Research Article

Proximate, Minerals and Anti-nutritional Compositions of Three Vegetables Commonly Consumed in Ekiti State, Nigeria

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ABSTRACT

The leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* are popularly consumed in Ekiti State as well as other communities in the south western part of Nigeria. They were analyzed to determine proximate, minerals and anti-nutrients compositions. Data obtained showed protein content of 18.6, 19.2 and 18.0 % for *C. maxima, A. viridis and B. alba* respectively. Carbohydrates (47.8 – 51.3 %), crude fat (3.98 – 4.40 %), moisture (7.21-10.4 %) and ash (8.88-9.13 %) contents were within the range expected for dry leafy vegetables. The calorific values were 1320, 1257 and 1294 kJ/100g for *C. maxima, A. viridis and B. alba* respectively. Appreciable levels of essential and trace elements were observed in the samples. The Na/K ratio (0.541-0.602) were close to 0.6, the value that favours non-enhancement of high blood pressure disease in man. The Ca/Mg values obtained ranged between 1.14-1.34, whereas the recommended value is 1.0. The milliequivalent ratios of [K/(Ca+Mg)] (2.27-2.67) were slightly higher than 2.2 which means the sample would promote hypomagnesaemia in man. The anti-nutrients levels were below the established toxic levels in human foods. The study therefore revealed that the leaves of *C. maxima, A. viridis and B. alba* can serve as good sources of nutrients and minerals for human beings.

Keywords: Vegetables, proximate, minerals and anti-nutritional compositions.

INTRODUCTION

vegetables are known to be important sources of protective foods[1]. They have also been reported to be good sources of oil, carbohydrates, minerals as well as vitamins[2]. Edible oils from plant sources are of interest in various food and application industries. They provide characteristic flavours and texture to food as integral diet components[3] and can also serve as a source of oleo-chemicals[4]. The potassium content of leafy vegetables is good in the control of diuretic and hypertensive implications [5]. George[5] ascertained that the proteins in vegetables are superior to those in fruits but inferior to those in grains. Vegetable fats and oils are known to lower blood lipids thereby reducing the occurrence of diseases associated with damage of the coronary artery[2]. These plant products however, contain anti-nutrients that can affect the bioavailability of the certain nutrients[6]. They are known to interfere with metabolic processes such that growth and bioavailability of nutrients are adversely affected[7]. Phytate and oxalate have chelating ability especially with di- and tri-valent metallic ions such as Cd, Mg, Zn and Fe to form insoluble or poorly soluble complexes that are not readily absorbed from gastrointestinal tract, thus decreasing their bioavailability[8]. In addition, researchers have come up with the fact that some plant chemicals which have been regarded as anti-nutrients have potentials in helping to reduce the risk of several deadly diseases in man[9,10]. Reports showed that these phytochemicals reduce LDL (the cholesterol involved in depositing fat in the arteries)[11], prevent blood clotting which can reduce the risk of a heart attack or a stroke. Sulphur compounds which are examples of phytochemicals, are known also to reduce cholesterol production in the body and though that keep the blood pressure down[11]. They do these either by working alone or in combination of other nutrients in foods[6,9].

Green leafy vegetables constitute an indispensable component of human diets in Africa and west Africa in particular. It has been estimated that over 60 species of leafy vegetables are consumed in Nigeria alone[12], among these are *Cucurbita maxima, Amaranthus viridis and Basella alba*. *Amaranthus viridis L* is an erect, perennial broad leaf herb, commonly known as Tete (Yoruba: Nigeria), marissag shak nately in Bengali, Jangali chaulai in Hindi, widespread in tropical and sub-tropical regions of the world and in the upland rice, ususally found in well-drained soils, in openwaste places and cultivated lands. Traditionally, it is an edible plant whose parts have been found useful as antidote for snake bites (stem), scorpion stings (leaves) and often described as a good medicinal food being a potential source of flavonoids[25].

