Nutrient profiling of leaves and seeds of *Momordica charantia* (bitter melon)

ABSTRACT

Momordica charantia is a vegetable that is used for nutritional and medicinal purposes. Despite its wide usage, information about the nutritional composition is scanty. In this study the nutritional value of *M. charantia* leaves and seeds was estimated using standard analytical procedures. Proximate composition of the leaves showed 14.39±0.37% minerals, 27.38±0.44% protein, 2.19±0.27% Lipids, 3.48±0.23% fiber, and 41.08±0.92% carbohydrate while the seeds contained 9.83±0.33%, 19.78±0.28%, 11.88±0.56%, 26.09±0.14%, 11.54±0.31% of the respective nutrients, indicating significant mean difference between the leaves and seeds ($P<0.05$). Benitez method was used for amino acid profiling; eighteen amino acids- Ile, Leu, Lys, Met, Cys, Phe, Tyr, Thr, Val, Ala, Arg, Asp, Glu, Gly, His, Pro Ser and Trp were detected. Furthermore, the leaves contain twelve fatty acids of which six were unsaturated while the seeds contain seven fatty acids with four being unsaturated. Total saturated fatty acid in the leaves and seeds were 65.50% and 52.90% respectively. Dipalmitic acid and stearic acid were respectively the most predominant saturated fatty acids in the leaves and seed samples. The predominant unsaturated fatty acid in the leaves and seeds was oleic acid (8.30%) and (13.0%) respectively. The bitter component (momordicin) in the seed was estimated to be 3.8% (*w/w*) of the powdered dry sample. This results showed that *M. charantia* leaves and seeds could be an important green leafy vegetable and a source of nutrients to supplement other major sources.

Key words

momordica charantia; Nutritional analysis; proximate analysis; amino acid profile; fatty acids, mormodicin.

Introduction

M. charantia, a member of the *Cucurbitaceae* family and commonly known as bitter gourd or bitter melon, thrives in humid and subtropical regions around the world (Anjum *et al.*, 2013). Because of its dietary value in both unripe and ripe fruits, they are now widely cultivated all over the world, including tropical countries (Anjum *et al.*, 2013, Saha *et al.*, 2012). They are adapted to a wide range of climates, but they grow best in warm weather. It is a revolutionary plant with versatile applications in the food industry and in therapy (Ali *et al.*, 2008). It is a common food item of the tropics and is used for the treatment of many chronic diseases including cancer, atherosclerosis, diabetes and many ailments in ayurvedic medicine (Bae *et al*., 2008). Also, the plant has the ability to expel intestinal gas, tumors, wound treatment, rheumatism, malaria, vaginal discharge and the seeds are used to induce abortion (Sofowora, 2006; Taylor, 2005).

Bitter melon contains a complex array of many beneficial compounds, hence a powerful nutritive plant. It contains bioactive chemicals, vitamins, minerals and antioxidants which all together contribute to its remarkable versatility in treating a wide range of illnesses. The fruits also contain high amounts of vitamins C, A, E, B_1, B_2 and B_3, as well as vitamin B_9. The reported caloric values for leaf, fruit and seed are 213.26, 241.66 and 176.61 Kcal/100 g respectively (Bakare *et al.*, 2011). The fruit is also rich in minerals like potassium, calcium, zinc, magnesium, phosphorus and iron, it is also a good source of dietary fiber. Medicinal value of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, which all confer a bitter taste (Snee *et al.*, 2010). Bitter melon being rich in all the essential vitamins and minerals can be used to regulate or prevent hypertension, eye complications, neuritis and the leaf and fruit contain considerable amount of carbohydrate.

