.htm>. Accessed 8/03/06
- [18] V Krause, H Delisle and N Solomons. Fortified foods contribute one and half of recommended vitamin A intake in poor urban Guatemalan toddlers. J. Nutr. 128(5): 860-864. 1998.
- [19] A Melse-Boonstra, E Pee, S. Martin, S. Halati, M. Sari, S Kosen, L Muhila, M Bloem. The potential of various foods to serve as carrier for micronutrient fortification, data from remote areas in Indonesia. European. J. Clin. Nutr. 54:822-887. 2000.
- [20] A A Gbolade. "Inventory of antidiabetic plants in selected districts of Lagos State, Nigeria." Journal of Ethno pharmacology 121: 135– 139. www.elsevier.com/locate/jethpharm. 2009.
- [21] National Bureau of Statistics (2007). Federal Republic of Nigeria 2006 Population Census. <http://www.nigerianstat.gov.ng/nbsapps/Connections/Pop2006.pdf>
- [22] M.Miller, J Humphrey, E Johnson, E Marinda, R Brookmeyer and J. Katz. Why do children become vitamin A deficient? Proceedings of the XX. International Vitamin A Consultative Group Meeting. Am. Soci. for J. Nutr. Sci. 28675-28805. 2002.
- [23] M B E Living stone and P J Robinson. Measurement of dietary intake in children. Proceedings of the Nutrition Society 2000:59, 279- 293. 2000.
- [24] T. Vijayapushpam, K Menon, D. Rao, G. Anthony. A qualitative assessment of nutrition knowledge levels and dietary intake of school children in Hyderabad. Public Health Nutrition (7) 683-688. 2002.
- [25] U Adirijeje. Effect of household feeding practices on pre-school child nutrition in Badagry, Lagos-State, Nigeria. International conference on Infant and Pre-school Child Nutrition, Ibadan. Abstract. P.43 Nov. 18-21, 1998.
- [26] M B Maziya-Dixon, I O Akinyele, R A Sanusi, T E Oguntona, S K Nokoe, E W Harris. Vitamin A status of children under 5 in Nigeria: Results of the Nigeria food consumption and nutrition Survey (Abstract). Presented at the XX11 International Vitamin A Consultative Group (IVACG) Meeting. Vitamin A and the Common Agenda for Micronutrients, 15-17 November 2004, Lima, Peru. p. 84. 2004.
- [27] U. Ramakrishnan, R. Martorell, M. Latham, R. Abel. Dietary Vitamin A intake of pre-school-age children in South India. J. Nutr. 129:2021-2027. 1999.
- [28] F. S. Solon. Update of food fortification in Philippines. Sight and Life (ed. Frigg Martin), p. 8-9. 3/2003.
- [29] Ma Pedro, C Garcia, W Molano, A Guller, J De Leon. Vitamin A and Iron intake among preschool-age with and without fortification of processed foods and fortified staples. 2007.
- [30] C J Prynne, A A Paul, G D Mishra, R J Hardy, C Bolton-Smith, & M E J Wadsworth. Socio-demographic inequalities in the diet of young children in the 1946 British birth cohort. Public Health Nutrition 5 (6), 733-745. 2002.
- [31] M K Fox, K Reidy, V Karwe, P Ziegler. "Average portions of foods commonly eaten by infants and toddlers in the U.S." Am. J. Dietetic Asso: Vol: 106, Issue: 1 Suppl 1, Pp: S66-S76. 2006. http://www.medical.gerber.com/nirf/cm2/upload/6azeba48-dab7-4912-99b6-40f2f001fcl1/average_portions.pdf. Accessed 14/8/11.
- [32] M A Oyunga-Ogubi, E Okwach, N J Waudu, A Makokha and S O Oyiye "Content and bioavailability of micronutrients in street foods of low income groups, Nairobi, Kenya." 2009. http://www.kari.org/biennialconference/conference12/docs/cowTENT&BioA_vailability_of_micronutrients_in_street.html. Accessed 20/8/11.
- [33] R. R. Eitenmiller and W O Landen Jr. Fat-soluble vitamins: Vitamin A and carotenoids. In: Vitamins Analysis for the Health and Food Sciences. Woodhead ISBN 0849326680. Pp. 3-60. 1998.
- [34] T. Norden and D. Kendall. Determination of vitamin A as retinyl palmitate in processed-grain commodities. Working instructions and methods validation. United States Development of Agriculture Grain, Inspection, Packers and Stockyards. Administration Technical Services Division Analytical, Reference and Testing Services Branch. Pp. 1 – 31. 2000.
- [35] D. Eriksen. Vitamin A determination by HPLC. Code: 10002-01:1-5. 2008.
- [36] F. N. Uchendu, T. Atinmo, and O. Oyewole. Stability of Vitamin A in selected Nigerian bread made from commercial fortified wheat flour. Inter. J. of Applied Sci. and Tech. Vol. 2 No. 3: 93-97. 2012.
- [37] I O Williams, R S Parker and J Swanson (2009). Vitamin A content of Southeastern Nigerian vegetable dishes, their consumption pattern and contribution to vitamin A requirement of pregnant women in Calabar urban, Nigeria. Pakistan J. of Nutrition 8 (7):1000-1004. 2009.
- [38] A S Rahman, M A Wahed, M S Alam, T Ahmed, F Ahmed, M A Quaiyum and D A Sack. Randomized double-blind controlled trial of wheat flour (chapatti) fortified with vitamin A and iron in improving vitamin A and iron status in health, school aged children in rural Bangladesh. Arlington, Va, USA: MOST /US Agency for International Development, 2003.
- [39] M Blum. Status paper: Food fortification, a key strategy to end micronutrient malnutrition. In: Nutriview 97/Special Issue. Basel, Switzerland Vitamin Division, F. Hoffman-La Roche Limited. Pp.1-16. 1997.
- [40] FORTAF. Properties of vitamins used in cereal fortification (Section 7 in MI Fortification Handbook). 2011. http://www.fortaf.org/files/properties_of_vitamins.pdf. Accessed 29/3/2011.185.
- [41] A Sommer and K P J West. Vitamin A deficiency: health, survival and vision. New York: Oxford University Press. 1996.
- [42] F S Solon, R D Klemm, L Sanchez, I DArnton-Hill, N E Craft, P Christian, and K P J West. Efficacy of a vitamin A fortified wheat flour bun on the vitamin A status of Filipino school children. Am. J. Clin. Nutrition: 72: 738 – 44. 2000.