Proximate and Anti -Nutritional Properties of Four Forms ofthegenusBasella (Basellaceae) in South-western, Nigeria

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Abstract

Background

Three species and a land race of the Genus *Basella* Linn. namely; *Basella alba, Basella cordifolia, Basella rubra* and *Basella alba* round exist in Nigeria. All the members are consumed as leafy vegetables. The aim of this study is to find out which of the *Basella* forms is more nutritious and the levels of the ant-nutritional components. Results from this study will add to our knowledge of the *Basella* species and also form the basis for recommendations to be made to farmers on the species to increase its cultivation and consumption.

Methods

They were evaluated for the percentage proximate, Vitamins and anti-nutritional properties using Standard methods of the Association of Official Analytical Chemists.

Results

The concentrations of the proximate, anti-nutritional and vitamin constituents varied among the species and the land race. *B. alba* had the highest moisture (98.00 ± 0.01%), crude fibre (0.59 ± 1.01%) and Ash (33.39 ± 2.11%) contents. *B. rubra* had the highest protein (3.64 ± 0.01%) and Vitamin E (0.50 ± 0.02%). *B. cordifolia* had the highest fat content (0.68 ± 1.03%). the species had Vitamin B1 content (2.00 ± 0.02%) except *B. alba* round (1.50 ± 0.02%). The percentage of proximate, Vitamins B2 and E contents were within required limits and are excellent sources of Vitamins.

Conclusion

The anti-nutrients were within the safe limits. Cyanide and Mercury were not detected in all the forms. All the vegetables can be planted and consumed depending on the need of the consumers.

Introduction

Basella commonly referred as Indian spinach, Ceylon spinach or red vine e.t.c is a traditional vegetable among the Yorubas in Nigeria and it is referred to as Amunututu. (1) reported that *Basella* is a momotypic genus consisting of *B. alba* (synonym *B. rubra*). Farmers and consumers recognise two types of *Basella* based on the presence and absence of purple/ red pigmemt on the stems and leaves. They are generally referred to as *B. alba* and *B. rubra. B. alba* are those with dark green oval or almost round leaves having green stems while *B. rubra* are those with purple oval leaves and purple stems. However one other species and a land race has been reported (2) which are *B. cordifolia* and *B. alba* round. All the four species are vines and are used as leafy vegetables. The ethno-botanical uses of members of the genus are well documented but information on the nutritional and anti-nutritional components are limited. Some authors such (3) and (4) reported on some aspects of the nutritional components of *B. alba* and *B. rubra*. Unfortunately these reports are not comprehensive due to lack of information on *B. cordifolia* and *B. alba* round.

In view of the multiple uses in folk medicine, there is the need for a comparative study of the proximate, vitamins and anti-nutritional elements of the species of *Basella* and a form from the South west, Nigeria. The aim of this study is to find out which of the *Basella* forms is more nutritious and the levels of the ant-nutritional components in each of the species and the land race. Results from this study will

i. Add to the knowledge of *Basella* in Nigeria and
ii. Form the basis of recommendations to be made to farmers on the species to increase its cultivation and that which consumers should take.

Methods and materials

Crude fat determination (5)

One-gram of each dried sample was weighed into fat free extraction thimble and plugged lightly with cotton wool. The thimble was placed in the extractor and fitted up with reflux condenser and a 250ml soxhlet flask which has been previously dried in the oven, cooled in the desiccators and weighed. The soxhlet flask was then filled to $^{3}/_{4}$ of its volume with petroleum ether (boiling point, 40º – 60ºC). Extractor plus condenser set was placed on the heater. The heater was put on for six hours with constant running water from the tap for condensation of ether vapour. The set was constantly watched for ether leaks and the heat source was adjusted appropriately for the ether to boil gently. The ether was left to siphon over several times (at least 10–12 times) until it was short of siphoning. It was after this was noticed that ether content of the extractor was carefully drained into the ether stock bottle. The thimble containing sample was then removed and dried on a clock glass on the bench top. The extractor, flask and condenser were replaced and the distillation continued until the flask was practically dry. The flask which now contained the fat or oil was detached, its exterior cleaned and dried to a constant weight in the oven.

The initial weight of dry soxhlet flask was W_o and the final weight of oven dried flask + fat was W_1. Percentage fat was obtained by the formula:

$$\frac{W_1 - W_o}{\text{Weight of Sample}} \times 100$$

Determination of Fibre (AOAC 958.06)

Two-gram of the sample was put into the fibre flask and 100 mL of 0.255 N Tetraoxosulphate (VI) acid (H_2SO_4) added. The mixture was heated under reflux for 1h with the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100 mL of 0.313 N Sodium hydroxide (NaOH) was added and heated under reflux for another one hour. The mixture was filtered through a fibre sieve cloth and 10 mL of acetone added to dissolve any organic constituent. The residue was washed with about 50 mL hot water on the sieve cloth before it was finally transferred into the crucible. The crucible and the residue were oven-dried at 105ºC overnight to drive off moisture. The oven-dried crucible containing the residue was cooled in a dessiccator and later weighed to obtain the weight W_1. The crucible with weight W_1 was transferred to the muffle furnace for ashing at 550°C for 4h.The crucible containing white or grey ash (free of carbonaceous material) was cooled in the dessiccator and weight to obtain W_2. The difference W_1- W_2 gives the weight of fibre. The percentage fibre was obtained by the formula:

$$\% \text{ Fibre} = \frac{W_1 - W_2}{\text{Weight of sample}} \times 100$$

Determination of Ash (AOAC official method 942.05)