Even through most tropical Africa countries are blessed with diversity of food stuffs which play a basic role in nutrition and healthy body development, there is a great concern on the nutritional status of general population more especially children, pregnant and lactating mothers habiting the developing countries (Andersen *et al.*, 2003) due to 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 (Adebooye and Phillips, 2006). In these regions, starch-based foods are the main staple food which supply both energy and protein requirement. Thus, protein deficiency prevails among the populace as recognized by Food and Agricultural Organization (FAO) (Ladeji *et al.*, 1995). To alleviate the situation, efforts are focused toward exploiting under-exploited and lesser-known wild plants as sources of nutrient supplements. In an attempt to bridge up the gap in knowledge about the nutritional properties of *M. charantia*, we report the proximate, fatty acids, amino acids compositions of the leaves and seed of the plant. In addition, we estimated the bitter content of this wild green leafy vegetable so as to ascertain its nutritional composition.

Materials and Methods

All the reagents that were used for this research are of analytical grade which were purchased from reputable source.

Sample Collection

M. charantia leaves that was used in this study are sampled from Samaru Zaria, Kaduna state, Nigeria.

Preparation of Sample

The seeds and leaves of *M. charantia* were washed with water to eliminate dust and other adhering particles and air dried under shade for 2 weeks at 25˚C, the sample was ground into fine powder using mortar and pestle, and the dried powdered sample was used for the analysis.

Proximate Analysis

The recommended methods of the Association of Official Analytical Chemists (AOAC, 2005) was used for the determination of moisture, ash, crude lipid, crude fiber, crude protein and carbohydrate content based on the difference between the wet weight and the weight after oven drying of sample. The crucible was weighed, 2 g of sample was added into crucible and weighed, dried in hot air oven for 24 hrs at 105˚C cooled in a desiccators and the weight was taking. Then the dried sample was return into the oven for further 24 hrs to make sure drying is completed.

Ash Content

The sample was ignited at 600˚C to turn off all organic materials. The inorganic materials which does not volatilize at that temperature is called the ash. Briefly, the crucible was ignited for 1 hour in a muffle furnace, cooled in a desiccator and weighed quickly to prevent moisture absorption, 2 g of sample was added into crucible and weighed, and was place into muffle furnace at 600˚C for 6 hrs for ashing. Then it was cooled in a desiccator and weighed again. Percentage ash was calculated.

Crude Fiber

The samples were defaulted and treated successively with boiling solutions of sulphuric acid and sodium hydroxide specific concentrations. The residue was separated by filtration, washed, dried, weighed and ashed. The loss of weight resulting from ashing correspond to the fiber present in the test sample, as described by procedures originally proposed by the Weende Experiment Station

and officially recorded in the procedures of (AOAC 1990). Briefly, 2 g of sample was weighed in 1 L conical flask, 200 ml of boiling of 1.25% H_2SO_4 and 200 ml of water was added gently and boiled for 30 minutes. A muslin cloth was used to filter which was stretched over 9 cm^3 Buchner funnel, distilled water was used in rinsing. Spatula was used to scrap the material back into the flask. The 200 ml of boiling of 1.25% of NaOH was added and boiled for 30 minutes. The boiled sample was filtered and washed with hot water, the residue was finally washed with acetone and collected into a crucible. It was allowed to dry overnight in the oven at 105°C, and was then cooled in a desiccators and weighed, kept in muffle furnace to ash at 600°C for 30 minutes. It was cooled and weighed. Percentage fiber was obtained.

Crude Protein (Kjeldhal Method)

The sample was digested in sulphuric acid to break down organic matter and reduce nitrogenous compounds to ammonium compounds. Ammonia was liberated by boiling with sodium hydroxide, the steam was distilled into boric acid solution and determined titrimetrically. 500 mg of sample was weighed into the digestion flask, 30 cm^3 of Conc. H_2SO_4 was added and two kjeldhal tabs were also added. It was heated gently on a digestion apparatus by means of electric elements. At this stage of digestion, the reaction mixture turned black due to dehydration of sulphuric acid and formation of free carbon. As the reaction of free carbon oxidized, a clear yellow solution remained. After heating strongly for 2 hours, the sulphuric acid was seen by its condensation in the lower part of the flask. This was allowed to cool after digestion and small quantity of distilled water was added to dissolve the crystals that was formed, and make to mark with distilled water in a 100 cm^3 volumetric flask. 10 ml of 2% boric acid solution and 2 drops of indicator was mixed into 100 ml conical flask. While 10 ml of the diluted sample was pipetted into the Markham distiller with 10 ml of 40% sodium hydroxide. The mixed boric acid and indicator in the flask was placed at the

bottom of the condenser to collect the ammonia, while all other possible channel for the escape of the ammonia closed. When about 50 cm^3 of the distillate was then titrated with 0.01 N standard HCL using 25 ml burette graduated at 0.1 ml interval, which gave a grey-mauve end point. Then the percentage nitrogen was calculated using formula.