Basella alba belongs to the family *Basellaceae* and of the genus *Basella,* commonly called Indian spinach, climbing spinach, Asian spinach, Amunututu (Yoruba: Nigeria). It is perennial vine found in the tropics where it is widely used as a leafy vegetable. It is a fast-growing, soft- stemmed vine reaching up to 10 m in length. Its thick, semi-succulent, heart-shaped leaves have a mild flavour and mucilaginous texture. The stem of the cultivar *Basella alba* 'Rubra' is reddish-purple. *Basella* grows well under full sunlight in hot, humid climates and in areas lower than 500 m above sea level, native to tropical Asia .Growth is slow in low temperatures resulting in low yields. Flowering is induced during the short-day months of November to February. It grows best in sandy loam soils rich in organic matter with pH ranging from 5.5 to 8.0. The succulent mucilage is a particularly rich source of soluble fibre. Among many other possibilities, *Basella alba* may be used to thicken soups or stir-fries with gallic and chili peppers. The vegetable is used in Chinese cuisine while in Africa; the mucilaginous cooked shoots are commonly used. It has been shown to contain certain phenolic phytochemicals and antioxidants[26].

A pumpkin is a gourd-like squash of the genus *Cucurbita* and the family Cucurbitaceae (which also includes gourds). It commonly refers to cultivars of any one of the species *Cucurbita pepo*, *Cucurbita mixta*, *Cucurbita maxima*, and *Cucurbita moschata*. The pumpkin plant is a rambling vine that is grown for its familiar orange fruit. They have large, dark green leaves, orange trumpet-shaped flowers, and prickly hairs on the stems and leaves.

The fight against poverty, hunger, malnutrition and undernourishment continues to be a basic goal of development and a variety of strategies are being applied. Strategies-based micronutrients rich food like vegetables are considered essential because dark green vegetables have been recognized as one of the richest natural sources of riboflavin, vitamin A, ascorbic acid and minerals[13]. Many of such plants have been identified but lack of scientific data on their chemical compositions has limited the prospect of their utilization[12], *Cucurbita maxima, Amaranthus viridis and Basella alba* fall within the category of such plants. The three vegetables used in this work are popular among many communities in Ekiti State and other south- western states of Nigeria. For the well-being of the communities where these vegetables are consumed, one can better assess their importance by learning more about their nutritional and anti-nutritional status. This study was therefore designed to examine the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* for proximate, mineral compositions and anti-nutritional factors in order to provide information that can enhance their wider utilization.

MATERIAL AND METHODS

Collection and treatment of samples

The vegetable samples were randomly collected from different markets, both in Iworoko and Ado Ekiti metropolis, of Ekiti State, Nigeria in the month of August, 2012. The tender leaves were carefully plucked and air-dried after which the dried leaves were then grounded into fine powder using pestle and mortar and stored in a screw capped containers prior to analysis.

Determination of chemical constituent in the leafy vegetables

Chemical analyses of the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* were carried out to determine the protein, carbohydrate, lipid, fibre, ash and moisture content of each of them using Association of Analytical chemists (AOAC)[27]. Carbohydrate was determined by difference. The calorific value was determined by multiplying the nitrogen-free extract, protein and crude fat by the factors of 17, 17 and 37 respectively[31] and the results reported in kJ/100g sample.

Mineral content determination

The minerals were analysed from the solution obtained by first dry ashing the samples at 550°C. The filtered solutions were used to determine Na, K, Ca, Mg, Zn, Fe, Mn, Cu, Cr by means of atomic absorption spectrophotometer (Buck Scientific Model-200 A/210, Norwalk, Connecticut 06855) and phosphorus was determined colorimetrically by Spectronic 20 (Gallenkamp, UK) using the phosphovanado molybdate method[27]. All chemicals used were of British Drug House (BDH, London, UK) analytical grade. The detection limits for the metals in aqueous solution had been determined previously using the methods of Varian Techtron [38] giving the following values in µg/mL: Fe (0.01), Cu (0.002), Na (0.002), K (0.005). Ca (0.04), Mg (0.002), Zn (0.005), Mn (0.01), Cr (0.005). The optimal analytical range was 0.1-0.5 absorbance units with coefficients of variation from 0.9 % to 2.21 %.

Anti-nutritional factors

Determination of phytic acid and phytin phosphorus

4 g of the sample was soaked in 100ml 2% HCl for 3 hours and then filtered. 25ml of the filtrate was placed in a 100ml conical flask and 5ml of 0.03% NH_4SCN solution was added as indicator. 50ml of distilled water was added to give it the proper acidity (pH 4.5). This was titrated with ferric chloride solution which contained 0.005mg of Fe per ml of $FeCl_3$ used until a brownish yellow colour persisted for 5miuntes. Phytin phosphorus (Pp) was determined and the phytic acid content was calculated by multiplying the value of Pp by 3.55[37]. Each milligram of iron is equivalent to 1.19 mg of Pp.