Two-gram each of the samples were weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550ºC and left for about 4h. About this time it had turned to white ash. The crucible and its content were cooled to about 100 ºC in air, then room temperature in a dessiccator and weighed. This was done in triplicate. The percentage ash was calculated from the formula below:

$$\text{Ash content} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of Crude protein.

Ground dried samples of mature leaves; 0.5g of each form of *Basella* was weighed and poured in Kjeldahl digestion tube. 10 ml of concentrated Tetraoxosulphate (VI) acid and Kjeldahl tablets were added to each tube. The samples were digested in a heater placed inside a fume chamber for about 1–2 ½ hours until a clear homogenous mixture was obtained. On cooling, 50 ml of distilled water were added to the contents of the tubes. The tubes were later put in micro Kjeldahl analyses tubes for distillation together with boric acid in the distillation flask. The content of the tube were titrated against 0.1 M Hydrochloric acid to determine the percentage nitrogen which was later multiplied by a conversion factor of 6.25 to obtain the crude protein present.

Determination of Thiamine or Vitamin B_2

Thiamine or Vitamin B_1 was determined using the method of (5). Five gram (5 g) each of the samples of the four types of *Basella*, were homogenized with 50 ml of ethanoic Sodium hydroxide. This was filtered into100 ml flask. Ten milliliter (10 mL) of the filtrate was pipetted into a 100 ml flask and 10 ml of

Potassium dichromate was added, a colour developed and the absorbance was read at 360 nm. A blank was prepared and the colour also developed and the absorbance was read at the same wavelength.

Determination of Tocophenol or Vitamin E

Vitamin E was determined by the official methods of the Association of Official Analytical Chemists (5). One gram (1 g) each of the samples of the four type of *Basella*, were weighed and then macerated with 20 mL of n-hexane in a test tube for 10 min and centrifuged for 10min. The solution was filtered; 3 mL of the filtrate was transferred into a dry test tube in duplicates and evaporated to dryness in boiling water bath. Following this, 2 mls of 0.5N alcoholic potassium hydroxide were added and boiled for 30 minutes in water bath. Then 3 mL of n-hexane was added and then shaken vigorously. The n-hexane was transferred into another set of test tubes and evaporated to dryness. A volume, 2 mL of ethanol was added to the residue. Another volume, 1 ml of 0.2% ferric chloride in ethanol was added. Then 1 mL of 0.5% α^1 α^1-dipyridyl in ethanol was added followed by the addition of 1 mL of ethanol to make up to 5 ml. The solution was mixed and absorbance taken at 520 nm against the blank.

Determination of Cyanide

Fifteen gram of each form of the vegetables were weighed into 1000 mL flask and 200 mL of distilled water was added and allowed to stand for four h. The resulting mixture was vacuum distilled and the distillate collected in 20ml of 0.5 M Sodium hydroxide (NaOH) solution. The HCN content of the samples was determined using the alkaline titration method of Association of Official Analytical Chemists (5). The distillate was diluted to 250 mL and an aliquot of 100 ml was titrated by adding 8 ml of 6 N Ammonium hydroxide (NH_4OH) solution and 2 mL of 5% Potassium iodide (KI) solution. This was then titrated against 0.02N Silver nitrate ($AgNO_3$) solution to get a light turbid end point. The titre values were then used to calculate the cyanide concentration in mg HCN/ kg.

Note

1 mL of 0.02N Silver nitrate ($AgNO_3$) = 1.08 mg HCN.

Determination of Oxalate

Total oxalate was determined according to the Day and Underwood (1986) procedure. To one (1) gram of the ground powder, 75 mL of 15 N Tetraoxosulphate (VI) acid (H_2SO_4) was added. The solution was carefully stirred intermittently with a magnetic stirrer for one hour and filtered using Whatman 1 filter paper. Then 25 mL of the filtrate was pipetted into a flask and titrated against 0.1 N Potassium permanganate ($KMnO_4$) solutions until a faint pink colour appeared and persisted for 30 seconds.

Determination of Phytate

Phytate was determined using the method described by (5). Four gram of the ground powder was soaked in 100 ml of 2% hydrochloric acid (HCL) for five hours and filtered. To 25 ml of the filtrate, 5 ml of 0.03%

Ammonium thiocyanate (NH_4SCN) solution was added. The mixture was filtered with Iron III chloride solution until a brownish – yellow colour that persisted for 5 minutes was obtained. Phytate (mg/ 100g) was calculated thus:

$$\text{Phytate} = \frac{\text{T x molarity of ferric chloride x volume of HCL}}{\text{Weight of sample x Aliquot taken}}$$

Where T is Titre value blank sample

Results

The proximate compositions of the four forms of *Basella* revealed the moisture content, crude fibre, fat, protein, ash and the vitamin contents of the vegetables (Table 1, and Fig. 1).