$$\% \text{ nitrogen} = \frac{\text{NA} \times \text{TV} \times\ 0.014 \times \text{DF}}{\text{Volume of aliquot} \times \text{weight of sample}} \times 100$$

NA = normality of acid (0.01N)

TV = titer value

DF = dilution factor

Volume of aliquot = 10 ml

Crude Protein (%) = 6.25 x Nitrogen (%)

Crude Fats/ Lipids

The sample was extracted with light petroleum, the solvent was distilled off and the dried extract was weighed. Exactly 500 mg of the sample was weighed and wrapped in a filter paper into an extraction thimble. The thimble was placed inside the Soxhlet apparatus, dried, tarred solvent flask were placed in position beneath, with the required quantity of solvent and connected to the condenser. The heating rate was adjusted to give a condensation rate of three drops/second and were extracted for 6 hours. The thimble was removed on completion, and the ether reclaimed using the apparatus. The completion of the removal of ether was on a boiling bath and then the flask was dried at 105°C for 30 minutes, allowed to cool in a desiccator before weighing to constant weight. Percentage fat was determined.

Carbohydrate Contents by Difference

Percentage content was measured by subtracting all values gotten from 100. The value obtained represents percentage carbohydrate content of sample (AOAC, 2005).

Total carbohydrate = 100- (crude protein + crude fat + crude fiber + total ash + %moisture)

Determination of Amino Acid Profile

The Amino Acid profile in the known sample was determined using methods described by Benitez (1989). The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Bio System Amino Acid Analyzer.

Defatting Sample

The sample was defatted using chloroform/methanol mixture of ratio 2:1. About 4 g of the sample was put in extraction thimble and extracted for 15 hours in Soxhlet extraction apparatus (AOAC, 2006).

Nitrogen Determination

One hundred and fifteen milligram of ground sample was weighed, wrapped in Whatman filter paper and put in the Kjeldhal digestion flask. Concentrated sulphuric acid (10 ml) was added. Catalyst mixture (0.5 g) containing sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$) and selenium oxide (SeO_2) in the ratio of 10:5:1 was added into the flask to facilitate digestion. Four pieces of anti-bumping granules were added.

The flask was then put in Kjeldhal digestion apparatus for 3 hours until the liquid turned light green. The digested sample was cooled and diluted with distilled water to 100 ml in standard volumetric flask. Aliquot (10 m1) of the diluted solution with 10 ml of 45% sodium hydroxide was put into the Markham distillation apparatus and distilled into 10 ml of 2% boric acid containing 4 drops of bromocresol green/methyl red indicator until about 70 ml of distillate was collected.

The distillate was then titrated with standardize 0.01 N hydrochloric acid to grey colored end point.

$$\text{Percentage Nitrogen} = \frac{(a-b) \times 0.01 \times 14 \times V \times 100}{W \times C}$$

Where:

a. = Titre value of the digested sample

b. = Titre value of blank sample

v. = Volume after dilution (100 ml)

W. = Weight of dried sample (0.115 mg)

C. = Aliquot of the sample used (10 ml)

14. = Nitrogen constant in mg.

Hydrolysis of the Sample

Two hundred milligram of the defatted sample was weighed into glass ampoule. Exactly 7 ml of 6 N HCL was added and oxygen was expelled by passing nitrogen into the ampoule (this is to avoid possible oxidation of some amino acids during hydrolysis e.g. methionine and cysteine). The glass ampoule was then sealed with Bunsen burner flame and put in an oven preset at 105°C ± 5°C for 22 hours. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humins. It should be noted that tryptophan is destroyed by 6 N HCL during hydrolysis.

