Assessment of Essential Micronutrients' Adequacy in Adolescent Girls: A Case Study of a Female College in Bosso Area, Minna, Nigeria.

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Abstract
Food source is considered to have provided essential minerals, which are important for prevention and solution to cases of mineral deficiency disease in adolescent girls. In this study, copper, iron, manganese, zinc, calcium, magnesium, phosphorus, potassium, and sodium essential minerals were accounted for in five (5) ready-to-eat food samples consumed in a notable girls' college in Bosso, Minna, Nigeria. The samples were prepared for wet digestion and the elements, major and trace were determined by Atomic Absorption Spectrophotometer, AAS except phosphorus obtained using colorimetric method. The trace elements were adequate within the limit of observation in all samples except copper in Shinkafa da Wake, Wake da Maijah and manganese in Wake da Maijah. Phosphorus and magnesium among essential major minerals were recorded adequate with highest values in the food samples. Potassium, calcium and sodium were appreciably low respectively. The study showed that careful selections among the local foods and repetition could provide more values of the essential and trace elements, which would meet the approved Required Daily Allowance, RDA. The foods have potential to contribute to healthy living management and sustainability in the school girls.

Keywords: *Assessment; adolescent girls; micronutrients; Flame Atomic Absorption Spectrophotometer (FAAS); mineral deficiency.*

Introduction

Food is related to health regardless of age. Adolescent health and nutrition are important as it is of recent interest (WHO, 2005). The requirement for nutrients is increased at this period (between 10 – 19 years) which is a transition stage to adulthood; the stage they are expected to be schooling (WHO, 2005) Inadequate intakes of nutrients, however from foods, have adverse effects on the physical growth and cognitive development (Shinjini and Sunita, 2001). Nutrition deficiency are seriously consequential especially for adolescent girls whereby under-nutrition could be passed on to the younger generation (Mulugeta et al., 2009). Adequate nutrition needs are greatest in adolescence as it influences their growth and development (Lifshitz et al., 1993). When adolescent stages are nutrient deficient; stunt growth, lower immune responsiveness and hence, increase rate of morbidity prevail (FAO/WHO, 1992;

WHO, 1998; Bhaskaram, 2001). Foods must be administered to provide nourishment to the body qualitatively, quantitatively and affordably (Salau and Hassan, 2014) to remediate nutrient deficiencies in adolescence. The foods contain chemical substances, micro and macronutrients, which assist in various bodily functions via fluids regulation and interactions. Mineral elements which are micronutrients such as major and trace work hand-in-hand with other classes of foods and promote the functioning of macronutrients. Mineral malnutrition is the highest risk to health worldwide and this account for 11% of global disease (Lancet, 2008). Therefore, adolescent girls' preparation nutritionally for a healthy adult life is important (Kaur et al., 2007). However, only a few studies in Nigeria have researched malnutrition with respect to the level of energy and micronutrients in adolescent girls' diets (Ijarotimi, 2004) and anthropometric assessment in adolescents (Ijarotimi, et al., 2003; Omobuwa et al., 2014; Nwokoro et al., 2006).

Analysis of food to ascertain its mineral constituents is of common interest. Some literature data on food analysis focus on individually isolated foodstuff in either prepared, raw or both forms. The aim of this study was to assess major essential minerals in served dishes of a girls' college in Bosso Local Government, Minna metropolis, Nigeria, as well as the food sourcing capability for the elements. This is to reveal that the school diets are capable of providing the essential elements adequate to discourage the mineral supplements as some data suggested.

Materials and Methods

Samples Collection and Treatment

All the food samples were obtained as prepared directly from the culinary unit in the girls' college in Minna metropolis. These samples were allowed to cool and refrigerated. The food samples represented adolescent size of 200g average weight. The samples were homogenized thoroughly in the ceramic pestle and mortar accommodating the minutest component of the food mixture. The mixing continued until homogeneous blend which was later transferred to oven in previously cleaned porcelain crucibles. The samples were fully dried at 100^{o}C for 48 hours. Dried samples were grinded into fine powder in titanium blade grinding machine. The fine powder of 100g was the average dried sample obtained. This was then kept separately in labeled polyethylene bags and sealed.

Sample Pretreatment and Ashing

All glass wares used were immersed in 10% (v/v) nitric acid for 24 hours and then washed with distilled water and rinsed with de-ionised water to avoid contaminations.
1.0g of each dried food samples were carefully weighed into 250 cm^3 beaker. And 18 ml of nitric acid, 2.0 ml of Perchloric acid and 1.0 ml of Sulphuric acid was added to the sample and heated on a hot plate at about 80^{o}C. The digestion continued until a clear solution was obtained to signify a complete digestion. After cooling, the digested sample were filtered and diluted to 250 ml with distilled water into a 250ml volumetric flask which was then transferred into a sample bottle for further analysis.

Sample Determination

Flame Atomic Absorption Spectroscopy (FAAS) was used to determine the mineral contents of the samples. However, Colorimetric method involving Vanado Molybdate Complex was used to determine phosphorus.