Table 1
Proximate Analysis of the Four Forms of *Basella* (%)

Vegetables	**Proximate parameters**						
	Moisture	CrudeFibre	Fat	Protein	Ash	Vitamin B2	Vitamin E
B. rubra	86.50 ± 0.01	4.50 ± 0.21	0.43 ± 1.01	3.64 ± 0.01	19.27 ± 2.00	2.0 ± 0.03	0.5 ± 0.02
B. alba	98.00 ± 0.01	11.26 ± 1.01	0.59 ± 1.01	0.86 ± 1.00	33.39 ± 2.11	2.0 ± 0.02	0.1 ± 0.01
B.cordifolia	95.00 ± 0.01	4.47 ± 0.21	0.68 ± 1.03	3.00 ± 1.00	17.27 ± 1.15	2.0 ± 0.02	0.1 ± 0.01
B.alba round	91.30 ± 0.01	8.10 ± 0.23	0.04 ± 0.03	2.64 ± 1.00	21.22 ± 2.01	1.5 ± 0.02	0.3 ± 0.10

Moisture content

Moisture content of the four forms of *Basella* was between 86.5–98%. *B. alba* round had 91.30% moisture content, *B. alba*, 98.00%; *B. cordifolia*, 95.00% and *B. rubra*, 86.50

Crude fibre

The percentage crude fibre range is 4.47–11.26. The crude fibre content of *B. rubra* is 4.50%, *B. cordifolia* (4.47%), *B. alba* (11.26%), *B. alba* round, 8.10%. *B. alba* form has the highest while crude *B. cordifolia* had the least (4.47%).

Fat

The percentage fat for the vegetables ranged from 0.04–0.68%. The least % Fat occurs in *B. alba* round form, 0.04% and the highest in *B. cordifolia* 0.68%. *B. alba* had 0.59% Fat, while *B. rubra*, had 0.43%.

Protein

Protein content of the vegetables ranges from 0.86–3.64%. *B. alba* has the least protein content (0.86%).The protein content of *B. rubra* is 3.64%, *B. alba* round, 2.64%, *B. cordifolia* is 3.00%.

Ash

The Ash content of the vegetables studied ranged from 17.27–33.39%. *B. cordifolia* had the least Ash content (17.27%). *B. rubra* had 19.27%, *B. alba* round, 21.22% and *B. alba* had the highest (33.39%). The proximate contents of the vegetables vary significantly in the percentage

Vitamin contents of the vegetables

The range of value for Vitamin B2 is 1.5 ± 0.02–2.0 ± 0.03 mg/kg. *B. rubra* had 2.0 ± 0.03 mg/kg, *B. alba* had 2.0 ± 0.02 mg/kg, *B. cordifolia* had 2.0 ± 0.02 mg/kg while *B. alba* round had 1.5 ± 0.02 mg/kg. There is little difference in the vitamin B2 contents of the four vegetables. The range of value for Vitamin E is 0.10 ± 0.01–0.50 ± 0.02 mg/kg. *B. rubra* had 0.50 ± 0.02 mg/kg, *B. alba* had 0.10 ± 0.01 mg/kg, *B. cordifolia* had 0.10 ± 0.01 mg/kg while *B. alba* round had 0.30 ± 0.10 mg/kg. *B. rubra* had the highest Vitamin E content

Anti-nutritional elements

Table 2 and Fig. 2 showed the anti-nutritional elements analysed for in the vegetables studied. These anti-nutritional substances evaluated are mercury, cyanide, protease inhibitor, oxalates, and phatates. Mercury and cyanide were absent in all vegetables studied. The range of value of oxalate in the vegetables is 155.00 ± 2–250.00 ± 4 mg/kg. The highest value of oxalate was found in *B. cordifolia*, 250 ± 4 mg/kg, the least value of oxalate is found in *B. alba* had 217.50 ± 3 mg/kg; *B. alba* round had 235.00 ± 2 mg/kg and *B. rubra* had 245.00 ± 4 mg/kg. Protease inhibitor in *B. rubra* and *B. cordifolia* are 1.00 ± 0.01 mg/kg each. Protease inhibitor was absent in *B. alba* and *B. alba* round. Phatate range of value is 102.50 ± 0.02 mg/kg in *B. cordifolia*. *B. alba* had125.00 ± 0.02 mg/kg, *B. rubra* had 160.00 ± 0.02 mg/kg and 135.00 ± 0.03 in *B. alba* round. T-test showed that there are significant differences ($P < 0.05$) in oxalate, protease inhibitor, and phytate components of the vegetables.

