CHEMICAL COMPOSITION OF *MOMORDICA CHARANTIA* LEAVES

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Abstract - In this study the nutritional value of *Momordica charantia* leaf was estimated using standard analytical procedures. The results of the proximate composition (%DW) showed that the leaf contained 15.00±0.50 moisture, 17.93±0.47 ash, 10.25±0.52 protein, 3.03±0.76 Lipid, 25.31±0.32 fiber, 28.52±0.42 carbohydrate and Calorific Value 182.35Kcal/100g. The study detected seventeen amino acids (Ile, leu, lys, met, cys, phe, tyr, thr, val, ala, arg, asp, glu, gly, his, pro and ser) with glu, leu and asp being the predominant amino acids. Ile, leu, and val were also present. The results of the mineral composition per 100g (DW) were as follows: K (1.78cmol/kg), Na (0.94cmol/kg), Ca (0.79cmol/kg), Mg (0.12cmol/kg), P (17.80mg/kg), Fe (7.69mg/kg), Cu (7.57mg/kg), Mn (12.50mg/kg), Zn (13.88mg/kg) and Co (13.46mg/kg). Antinutrient composition of the plant leaf showed the presence of Saponin, Oxalate, Cyanide and Tannin. The leaves show the presence of antioxidant vitamins (vitamin A, C and E). This is an indication that the leaf of *Momordica charantia* leaves is a potential source of nutrient to man and livestock because of its considerable amount of all the essential food components.

Keywords - *Momordica charantia*, Bitter Melon, Aliero Kebbi State, Nutritional Analysis, Wild Edible Plants.

INTRODUCTION

Most tropical Africa countries are blessed with diversity of food stuffs which play a basic role in nutrition and healthy body development. Researchers, governments and other organizations charge with food and nutrition show great concern on the nutritional status of general population more especially children, pregnant and lactating mothers habiting the developing countries [1]. In these countries, natural disasters, bad economic policies, political instability, population explosion, high price of food commodities, poor implementation of agricultural policies and restrictions in food importation are the major factors that contribute to the burden of inadequate food intake among average people [2]. In these regions, starch-based foods are the main staples food which supply both energy and protein requirement. Thus, protein deficiency prevails among the populace as recognized by Food and Agricultural Organization [3]. To alleviate the situation, efforts should be focus on exploiting under-exploited and lesser-known wild plants as sources of nutrients supplements. *Momordica charantia*, known as bitter gourd or balsam-pear in English and locally called "*Garahuni*" (Hausa Language). It is a tropical and subtropical vine of the family *Cucurbitacea*, widely grown in Asia and Africa. This herbaceous, tendril-bearing vine grows up to 5 m (16 ft.) in length. It bears simple, alternate leaves 4–12 cm (1.6–4.7 in) across, with three to seven deeply separated lobes.

Bitter melon as fondly called has been implicated experimentally to achieve a positive sugar regulatory effect by suppressing the neural response to sweet taste stimuli and also keep the body functions operating normally. Other use of the plant include to expel intestinal gas, for tumors, wound treatment, rheumatism, malaria, vaginal discharge and the seeds are used to induce abortion [4][5]. A tea preparation from the leaf is used for diabetes. In Nigeria, Ghana and India peninsula, the root of the plant is used as an abortifacient together with the fruit as well as an ingredient in aphrodisiac preparation [4]. The young fruits and shoots are reported to serve as supplementary or emergency food in some part of West Africa, and as an effective emanagogue to facilitate child birth in Ivory Coast [6].

II. DETAILS EXPERIMENTAL

2.1. Materials and Procedures

Sample Collection and Identification

Momordica charatia fresh leaves used in this study were sampled in Zuru Local Government Area, Kebbi State, Nigeria in December 2015. The plant was transported to the laboratory in a polyethylene bag and identified by a taxonomist at Botany unit, Department of Biological Sciences, Kebbi State University of Science and Technology Aliero. A voucher specimen number of **527** was obtained.
The leaves were washed with water to eliminate dust and other adhering particles and air dried under shade for 2 weeks at 25^0C. The sample was grounded into fine powder using mortar and pestle, and the powdered sample was used for the analyses.

Proximate Analysis

The recommended methods of the Association of Official Analytical Chemists [7] were used for the determination of moisture, ash, crude lipid, crude fiber and nitrogen content. The calorific value of the sample was estimated according to the method of [8].