The filtrate was then evaporated to dryness using rotary evaporator. The residue was dissolved with 5 ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which was kept in the freezer.

Loading of the Hydrolysate into Analyzer

The amount loaded was 60 ml. This was dispended into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysate. The period of Analysis lasted for 76 minutes. An integrator attached to the Analyzer calculates the peak area proportional to the concentration of each of the amino acids.

Determination of Tryptophan

The tryptophan in the sample was hydrolyzed with 4.2 M Sodium hydroxide (Maria, M.Y. *et al.*, 2004). The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Bio systems PTH Amino Acid Analyzer.

Fatty Acid Composition

Fatty acid composition was determined by gas chromatography coupled to mass spectrometry (GC-MS) using capillary column (Hp Innowax Capillary; 60.0 m × 0.25mm × 0.25 µm). Fatty acid methyl ester was prepared using the method of (Garces and Mancha, 1993). l;heptane;benzene;2,2-dimethoxypropane: H_2SO_4 (37:36:20:5:2, by volume), At 80°C, the simultaneous digestion and lipid transmethylation takes place in a single phase. After cooling at room temperature, two phases are formed; the upper phase contains the fatty acid methyl esters (FAMES) ready for the analysis. This procedure allows the determination of fatty acid composition of lipids from tissues containing high proportion of triacylglycerols (oil seeds), water (leaves), or both.

Gas Chromatography-Mass Spectrometry

The already prepared fatty acid methyl ester was injected into the GC-MS. Helium was used as carrier gas at 1 ml per minute flow rate. The sample injection volume was adjusted as 1 µL and injected at split mode (50:1). Injection block of the instrument was maintained at 250°C. The oven

temperature was programmed as follows; started from 150˚C and raised to 200˚C with an increment of 10˚C per minute, held at 200˚C for 5 minutes, then increased to 250˚C with an increment of 5˚C per minute, held at 250˚C for 10 minutes (totally 30 minutes). MS spectra was monitored between 35-500 amu and the ionization mode used was electronic impact at 70 ev. The identification of the components was performed by WILEY, NIST and FLAVOR libraries. Fatty acid peaks also were identified by comparison with authentic fatty acid standards.

Estimation of Bitter Component

Bitter component was estimated by high performance liquid chromatography (HPLC). The column used for chromatographic separation was pinnacle DB18,15um 150*4.6m catalog #9414565-700 which is special for plant extract samples.

Preparation of Sample Solution

Saponin standard was dissolved with 3 ml of distilled water and shake well for proper mixture, 2 ml was withdrawn from the standard and place into a reagent bottle, 1 g of the powdered sample was mixed with 20 ml of methanol, then 2 ml of the mixed sample was withdrawn and poured into reagent bottle. The mixture was kept until the next day. Aliquot of the solution was injected into the HPLC.

Results

Proximate Analysis.

Proximate composition showed that *M. charantia* leaves contained 11.48±0.00 moisture, 14.39±0.37 ash, 27.38±0.44 protein, 2.19±0.27 Lipid, 3.48±0.23 fiber, 41.08±0.92 carbohydrate and the seeds contained 20.69±0.00 moisture, 9.83±0.33 ash, 19.78±0.28 protein, 11.88±0.56 lipid, 26.09±0.14 fiber, 11.54±0.31 carbohydrate.