Table 2
Vitamins and Anti Nutritional Elements Analyzed for in the Vegetables (mg/ kg)

Basellaforms	Oxalate	Cyanide	Phatates	Mercury	Vitamin B1	Vitamin E
B. rubra	245.00 ± 4	ND	160.00 ± 0.02	ND	2.0 ± 0.03	0.5 ± 0.02
B. alba	217.50 ± 3	ND	125.00 ± 0.02	ND	2.0 ± 0.02	0.1 ± 0.01
B.cordifolia	250.00 ± 4	ND	102.50 ± 0.02	ND	2.0 ± 0.02	0.1 ± 0.01
B.alba round	235.00 ± 2	ND	135.00 ± 0.03	ND	1.5 ± 0.02	0.3 ± 0.10

Legend: ND – Not detected

Discussion

The moisture contents of the four forms of *Basella* studied ranged from 86.5 ± 0.01–98 ± 0.01%. The study is in consonant with the report of (6) that reported the moisture content of 93.4% for *B. rubra*. T-test also shows that there is a significant difference in the moisture contents of the *Basella* forms. High moisture content in the *Basella* forms has resulted from the succulent nature of the leaves and this may prevent their storage for a long period. High moisture content reduces the shelf life of vegetables. (7) and (8) reported that high moisture content in vegetables indicate higher chances of microbial degradation during storage. However the high moisture content of the vegetables has its advantage in that it may be responsible for the use of *Basella* in traditional herbal preparations. (9) and (10) noted that the high moisture content in vegetables provide for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities of these leafy vegetables .

The crude fibre of the four forms of *Basella* ranged from 4.47–11.2%. *B. alba* had the highest percentage of crude fibre (11.26%) while *B. cordifolia* had the least (4.47%). Crude fibres vary significantly among the four forms of *Basella* studied. (10) reported that *Basella* has 6.05% crude fibre. (6) reported 0.6% fibre content for *Basella rubra*. (9). (10) reported 8.50–20.90% crude fibre content for some Nigerian vegetables; thus the value of crude fibre recorded in this study falls within the range reported by (10) except in *B. cordifolia* that has the value 4.47% crude fibre content. Fibres cleanse the digestive tract by removing potential carcinogens from the body and prevent the absorption of excess cholesterol (6). Fibres also add bulk to food and prevent the intake of excess starchy food, enhance gastro-intestinal function, prevent constipation and may guard against metabolic conditions such as hypercholesterolemia and diabetes mellitus (11). Fibres have been described as an antioxidant because they act as chelating agents (12). (13) noted that dietary fibre is inversely associated with the 1, 1-diphenyl-2- picryhydrazl (DPPH) radical scavenging activity. They explained that the main antioxidant mechanism of dietary fibre is as a chelating agent and another mechanism is free radical scavenging due to some polyphenols which are associated with dietary fibres. The percentage fat content of the *Basella* ranged from 0.04 ± 0.03% in *B. alba* round and 0.68 ± 1.01% in *B. cordifolia*. The fat content of *B. alba* is 0.59 ± 1.03% and *B. rubra* has 0.43 ± 1.01%. The four forms of *Basella* vary significantly in their fat contents. Comparative studies of the fat contents of the *Basella*, vary significantly in their fat content at $p < 0.05$. The vegetables have low fat content thus they could be recommended to obese persons who do not need excess fat. (14) reported that fat help with brain function, joint mobilization and even energy production. They also help the body to absorb fat soluble vitamins such as Vitamins A and E. The percentage protein content of the *Basella* forms ranged from 0.86 ± 1.00% in *B. cordifolia* and 3.64 ± 0.01% in *B. rubra*. *B. cordifola* protein content is 3.00 ± 1.00 while *B. alba* round had 2.64 ± 1.00%. The protein contents were very low in all the *Basella* forms. This confirmed the report of (6) who reported 1.6mg/100g in *B. rubra*. The four forms of *Basella* vary significantly at $p < 0.05$. (15) Comparative studies of the protein contents of the four forms of *Basella*, vary significantly in their protein contents at $p < 0.05$. Although the protein contents of the vegetables studied were low, they contribute to protein intake in the diet even though the report of (15) noted that plants food that provide more than 12% of their calorie values from proteins are good sources of protein. The antioxidant properties of proteins have been reported by (16). According to them proteins owe their antioxidant properties to their constituent amino acids which act on the free radicals by chelating metal ions. The presence of proteins in the vegetables studied indicate that they are supplementary sources of proteins in households that cannot afford expensive protein sources and the antioxidant properties of the extracts of the vegetables make them to be useful in herbal preparations. The percentage Ash contents of the *Basella* ranged from 17.27 ± 2.11% in *B. cordifolia* and 33.39 ± 1.15% *B. alba* that is the highest. *B. rubra* had 19.27 ± 2.00 while *B. alba* round had 21.33 ± 2.01%. Among the *Basella*, *B. alba* had the highest ash content (33.30 ± 1.15%). The four *Basella* vary significantly in their ash contents at $p < 0.05$. Ash contents of the vegetables used in this study is higher those reported (6, 9, 12) noted that there is a negative correlation between ash and antioxidant properties because ash contains heavy metals (including iron) and minerals which act as prooxidants. This study revealed that proximate analysis of plant materials could give additional evidences on the taxonomic relationship between plant groups.