Iron equivalence = titre value x 1.95.

Pp = **titre value × 1.95 × 1.19**

Therefore, phytic acid = **titre value x 1.95 x 1.19 x 3.55 mg**

$$\textbf{\% Phytic acid} = \frac{\textbf{titre value}}{\textbf{1000}} \times \frac{\textbf{8.24} \times \textbf{100}}{\textbf{Weight of sample}}$$

Phytin phosphorus as percentage of phosphorus (Pp % P) = Pp/P × 100

Determination of tannin

200mg of the sample was weighed into a 50ml sample bottle. 10ml of 70% aqueous acetone was added and properly covered. The bottles were put in an orbital shaker and shaken for 2 hours at 30^0C. Each solution was then centrifuged and the supernatant stored in ice. 0.2ml of each solution was pipetted into test tubes and 0.8ml of distilled water was added. Standard tannic acid solutions were prepared from a 0.5mg/ml stock and the solution made up to 1ml with distilled water.

0.5ml folin reagent was added to both sample and standard followed by 2.5ml of 20% Na_2CO_3. The solutions were then vortexed and allowed to incubate for 40 minutes at room temperature after which absorbance was red against a reagent blank concentration of the sample from a standard tannic acid curve[32].

Determination of oxalate

1g of the sample was weighed into 100ml conical flask. 75ml of $1.5NH_2SO_4$ was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 hour and then filtered using Whatman filter paper.

25ml of sample filtrate was collected and titrated hot (80-90^0C) against $0.1NKMnO_4$ solution to the point when a faint pink colour appeared that persisted for at least 30 seconds[33].

Determination of alkaloid

Alkaloid determination was carried out following the procedure of Harborne[34]. 5.0g of the sample was weighed into a 250ml beaker and 200ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4h. This was filtered and the extract was concentrated on a water bath to one quarter the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid which was dried and weighed.

Determination of saponin

The method used was that of Obadoni and Ochuko[35]. 5g of the sample was put into a conical flask and 100cm^3 of 20% aqueous ethanol were added. The sample was heated over a hot water bath for 4h with continuous stirring at about 55^0C. The mixture was filtered and the residue re-extracted with another 200ml 20% ethanol. The combined extracts were reduced to 40ml over water bath at about 90^0C. The concentrate was transferred into a 250ml separating funnel and 20ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated.

60ml n-butanol was added. The combined n-butanol extracts were washed twice with 10ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath after evaporation; the sample was dried in the oven to a constant weight. The saponin content was calculated as percentage.

Determination of flavonoid

The method of Boham and Kocipai-Abyazan[36] was followed in the determination of flavonoid. 5g of the sample was extracted repeatedly with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered through whatman filter paper (125ml). The filtrate was later transferred into a crucible and evaporated into dryness and weighed to a constant weight.

RESULTS AND DISCUSSION

The proximate compositions of the three vegetables as well as % of energy due to protein, carbohydrate and fat are shown in table 1. The result of the analysis showed averagely high content of protein (18.6, 19.2 and 18.0) for the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* respectively.

These values compared favourably with the values reported for *S.indicum* (18.59 %) and *B. aegypttiaca* (15.86 %)[12] but comparatively higher than the values reported for *A. hybridus* (4.60 %) and *T. occidentallis* (4.30 %) but lower than the value reported for *Cochorus olitoris* (27.4 %)[14,15]. The protein content in the present report were better than those reported by Abidemi et al.[16]. The ash content which is a measure of the mineral content of food ranged between 8.88 and 9.13 %. This range is comparably higher than those reported for some local vegetables by Agbaire and Emoyan[17] and Abidemi et al[18]. The crude fibre contents of the three vegetables were moderately high (9.46,9.57 and 8.93 % for *Cucurbita maxima, Amaranthus viridis and Basella alba* respectively). This implies that in the diet, the three vegetables will perform the role of promoting softer stool with increased frequency and regularity of elimination as characteristics of fibre-rich diets[12,19]. The lipids (fats) content of the vegetables (4.46, 3.98 and 4.38 % for *Cucurbita maxima, Amaranthus viridis and Basella alba* respectively), were comparably higher than those reported fo *S. indicum* (1.66 %) and *B. aegypttiaca* (2.90 %)[12] and 2.78 % (*F.asperifolia*) and 3.01 % (*F. sycomorous*)[20].