Anti-Nutritional Factors

The antinutritional quantification for oxalate, cyanide, tannin and saponin were carried out according to the methods of [9], [10], [11], and [7] respectively.

Antioxidant vitamins (A, C and E) composition
The concentrations of vitamins A, C and E were determined according to the method of association of official analytical chemist [12]

Determination of Amino Acids
Amino acid determination was carried out using ion-exchange chromatography with Technicon Sequential Multisample Amino Acid Analyzer, TSM (Technicon Instruments Corporation, Dublin, Ireland) at Postgraduate laboratory, Zoology Unit, University of Jos, Nigeria as outline by [13]

Mineral Analysis
The sample mineral elements (K, P, Mg, Co, Ca, Cu, Zn, Fe, Na and Mn) contents were analyzed using energy dispersive X-ray fluorescence (EDXRF) transmission emission technique at the Centre for Energy Research and Training, Ahmadu Bello University, Zaria, Nigeria according to the method of [14]. The powdered sample (0.3g) was homogenized with 3 drops of organic liquid binder (polystyrene dissolved in toluene) in a 19 mm diameter die and pressed at 10 tons with a Special hydraulic press to form a pallet. Measurements of the sample (in duplicates) were performed using energy-dispersive spectrometer which consist of an annuar 25 mCi109Cd isotopic as the excitation source that emits Ag-K X-ray (22.1 keV) and a Mo X-ray tube (50KV, 5mA) with thick foil of pure Mo used as target material for absorption correction. The system consist furthermore, of a Canberra Si (Li) detector with a resolution of 170eV at 5.9keV line, coupled to a computer controlled ADC-Card (Trump 8K). The spectra for the sample was collected for 5000S and evaluated using the AXIL-QXAS program.P, Na and Mg were analyzed after wet digestion of one gram powdered sample with nitric/perchloric/sulphuric acid (9:2:1) mixture. Phosphorus content was determined colorimetrically with Jenway 6100 spectrophotometer using phospho-vanadomolybdate method. P was analyzed using Corning 400 flame photometer while magnesium was analyzed complexometrically [15].

III. RESULTS AND DISCUSSION

3.1. Proximate Composition

Parameter	%Composition (DW)
Moisture content	15.00±0.50
Ash content	17.93±0.47
Crude Protein	10.25±0.51
Crude lipid	3.03±0.76
Crude Fiber	25.31±0.32
Carbohydrate	28.52±0.43
Calorific Value (Kcal/100g)	182.35

Table 3.1 Proximate Composition of *Momordica charantia* Leaves

The data are mean value ± standard deviation of triplicates.
DW= Dry Weight
The results of the proximate composition of *Momordica charantia* leaves (Table 3.1 above) shows that the leaf has high moisture content (15.0 ± 0.50% DW) compare with the reported range (58.0 ± 2.5% to 93.4± 0.7%) in some leafy vegetables consumed in Sokoto, Nigeria,[16]. [17] however, reported higher range of values (81.4 - 90.3%) in some Nigerian green leafy vegetables, this may be due to the geographical area and the nature of the farmland where the sample was obtained. The ash content, which is an index of mineral contents in biota, is high (17.93 ± 0.47%) in *Momordica charantia* leaves compared to the values reported in leaves of *Ipomea batatas* (1.8%DW), *Corchorus tridens* (8.7%) grown in Ghana [8], but compared favorably with the values reported in some Nigerian leafy vegetables [16],[17].[18] had also reported high ash content in some greens use by the lactating mother such as bitter leaves, *Vernonia colorate* (15.86%DW) and *Moringa oleifera* (15.09%DW). This indicates *Momordica charantia* leaves could be good sources of mineral elements. The leaves crude protein content (10.25 ± 0.51%DW) was higher than protein content of *Momordica foecide* (4.6%DW) and *Momordica involucrata* leaves consumed in Swaziland [19] but lower than those of *Moringa oleifera* (20.72%) [18] and *Lesianthera africana* leaves (13.1-14.9%) [20]. As well as that of *M. balsamina* (11.29 ± 0.07) [21]. According to [22], plant food that provide more than 12% of its calorific value from protein are considered good source of protein. Therefore, *Momordica charantia* leaves (14.56%DW) provide this requirement. Furthermore, adults, children, pregnant and lactating mothers require 34-56g, 13-19g, 71g and 71g of protein daily respectively [23].