Anti-nutritional elements

Vegetables contain both essential and toxic elements over a wide range of concentrations and concentration of these elements is a function of the concentration in the soil in which the vegetables were planted (11). (17) noted that the presence of substances in plants which may be harmful to consumers is dependent on environmental conditions; crop fertilization, age, post-harvest handling and methods of preparation. Green leafy vegetables apart from being fair sources of proteins and good sources of vitamins and minerals but some contain anti-nutrients that interfere with the absorption of some nutrients in the diet (18). These anti-nutritional elements include compounds like phytic acid, oxalates, pro-anthrocyanin, tannin and dietary fibre which reduce the bio availability of the nutrients (19). However, (20) reported that anti-nutritional phytochemicals exhibit protective effects thus making them to serve dual purpose of reducing some essential nutrients and protecting the body against a number of biochemical, physiological and metabolic disorder.

The vegetables under study were evaluated for the presence of anti-nutritional substances. Mercury and cyanide were not detected in the four forms of *Basella*, oxalates, protease inhibitors and phatates were however detected.

The occurrence of cyanides in a number of vegetables was reported (18; 21). (20) reported cyanide contents of *B. alba* and 5.04 ± 0.20 mg HCN/kg and 5.37 mg HCN/kg respectively. In this study cyanide was not detected in all the vegetables studied, despite the estimated maximum sub-lethal dose of cyanide: 20 mgHCN/kg (22; 23) and the vegetables are further processed (cooking, steaming, heating, boiling) before consumption, the cyanide levels could be reduced (24) in case there are traces of cyanide.

Oxalate value ranged from 217.50 mg/kg in *B. alba* to 250.00mg/kg in *B. cordifolia, B. alba* round has 235 mg/kg and *B. rubra* has 245 mg/kg .The oxalate content of the four forms of *Basella* varies significantly at $p < 0.05$. Oxalates are known to vary widely in leafy vegetables and this variation in the level of oxalates have been attributed to genetic, environmental, plant part collected and its growth stage as well as the method of analysis (25). (26) reported that higher soil fertility resulted in increased oxalate in *Basella*. This assertion suggests that the concentration of oxalate in plant body is dependent on the oxalate present in the soil. Oxalate chelate bivalent minerals such as calcium and iron. This has serious negative effects on health, particularly vulnerable groups, viz, children, pregnant women and lactating mothers that require more iron and calcium (25). (27) reported that Oxalate tends to render calcium unavailable by binding to the calcium ion to form complexes; this prevents the absorption and utilization of calcium by the body thereby causing diseases such as ricket and ostemalacia. (28) also noted that calcium crystals may also precipitate around renal tubules causing renal stones.

Enzyme inhibitors are widely distributed in plant and animal tissues. Trypsin inhibitors are directed towards trypsin. Chymotrypsin inhibitors are capable of inhibiting trypsin as well as chymotrypsin at independent binding sites (29).

Phatates value ranged from 102 mg/kg in *B. cordifolia* to 160 mg/kg in *B. rubra*. *B. alba*had 125 ± 0.02 mg/kg while *B. alba* round had 135 ± 0.03 mg/kg. The phatates content of the four forms of *Basella* varies significantly at $p < 0.05$. Phytic acid is an organic acid found in plant materials and it combines with some essential elements such as iron, calcium, zinc and phosphorous to form salts called phytates which are not absorbed by the body thereby reducing the bioavailability of these elements (27) These results in anaemia and other mineral deficiency disorders, (30). Phytate is also associated with nutritional diseases such as rickets and osteomalacia in children and adults (31). One sample T-test shows that there are significant differences ($P < 0.05$) in oxalate and phytate components of the vegetables.

Vitamins

The four forms of *Basella* contained B2 or thiamine and E. Vitamin B2value ranged from 1.5 ± 0.02 mg/kg in *B. alba* to 2.0 ± 0.02 mg/kg in *B. alba* round. Vitamin B2 value is 2.0 ± 0.03 mg/kg in *B. rubra* and 2.0 ± 0.02 mg/kg in *B. cordifolia*. Vitamin B_1 content of the *Basella* varies significantly among the four forms at $p < 0.05$.

Vitamin E value ranged from 0.10 ± 0.01 mg/kg in *B. cordifolia* and *B. alba* to 0.50 ± 0.02mg/kg in *B. rubra*. Vitamin E contents of *B. alba* round is 0.30 ± 0.1. Vitamin E content of the *Basella* varies significantly among the four forms at $p < 0.05$. (32) described Vitamin E as a major antioxidant in the cell membrane and its presence interrupts the chain reaction of lipid peroxidation by reacting with lipid peroxyl damage. Vitamin E protects the membrane from oxidation by reacting with radical intermediates and prevents the propagation from continuing. Vitamins B2 and E were present in the vegetables studied in varied concentrations.