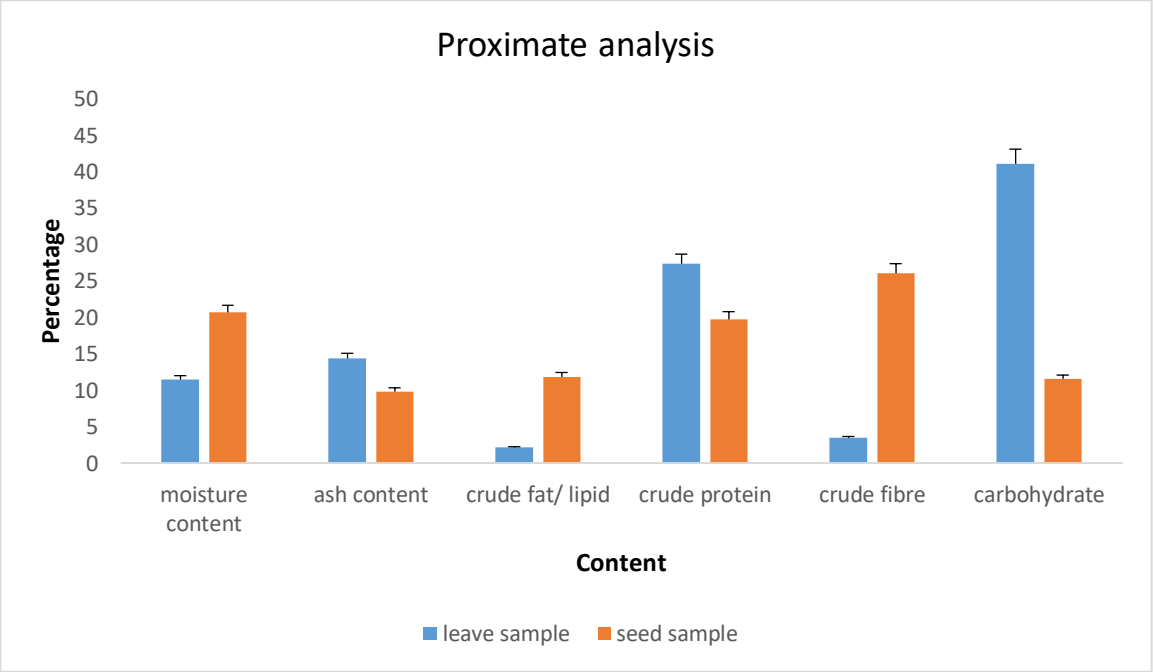

Figure 1: A graph showing proximate analysis carried out on the leaves and seeds samples of *M. charantia.* Values are expressed as mean ± SD. For each of the parameters analyzed mean difference was significant between the leave and seed sample ($P<0.05$).

Amino Acid Profile

Amino acids detected in *M. charantia* were eighteen in both the leaves and seeds samples namely: Ile, Leu, Lys, Met, Cys, Phe, Tyr, Thr, Val, Ala, Arg, Asp, Glu, Gly, His, Pro Ser and Trp, with Glu, Leu and Asp being the predominant amino acids.