Statistical Analysis: Results were expressed as mean values and standard deviations, (SD). Data was processed using Duncan by ANOVA, SPSS 16.0 version (2011) computer software.

Results and Discussion

The summary of result of the analysis was represented in Table 2. Five (5) dishes that represented the students' meals for a period review. Table 2 shows the mean and standard deviations. From this, the range of the major elements within the sample using Duncan by ANOVA statistically. For the samples the mean different is significant at the 0.05 level. There is significant difference in calcium, sodium, magnesium, potassium and phosphorus of the samples at P≤ 0.05. Also, in the trace metal analysis, there is significant difference in manganese and copper contents of samples at P≤0.05. However, there is no significance in the difference at P≥0.05 in zinc and iron contents of the samples.

Table 1: The foods studied and their ingredient contents

DISH	SAMPLE CODE	MAIN INGREDIENTS
Shinkafa Da Wake	A	Local Rice, Brown Beans, Palm Oil, Salt, Maggi, Dried Pepper, Onions
Shinkafa Da Maijah	B	Local Rice, Palm Oil, Salt, Dried Pepper, Maggi, Onions
Kunu Alkama Da Gerou	C	Millet, Wheat, Sugar
Wake Da Maijah	D	Brown Beans, Palm Oil, Salt, Maggi, Dried Pepper, Onions
Tuwon Gari Da Miyan alefun	E	Gari, Maggi, Vegetable Leaf, Dried Catfish, Palm Oil, Salt, Dried Pepper, Onions.

Table 2: Mean values of the mineral content of the dried food samples in mg/100g

Code	Ca	Na	Mg	K	P	Mn	Cu	Zn	Fe
A	$25.00^{a}\pm0.33^{c}$	$8.40^{a}\pm0.04^{c}$	$1143.0^{a}\pm0.04^{c}$	$83.80^{a}\pm0.07^{c}$	$540.00^{a}\pm0.03^{c}$	$25^{a}\pm0.02^{c}$	ND	$28.35^{a}\pm0.02^{c}$	$37.95^{a}\pm0.02^{c}$
B	$71.40^{a}\pm0.04^{c}$	$23.10^{a}\pm0.04^{c}$	$1135.5^{a}\pm0.05^{c}$	$215.30^{a}\pm0.05^{c}$	$1380.3^{a}\pm0.15^{c}$	$52^{a}\pm0.03^{c}$	$25.35^{a}\pm0.02^{c}$	$28.31^{a}\pm0.03^{c}$	$37^{a}\pm0.02^{c}$
C	$78.60^{a}\pm0.03^{c}$	$7.30^{a}\pm0.06^{c}$	$28.60^{a}\pm0.10^{c}$	$28.30^{a}\pm0.05^{c}$	$720.50^{a}\pm0.05^{c}$	$87^{a}\pm0.02^{c}$	$31^{a}\pm0.02^{b}$	$28.35^{a}\pm0.03^{c}$	$41.65^{a}\pm0.03^{c}$
D	$76.40^{a}\pm0.03^{c}$	$34.70^{a}\pm0.05^{c}$	$861.70^{a}\pm0.09^{c}$	$372.90^{a}\pm0.08^{c}$	$2042.0^{a}\pm0.02^{c}$	ND	ND	$27.15^{a}\pm0.02^{c}$	$41.15^{a}\pm0.02^{c}$
E	$45.10^{a}\pm0.03^{c}$	$12.00^{a}\pm0.05^{c}$	$36.41^{a}\pm0.03^{c}$	$103.00^{a}\pm0.02^{c}$	$546.30^{a}\pm0.04^{c}$	$26^{a}\pm0.02^{c}$	$21.15^{a}\pm0.03^{c}$	$30.45^{a}\pm0.02^{c}$	$41.45^{a}\pm0.02^{c}$

ND= Not Detected; a =Means of triplicate sample; c =Standard deviation of triplicate samples

Discussion

This study is designed to evaluate essential minerals consumption in adolescent girls' diets in an urban community college. The table 2 above presented the results of the minerals analysis. Manganese contributes to tissue development and activates enzyme system. The foods have moderate amount of manganese; *Kunu Alkama da Gerou* contained highest manganese content with the value 87±0.02 mg/100g followed by *Shinkafa da Maijah* with 52±0.03 mg/100g. The elemental content was least appreciable in *Shinkafa da Wake* 25±0.02 mg/100g.

Copper contents were considerably high in the studied foods compared with the Recommended Daily Intakes, RDI of 3mg. Its contents of the dishes ranged from 21.15±0.03 to 31±0.02 mg/100g. *Kunu Alkama da Gerou* had the highest value of copper content.

Zinc has much influence on growing tissues and promoting a rapid healing of tissue (wound). Zinc contents obtained were highly appreciable in all studied foods within safe limit in the range 27.15±0.02 mg/100g in *Wake da Maijah* and 30.45±0.02 mg/100g in *Tuwon Gari da Miyan Alefou* respectively. The average zinc contents in the foods is more adequate in comparison with the recommended intakes, 15mg.