Conclusion

The vegetables have sufficient proximate and vitamin compositions that make them nutritious and minimal anti-nutritional elements that can not pose health challenges to consumers. The forms vary significantly in their proximate, vitamins compositions and anti-nutritional elements and that depending on the consumers' needs, farmers can cultivate any of the forms. *B. alba* will be more useful as diuretic because of its high moisture content. *B. rubra* can be planted for its protein and Vitamin E while *B. cordifolia* can be cultivated essentially for fat and other macro molecules when the other forms are not available. *B. alba* round is generally low in all the macromolecules examined and can be planted or consumed when other forms are not available. Cyanides and mercury were absent in all the forms as well as insignificant concentrations of phytates and oxalates. The study also revealed that the soils that the vegetables were planted were free from contaminants. Thus there is the need to ensure that the soil does not have toxic substances in them so that the vegetables sown in them will be good for eating.

Declarations

Declaration of Competing Interest

The authors declare that there are no known competing financial interests or personal relationship that could have appeared to influence the work reported in this article

Author Contribution

Both authors did the collections, preparation of samples and made payments for the analysis and also worked on the manuscript writing

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References

1. Hutchinson J, Dalziel JM. Flora of West Tropical Africa. Published on behalf of the Government of Nigeria, Ghana, Sierra Leone and the Gambia by the Crown Agents for Oversea Governments and Administration Millibank London, S.W.1, 1958, Vol. 1: 155.
2. Adenegan TA. Taxonomic evaluation and ethno-botanical studies of the Genus *Basella* Linn. (Basellaceae) in South western, Nigeria. *Unpublished Ph.D. Thesis 2014*. Submitted to the Department of Botany, Obafemi Awolowo University, Ile – Ife, Nigeria.
3. Palada MC, Chang LC. Suggested Cultural Practices for *Basella.* Published by International Cooperators' Guide. Asian Vegetable Research and Development Centre; May 2003.
4. Roy SK, Gangopadhyay, Mukherjee KK. Is stem twinning forms of *B. alba* Linn. a naturally occurring variant. Curr Sci. 2010;98(10):1370–5.
5. AOAC. Official Methods of Analysis 11th edition.Washington, D.C: Association of Official Analytical Chemists, 1990.
6. Mensah JK, Okoli RI, Ohaju-Obodo JO, Eifediyi K. Phytochemical, nutritional and medicinal properties of some leafy vegetables consumed by Edo people of Nigeria. Afr J Biotechnol, Vol. 7 (14), pp 2304–9, 18th July, 2008.
7. British Pharmacopoeia. Published on the recommendation of the Medicines Commission. Printed in England for her Majesty Stationary Office at the University Press, Cambridge., 1980; UK. 2, 561 pp.
8. Edwards CH, Booker LK, Rumph CH, Wright WG, Ganapathy SN. Utilization of wheat by adult man: Nitrogen metabolism, plasma amino acids and lipids. Am J Cli Nutri. 1971;24:181–93.
9. Asaolu SS, Adefemi OS, Oyakilome IG, Ajibulu KE, Asaolu MF. Proximate and mineral composition of Nigeria leafy vegetables. J Food Res. 2012;1(3):0887–95.
10. Iheanacho K, Udebuani AC. Nutritional composition of some leafy vegetables consumed in Imo State. Nigeria J Appl Sci Environ Manage. 2009;13(3):35–8.
11. Isong E, Idiong G. Nutrient content of the edible leaves of seven wild plants from Nigeria. Plant foods for Human Nutrition, 1997; 51: 71–84. http://dx.doi.org/10.1023//A:1007922308985.
12. Shruthi SD, Naveenkumar HN, Adhikari R. A Review on the Medicinal Importance of *Basella alba* Linn. Int J Pharm Sci and Drug Res. 2012;4(2):110–4.
13. Maisuthisakul P, Maitree S, Rungnaphar P. Assessment of phenolic content and free radical-scavenging capacity of some Thai indigenous plants. Food Chem. 2007;100:1409–18.
14. Urbando-Rivera J, Navarro-Ocan'a A, Valdivia-Lo'pez MA. Mexican Lime peel: Comparative study on contents of dietary fibre and associated antioxidant activity. Food Chem. 2005;89:57–61.
15. Adeniyi SA, Ehiagbonare JE, Nwangu SCO. Nutritional evaluation of some staple leafy vegetables in Southern, Nigeria. Int J Agricultural Food Sci. 2012;292:37–43.
16. Ali SYR. Proximate and Mineral Composition of the Marchubeh *Asparagus officinalis* in Iran. 2006; https://www.researchgate.net/publication/237654305.
17. Harsha R, Sushma SM, Dirya R, MamathaRani DR, Panduranga MG. Hydroxyl radicals and DPPH scavenging activity of crude protein extract of *Leucas linifolia*. A folk medicinal plant; 2012.