The carbohydrate contents (51.3, 47.8 and 50.5 % for *Cucurbita maxima, Amaranthus viridis and Basella alba* respectively) were comparably higher than the values reported for *S. indicum* and *B. aegypttiaca* (34.04 and 32.38 %) respectively[12], but favourably compared with the values reported for full- fat and defatted *Cassia fistula* seeds flour (49.80 and 53.44 %) respectively[25]. Ash, lipid and carbohydrate contents of the three vegetables were within the range expected for dry leafy vegetables [21].

The nutritionally important minerals content of the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* respectively are shown in table 2. Minerals are important in human nutrition. It is well known that enzymatic activities as well as electrolytic balance of the blood fluid are related to the adequacy of Na, K, Mg, and Zn. Potassium is very important in maintaining the body fluid volume and osmotic equilibrium. Metal deficiency syndrome like rickets and calcification of bones is caused by calcium deficiency. Sodium content in the samples ranged from 19.5 to 21.3 mg/100g. Potassium ranged from 32.4 – 38.5 mg/100g while calcium content ranged between 15.4 – 17.7 mg/100g. The vegetables were averagely high in phosphorus, (the range being between 65.77 and 72.34 mg/100g). These values were comparably higher than those reported for *F. asperifolia* and *F. sycomorous* [20]. The levels of potassium, sodium, calcium and magnesium were comparably higher than manganese and copper levels. For normal retention of protein during growth and for balancing fluid, a K/ Na ratio of 1 is recommended[22].

Calculated mineral ratios were also shown in Table 2. The Ca/P was comparably lower than 0.5 which is the minimum ratio required for favourable calcium absorption in the intestine for bone formation[28]. The level of Ca/P is reported to have some effects on Ca in the blood of many animals[29]. The Na/K ratio was lower than 0.6, the value that favours non-enhancement of high blood pressure disease in man. For normal retention of protein during growth and for balancing metabolic fluid, a K/Na ratio of 1.0 is recommended[22]. The high K/Na ratio obtained for the testa flour suggests that bringing the ratio down would require the consumption of food sources rich in Na. The Ca/Mg values obtained ranged between 1.14-1.34, whereas the recommended value is 1.0. Both Ca and Mg would need adjustment for good health. The milliequivalent ratios of [K/(Ca+Mg)] (2.27-2.67) were slightly higher than 2.2 which means the sample would promote hypomagnesaemia in man.[23,30]. To avoid this health problem, Ca and Mg would need to be adjusted or could be accompanied by salting with Nacl to enhance balance of body fluids. Its consumption without salting with Nacl may lead to mineral imbalance in those fed solely on it[23].

Iron and zinc are among the required elements for humans and their daily requirements for adults are 10 and 15 mg respectively. Levels of iron in the vegetables were comparatively low but compared favourably with those reported for *F. asperifolia* and *F. sycomorous*[20]. However, the zinc requirement can easily be met by consuming the vegetables based on the levels obtained in the samples (17.7 – 20.3 mg/100g).Generally, based on the recommendations set out by NRC/NAS[23], the daily Zn, Fe and Mn requirements can easily be met while the diets may need to be supplemented with food materials high in K, P, Na, Mg and Ca. Iron, magnesium and calcium deficiencies can lead to abnormal bone development and anemia. Their presence in these vegetables is therefore advantageous. Though the levels of some of these elements are low, their consumption will help to alleviate symptoms of magnesium and zinc deficiency such as weakness, cardiac arrhythmia, poor growth, impairment of sexual development and poor wound healing often observed in the study area where majority are alcoholics[20].The anti-nutrient contents of the vegetables are listed in table 3. These are compounds that limit the wide use of many plants due to their ubiquitous occurrence as natural compounds capable of eliciting deleterious effect in man and animals[6,12].

The anti-nutritional factors: oxalate, tannin, saponin, phytate, alkaloids, phenolics and flavonoids were present in varying amounts in these vegetables. These anti-nutrients tend to bind to mineral elements thereby forming indigestible complex and in turn render unavailable the elements for biological function.Oxalate for instance, tends to render calcium ions in form of complexes (Calcium oxalate crystals) and prevent the absorption of and utilization of calcium and may also precipitate around the renal tubules thereby causing renal stones[20,24]. In general, the levels of anti-nutrients in the vegetables were comparatively low to significantly interfere with nutrient utilization. They are below the established toxic levels[20].