Assuming complete protein absorption; 100g DW of *Momordica charantia* leaves would contribute about 20 - 33%, 59 - 87%, 16% and 16% of their daily protein requirement respectively. The crude lipid content (3.03±0.76%) was low compared with reported values (8.3±27.0% DW) in some vegetables consumed in Nigeria and Republic of Niger [24]. However, the value is higher than 0.52±0.75% in some *Sonchus species* [25], and 2.66±0.13% [26]. The results indicated that the leaves of *Momordica charantia* are poor sources of plant lipid, which is in agreement with general observation that leafy vegetables are low lipid containing food, thus advantageous health wise to avoid obesity [27]. The crude fiber content of *Momordica charantia* leaves (25.31%DW) is high compared to 8.5±20.9% in some Nigerian vegetables [17]. The major drawbacks to the use of vegetables in human nutrition is their high fiber content which invariability causes intestinal irritation and lower nutrient bioavailability, hence large quantities of plant vegetables have to be

consumed to provide adequate levels of nutrients [28]. On the other hand, intake of dietary fiber can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes and colon and breast cancer [29]. The RDA of fiber for children, adults, pregnant and lactating mothers are 19-25%, 21 - 38%, 28% and 29% respectively. Thus, the leaves of *Momordica charantia* could be valuable sources of dietary fiber in human nutrition. The estimated available carbohydrate content (28.52±0.43%) in *Momordica charantia* leaves is higher than 20% obtained in *Senna obtusfolia* leaves [30], 23.7% in *Amaranthus incurvatus* leaves [8], but lower when compare to *M. balsamina* 29.05%. [26]. On the other hand, *Momordica charantia* leaves contain less available carbohydrate compared to *Corchorus tridens* (75.0%) and sweet potatoes leaves (82.8%) [8].

The recommended dietary allowance, RDA values, for children, adults, pregnant and lactating mothers are 130g, 130g, 175g and 210g respectively. This shows that the plant is capable of contributing 31%, 31%, 23% and 19% of their respective daily requirement when 100g dried leaves are consumed. The calorific value of *Momordica charantia* leaves is estimated to be 182.35kcal/100g, which is low compared to 248.8-307.1 kcal/100g reported in some Nigerian leafy vegetables [31], and *M. balsamina* 189.22kcal/100 [26]. High energy content was also reported in some Ghanaian green leafy vegetables such as *Corchorus tridens* (283.1 kcal/100g) and sweet potato leaves (288.3 kcal/100g). This show that the plant leaves has low calorific value which is in agreement with general observation that vegetables have low energy values [27].

3.2. Anti-nutrient Composition of *Momordica charantia* Leaves

Parameter	conc. (mg/100g)
Oxalate	0.01±0.00
Cyanide	0.86±0.20
Tannin	14.30±0.45
Saponin	35.21±0.76

Table 3.2 Anti-nutrient Composition of *Momordica charantia* Leaves

The data are mean value ± standard deviation of three replicates.

The result of anti-nutrient composition of *Momordica charantia* leaves in table 3.2 show that tannin (14.30±0.45) was observed to be high compared to the result obtained by [32] on *Momordica foecide* leaves. Tannin-protein complexes are insoluble and this decreases the protein digestibility [33]. Tannins have been reported to bring about anti-nutritional influences largely by precipitating dietary proteins and digestive proteins and digestive enzymes to form complexes which are not readily digestible [34]. Oxalate content of *Momordica charantia* (0.01±0.00%) is lower upon comparism with that obtained by *Ruspolia differens* [35]. These might be due to different species of the plant used and hence is better for consumption than other species, as it contains less antinutritional factors. Saponin (35.21±0.76) present was in high amount in *Momordica charantia* leaves compared with tannin cyanide and oxalate. Fruit containing saponin are believed to have antioxidant, anti-cancer, anti-inflammation and anti-viral properties [36]. Saponin help humans to fight fungal infections, combat microbes and viruses, boost the effectiveness of certain vaccines and knock out some kinds of tumor cells, particularly lungs and blood cancers. This compound served as natural antibiotics, which help the body to fight infection and microbial invasion [37].

Saponin also have cholesterol binding properties, it aid in reducing levels by forming complexes with cholesterol and bile acids [38]. Saponin has been found to be useful in the treatment for hypercholesterolemia. Saponin binds with cholesterol so it cannot be absorbed into the system and is excreted from the body [39]. Cyanide (0.86±0.20) was also found to be low in *Momordica charantia* based on the result obtained.