18. Uhegbu FO, Elekwa I, Iweala EEJ, Kanu I, Cyanide. Nitrate and Nitrite content of some leafy vegetables and fruits commonly consumed in the South East of Nigeria. Pak J Nutri. 2011;10(12):1190–4.
19. Akindahunsi AA, Salawu SO. Phytochemical screening of nutrient and anti- nutrient composition of selected Tropical green leafy vegetables. Afr J Biotechnol. 2005;4(6):497–501.
20. Aleter VA, Adeogun OA. Nutrients and anti- nutrient components of some Tropical leafy vegetables. Food Chem. 1995;54(4):375–9.
21. Onyesom I, Okon PN. Qualitative analysis of Nitrate and nitrite contents in vegetables commonly consumed in Delta State. Nigeria Bri J of Nutri. 2006;96:902–5.
22. FAO/WHO. Food Standard programmes. Cordex Alimentaris Commission XII supplement 4 FAO Rome Italy, 1991.
23. Onabolu AO, Oluwole SO, Bokanga M, Rosling H. Ecological variation of intake of cassava food and dietary cyanide load in Nigerian communities. Public Health Nutr. 2001;4:871–6.
24. Kemdirim OC, Chukwu AO, Achinewhu SC. Effect of traditional processing of cassava on the cyanide content of gari and cassava flour. Plant Foods Hum Nutr. 1995;48:335–9.
25. Getachew AG, Asfaw Z, Singh V, Woldu Z, Baidu-Forson JJ, Bhattacharya S. Dietary values of wild and semi wild edible plants in Southern Ethiopia. J of Food Agr Nutri and Dev. 2013;13(2):7485–503.
26. Schmidt DR, MacDonald HA, Brockman FE. Oxalate and nitrate contents of four Tropical Leafy vegetables grown at two soil fertility levels. J Agr. 1971;63(4):559–61. https://doi.org/10.2134/agronj1971.00021962006300040013x.
27. Ladeji O, Akin CU, Umaru HA. Level of Anti nutritional factors in Vegetables commonly eaten in Nigeria. Afr J Nutri Sci. 2004;7:71–3.
28. Agbaire PO. Levels of anti nutritional factors in some common leafy vegetables of southern Nigeria. Afr J Food Sci Technol. 2012;3(4):99–101.
29. El-Adany TA. Nutritional Composition and anti-nutritional factors of chicken peas (*Cicer arietinum* L.) undergoing different cooking methods and germination. Volume 57. Plant Food for Human Nutrition; 2002. pp. 83–97.
30. Erdman JN. Oily seeds phytates. Nutritional Implications. J Am Oil Chem Soc (JOCS). 1979;56:736–41.
31. Umaru HA, Adamu R, Dahiru D, Nadro MS. Level of anti-nutritional factors in some wide edible fruits of Northern Nigeria. Afr J Biotech. 2007;6(16):1935–8.
32. Metin G, Atukeren P, Gumustas KM, Belce A, Kayserilioglu A. The Effect of Vitamin E treatment on oxidative stress genetated in trained rats. J Exp Med. 2002;198:47–53.