Iron contributes to transporting oxygen to the tissue by red blood cell hemoglobin and storing oxygen in protein myoglobin for working muscles. In these studied foods, iron contents were observed to be adequate in all the dishes. The Indian Council of Medical Research recommends 20 – 30mg in balanced diets, reported in FAO compilation for Africa, 2010. The iron contents range from 37±0.02mg/100g in *Shinkafa da Maijah* and 41.65±0.03mg/100g in *Kunu Alkama da Gerou*, followed by *Tuwon Gari da Miyan Alefou* with the value 41.45±0.02mg/100g. *Kunu Alkama da Gerou* highly contained appreciable amount of essential trace elements in all the analysed foods than other foods, except *Tuwon Gari da Miyan Alefou* in zinc contents. These findings when compared with what reported in (Salau, Ali Deba, & Jimoh, 2012; Salau, Ali Deba, Usman, & Alagba, 2012) reveals that the trace mineral contents, copper, manganese and iron of this study are more adequate in all the food samples except in zinc.

The mineral contents of the major elements were reported also in the table. Phosphorus contents was generally in appreciable level in virtually all the foods. The foods were all rich in phosphorus. *Tuwon Gari da Miyan Alefo* contained the least value with 546.30±0.04mg/100g and *Shinkafa da Wake* 540.80±0.07mg/100g. *Shinkafa da Maijah* and *Wake da Maijah* contained the highest values of 1380.30±0.15mg/100g and 2042±0.02mg/100g respectively. Phosphorus helps to prevent deficiencies like loss of weight, phosphate crickets and weakening of bone risks.

Magnesium has the second highest values predominantly in *Shinkafa da Wake* and *Shinkafa da Maijah* of 1143.40±0.04mg/100g and 1135.50±0.05mg/100g respectively. This shows the two are good sources of magnesium whereas the lowly least values of 28.60±0.10mg/100g and 36.41±0.03 were obtained for *Kunu Alkama da Gerou* and *Tuwon Gari da Miyan alefou* respectively. However, Salau, Ali Deba, & Jimoh, 2012 reported the levels of phosphorus and magnesium in traditional diets in Minna which are less adequate in ranges to what this study reveals.

Potassium helps to reduce risks of heart related diseases; high blood pressure and stroke. The levels of potassium in the studied foods were significantly low in all the foods analysed. The highest potassium content 372.90±0.08mg/100g was found in *Wake da Maijah* followed by *Shinkafa da Maijah* with value of 215.30±0.005mg/100g. *kunu Alkama da Gerou* reported the least value of 28.30±0.05mg/100g. The above findings were more adequate in mineral intakes of adolescent girls' diets compared to similar report of intakes by Ijarotimi, 2004.
Calcium contents reported in the studied foods were appreciably minimal. The lowest value was reported from *Shinkafa da Wake* with 25.00±0.33mg/100g and the highest value 78.60±0.33mg/100g was from *Kunu Alkama da Gerou*. The latter seemed to contain significantly low amounts of the major elements. This might result from the preparation process as nutritious contents regarded as 'shaft' must have been discarded. For effective impact the meal should be repeated or fortified with added minerals to account for the various elements impact.

Sodium contained in the foods were relatively low compared with the recommended values. *Wake da Maijah* recorded with highest value of 34.70±0.05mg/100g and the lowest value of 8.40±0.04mg/100g. However, repeated meals would need be administered for effective sodium impact.
The findings of this study, in relation to some specific mineral intake deficiencies in adolescent girls are similar to those of Ijarotimi, 2004. Though, more pronounced in this case. This has established in tandems with other reports that deficiencies of micronutrients are prominent causes of infections amid adolescents and children in developing nations (Bhaskaram, 2001; Maharaj et al., 2001) as well as its wrong intakes have resulted into lesser intellectual development and physical capability (FAO, Rome 2005; UNICEF, 2005) at their adulthood.

Conclusion and Recommendation

From results of mineral contents in the studied foods, it is obvious that essential trace elements are adequately represented in all the foods within safe level of the RDI specifications for female student-boarders in secondary schools. These proves the foods to be feasible substitutes to supplementation. And this eventually plays a vital role in the solution to mineral deficiency diseases from these trace metals; manganese, copper, zinc, and iron. The foods such as *Kunu Alkama da Gerou, Shinkafa da Maijah and Tuwon Gari da Miyan Alefou* to be valuable due to their rich in the studied mineral elements.

This study also has shown broad variation in available provisions for the level of calcium, sodium, magnesium, phosphorus and potassium, however. These elements are paramount in maintaining a good healthy living. Magnesium and phosphorus account for adequacy in most of the foods, especially *Shinkafa da Wake, Shinkafa da Maijah and Wake da Maijah* while other elements adequacy should be provided through multiple combination of foods and fortified meals. Thus, it is evident that the problem of malnutrition in these girls is obvious as the diets are deficient in these elements, suggesting that the studied college and respondents need urgent intervention. More studies on larger parameters and sample size which is based on relevant nutrition intakes and other factors; bioavailability, will give more information on noted deficiencies. It is therefore necessary that school management and parents be enlightened on the importance of nutritional adequacy in adolescent girls.

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