3.3 Antioxidant vitamin composition of *Momordica charantia* Leaves

Parameter	conc. (mg/100g)
Vitamin A	0.186±0.72
Vitamin C	1.351±0.10
Vitamin E	0.185±0.25

Table 3.2 Anti-nutrient Composition of *Momordica charantia* Leaves

The data are mean value ± standard deviation of three replicates.

Antioxidant vitamin composition of *Momordica charantia* leaves shown in table 3.3 showed vitamin C content of 1.35mg/100g compared to vitamin A (0.18mg/100g) and E (0.18mg/100g) but lower than 25.40mg/100g *Amaranthus hybridus* leaves [40]. Vitamin A content of *Momordica charantia* leaves (0.18mg/100g) is low compared with 3.29mg/100g *Amaranthus hybridus* leaves [40] and also Vitamin E content of *Momordica charantia* leaves (0.18mg/100g) is also low compared with 0.50mg/kg *Amaranthus hybridus* leaves [40].

Ascorbic acid is necessary for healthy teeth, gums and bones and is essential for proper functioning of adrenal and thyroid glands. Also, ascorbic acid is an anti-oxidant and as such acts as a general de-toxicant. Vitamin E also acts as an antioxidant and protects cell walls [41]. Thus, the plant could contribute to the dietary vitamins most especially vitamin C in human nutrition when consumed in high amount.

3.4 Elemental Composition of *Momordica charantia* Leaves

Elements	Conc. (mg/kg)
Copper	7.57
Zinc	13.88
Iron	7.69
Manganese	12.50
Cobalt	13.46
Phosphorus	5512.66
Calcium	316.80
Magnesium	30.00
Sodium	216.66
Potassium	695.37

Table 3.4 Elemental Composition of *Momordica charantia* Leaves

The data are mean value ± standard deviation.

Table 3.4 shows the results of the mineral concentrations of *Momordica charantia* leaves. The sample has high amount of sodium (216.66mg/kg) compared with *Momordica balsamina* 122.49mg/kg leave [26], with relatively higher concentration of potassium (695.37mg/kg). A K/Na ratio in diet is an important factor in prevention of hypertension and atherosclerosis, since K depresses and Na enhances blood pressure [42]. [25 indicated that a K/Na ratio of 3-4 is considered the most adequate for the normal retention of protein during growth stage. Calcium and phosphorous are associated with each other for growth and maintenance of bones, teeth and muscles [43]. The calcium level in the *Momordica charantia* leaves was higher than the values reported in some green leafy vegetables consumed in Sokoto [16] and some wild edible leaves grown in Eastern Anatolia, Turkey [43]. On the other hand, the value is lower than sickle pod (*Cassia obtusfolia*) leaves [44], bitter leaf (*Vernonia amygdalina*) [45]). The phosphorous content (5,512.66mg/kg) was high compared with 166 - 640 mg/kg found in some green leafy vegetables consumed in Sokoto [16]. According to [25], for good calcium to phosphorus intestinal absorption, Ca/P ratio should be close to unity. This ratio is high in favour of calcium. Thus, *Momordica charantia* leaves appear to be good source of calcium but poor source of phosphorus.

Magnesium is an important mineral element in connection with circulatory diseases such as ischemic heart disease and calcium metabolism in bone [29]. In this study, high magnesium content of the leaves could be as a result of it present as component of chlorophyll [46]. The leaves' Magnesium (30mg/kg) is lower than the values reported in some green leafy vegetables consumed in Sokoto [16] and *M. balsamina* 220mg/kg leaves [26].

Iron is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats [47]. From the results, *Momordica charantia* leaves had low iron (7.69mg/kg) content compared with other green leafy vegetables [16], [45], but within the range found in underutilized leafy vegetables of Republic of Niger [24]. The bioavailability of iron is affected by the presence of antinutritional factors [16]. According to [29], the intestinal absorption of haeme-iron and non-haeme-iron differs (37% Vs 5%), and about 90% of the iron in food is non-haeme-iron. This shows that only about 3.02mg of leaves iron will be absorbed. Nonetheless, the amount is more than adequate as 1.00mg/day of iron is suitable for adult human to maintain the daily balance of intake and excretion [48]. The high percentage of iron in the sample could probably be the reason for the use of this plant by the lactating mothers to regenerate lost blood.