Figures

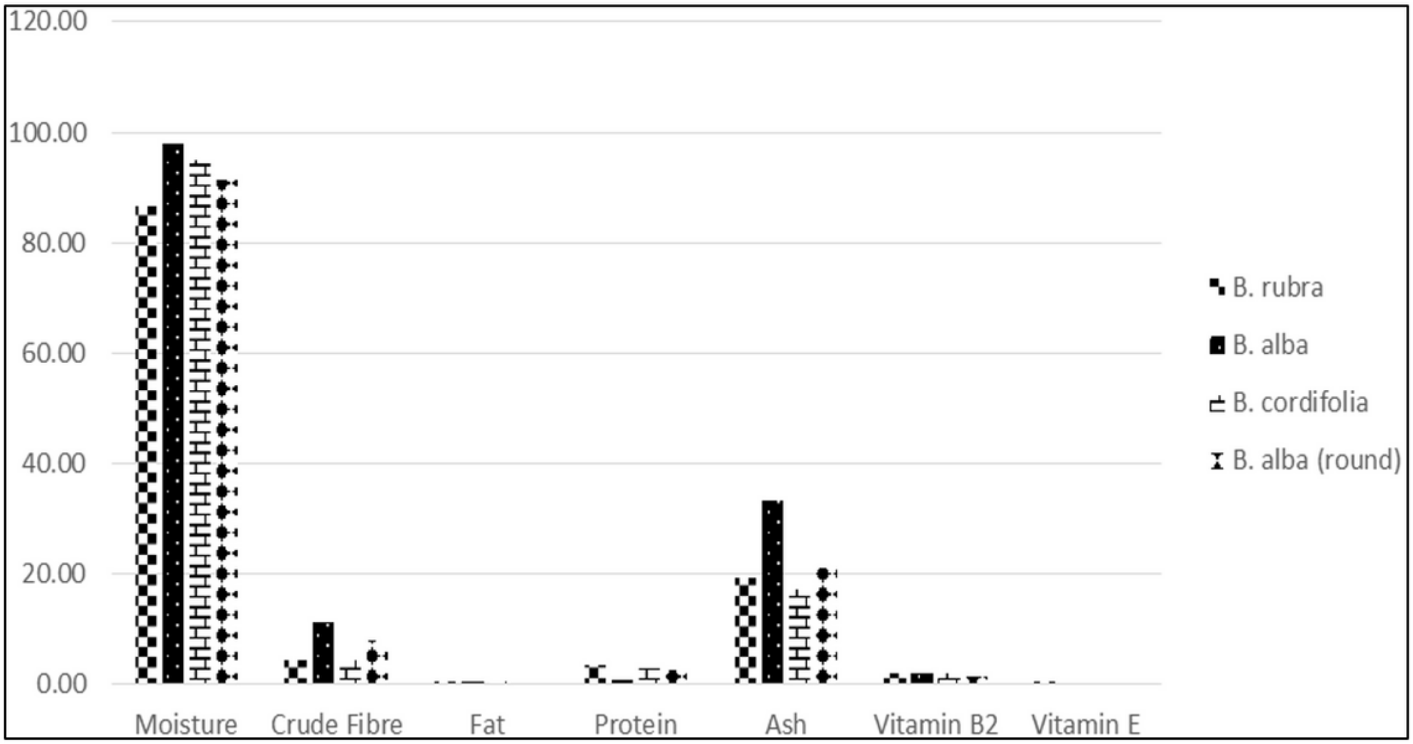

Figure 1

Mean values of proximate compositions and vitamins present in the four *Basella* forms

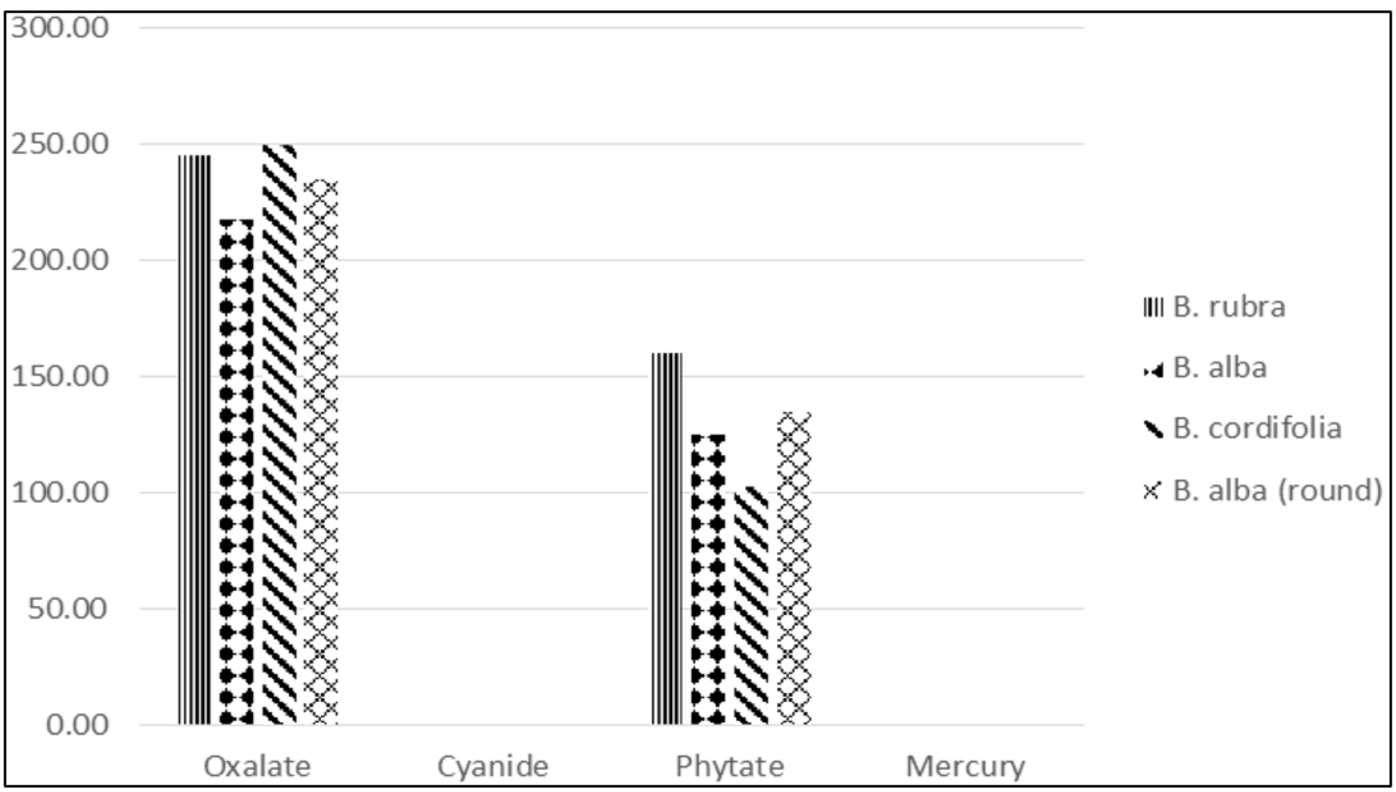

Figure 2

Mean values of anti-nutritional elements of four *Basella*