CONCLUSION

In conclusion, the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* consumed in in Ekiti State, Nigeria contain substantial levels of nutrients and could contribute useful amount to human diet. The mineral composition of these non-conventional leafy vegetables also showed that they could be rich sources of minerals. The anti-nutritional factors levels of the three vegetables are below the established toxic levels and this implies that the overall nutritional values of the vegetables will not be affected. The study therefore revealed that these vegetables which are largely consumed be the local communities in Ekiti State is not inferior to the conventional popular vegetables in Nigeria. Understandably, nutrient loss is of great concern during blanching and cooking of vegetables therefore, there is need to study the effects of cooking and processing procedures on nutrient availability of the vegetables, this will help to adequately establish their importance in human nutrition and provide basis for maximum utilization.

Table 1: Proximate compositions and energy distributions of the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* (dry weight)

Parameters	*Cucurbita maxima*	*Amaranthus viridis*	*Basella alba*	Mean	SD	CV%
Ash (%)	8.95	9.13	8.88	8.99	0.129	1.43
Moisture (%)	7.21	10.4	9.32	8.98	1.62	18.1
Crude protein (%)	18.6	19.2	18.0	18.6	0.600	3.23
Fat (%)	4.46	3.98	4.38	4.27	0.257	6.02
Crude fibre (%)	9.46	9.57	8.93	9.32	0.342	3.67
CHO (%)	51.3	47.8	50.5	49.9	1.83	3.68
PEF (%)	10.0	9.39	10.3	9.90	0.464	4.68
PEC (%)	66.1	64.6	66.4	65.7	0.964	1.47
PEP (%)	24.0	26.1	23.6	24.6	1.34	5.46
UEDP (%)	14.4	15.6	14.1	14.7	0.794	5.40
Energy kJ/100g	1320	1257	1294	1290	31.7	2.45

PEF = Proportion of total Energy due to Fat, PEC = Proportion of total Energy due to Carbohydrate, PEP = Proportion of total Energy due to Protein, UEDP = Utilizable Energy due to protein, SD = Standard Deviation, CV = Coefficient of Variation.

Table 2: Minerals compositions (mg/100g) of the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* (dry weight)

Minerals	*Cucurbita maxima*	*Amaranthus viridis*	*Basella alba*	Mean	SD	CV%
Na	19.5	21.3	20.4	20.4	0.900	4.41
K	32.4	38.5	37.7	36.2	3.32	9.17
Ca	15.4	16.4	17.7	16.5	1.15	6.97
Mg	11.5	12.4	15.5	13.1	2.10	16.0
Zn	17.7	20.3	18.5	18.8	1.33	7.07
Fe	5.22	5.31	6.24	5.59	0.560	10.0
Pb	<0.001	<0.001	<0.001	0.001	0.00	0.00
Cd	<0.001	<0.001	<0.001	0.001	0.00	0.00
Mn	5.60	4.96	5.37	5.31	0.320	6.03
Cu	0.370	0.410	0.390	0.390	0.020	5.13
P	65.8	72.3	69.6	69.2	3.30	4.77
Na/K	0.602	0.553	0.541	0.570	0.030	5.26
Ca/Mg	1.34	1.32	1.14	1.27	0.110	8.66
K/Na	1.66	1.81	1.85	1.77	0.100	5.65
(K/(Ca+Mg)*	2.41	2.67	2.27	2.45	0.200	8.16
Ca/P	0.234	0.227	0.254	0.238	0.014	5.89

*milliequivalent ratio

Table 3: Levels of anti-nutritional factors in the leaves of *Cucurbita maxima, Amaranthus viridis and Basella alba* (dry weight)

Anti-nutrients	*Cucurbita maxima*	*Amaranthus viridis*	*Basella alba*	Mean	SD	CV%
Tannin (mg/100g)	0.220	0.240	0.320	0.260	0.050	19.2
Phytate (mg/100g)	10.30	6.36	4.53	7.06	2.95	41.8
Phenolic (mg/100g)	0.150	0.160	0.200	0.170	0.030	17.6
Phytin Phosphorus (mg/100g)	2.90	1.80	1.28	1.99	0.830	41.7
Oxalate (mg/100g)	1.42	1.33	1.85	1.53	0.280	18.3
Saponin (%)	0.850	0.880	1.00	0.910	0.080	8.79
Flavonoid (%)	0.500	0.480	0.530	0.500	0.030	6.00

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