Copper is an essential trace element in human body where it exists as an integral part of copper proteins ceruloplasmin, which is concerned with the release of iron from the cells into the plasma and is involved in energy metabolism [49], [50]. The Copper content of *Momordica charantia* leaves (7.57mg/kg) was higher than 2.32mg/kg found in bitter leaf (*Vernonia amygdalina*) [45], some leafy vegetables found in Cross Rivers State, Nigeria [51], and in some wild leafy vegetables of Republic of Niger [24], but lower than that found in *Eraphorbia hirta* leave 14.70mg/kg respectively [52].

Manganese is another microelement essential for human nutrition, it acts as activator of many enzymes [49]. The Manganese content in *Momordica charantia* leaves (12.50mg/kg) is lower than values reported in some leafy vegetables found in Cross Rivers State, Nigeria [51]. The manganese content is also higher than that of bitter leaf (*Vernonia amygdalina*) [45] and some cultivated green leafy vegetables such as spinach, lettuce and in cabbage 11.60mg/kg [43]. The copper content of the white *Momordica charantia* leave is 7.57mg/kg. Therefore, *Momordica charantia* leaves can serve as nutritional supplement of copper especially for children. Copper is an essential constituent of several enzymes, such as cytochrome oxidase, catalase, tyrosinase, superoxide dismutase etc. Deficiency of copper causes demineralization of bones, demyelination of neural tissue, fragility of arteries, myocardial fibrosis etc. [53].

Zinc is involved in normal function of immune system. The *Momordica charantia* leaves zinc (13.88mg/kg) content in the sample compared favorably to most values reported for green leafy vegetables in literatures [45],[51]. Nutritional significant of mineral elements is usually compared with the standard recommended dietary allowance. When compared with standard values of [23], *Momordica charantia* contain more than adequate level of sodium (for adults and children), calcium, iron, copper, manganese, cobalt and magnesium (for children). Thus, the plant leaves could be good source of such mineral elements particularly the micro elements.

3.5 Amino Acid Composition of *Momordica charantia* Leaves

Amino Acid	Conc. (g/100g protein)
Threonine (Thr)*	2.94
Lysine (Lys) *	5.30
Valine (Val)*	4.99
Methionine (Met)*	1.17
Isoleucine (Leu)*	3.99
Leucine (Iso)*	6.80
Tyrosine (Tyr)*	2.00
Phenylalanine (Phe)*	4.34
Histidine (His)*	2.11
Arginine (Arg)*	5.85
Aspartic Acid (Asp)**	11.01
Serine (Ser)**	3.18
Glutamic Acid (Glu)**	12.84
Proline (Pro)**	3.04
Glycine (Gly)**	4.04
Alanine (Ala)**	3.94
Cysteine (Cys)**	0.91

Table 3.5 Amino Acid Composition of *Momordica charantia* Leaves

Key: * = Essential Amino Acids
** = Non-essential Amino Acids

Twenty amino acids are commonly found as components of proteins [49]. In this study only seventeen amino acids were detected (Table 3.5) as a result of conversion of glutamine and asparagine to glutamic and aspartic acids respectively [54] and complete destruction tryptophan during acid hydrolysis [55]. The result indicated that non-essential amino acids (alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline and serine) are higher in concentration (58.65%) compared to essential amino acids (isoleucine, leucine, lysine, methionine, cysteine phenylalanine, tyrosine, threonine, valine) which constitute 41.35% of the total amino acids analyzed. Among the essential amino acids, leucine and aromatic (phenylalanine and tyrosine) are the predominant amino acids, while glutamic acid and aspartic acid were found to be major nonessential amino acids in *Momordica charantia* leaves. To evaluate the nutritional quality of *Momordica charantia* leaves, the percentages of the essential amino acids in the samples were compared with those of reference standard amino acid profile established for both adults and children by [56] and the result (Table 3.5) indicates that all essential amino acids except sulphur containing amino acids exceeded the reference value for adults, while lysine, threonine and sulphur containing amino acids are below the standard requirement for children. For both adults and children, sulphur containing amino acids are the most limiting amino acids.

CONCLUSIONS

From the results of the analyses it can be shown that *Momordica charantia* leaves could be important green leafy vegetables as a source of nutrients to supplements other major sources. So based on this findings, the use of *Momordica charantia* leaves in making vegetable soups especially for pregnant, lactating mothers and children so as to meet up the body nutrient demand is encouraged. Chemical analysis alone however, should not be the sole criteria for judging the nutritional importance of a plant parts.

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