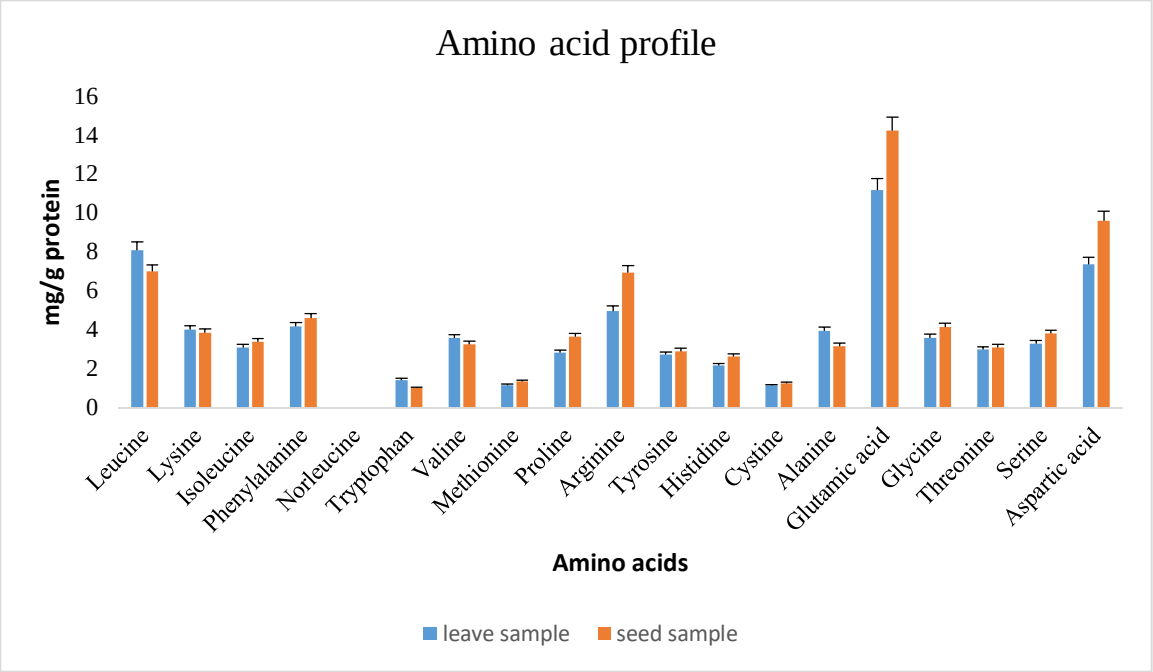

Figure 2: A graph showing the Amino acid profile of the leaves and seeds samples of *M. charantia.*

Fatty Acid Composition

Seed Sample

The fatty acid composition of *M. charantia* seeds samples showed seven peaks representing seven fatty acids of which four were unsaturated fatty acids.

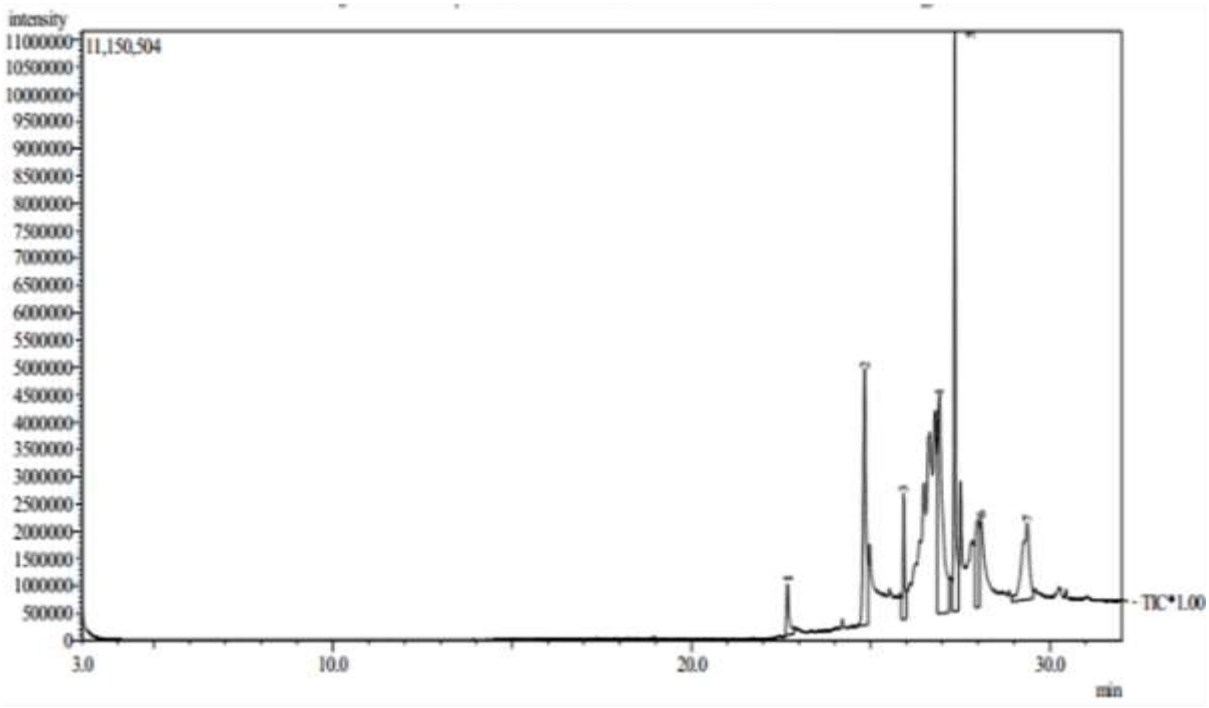

Figure 3: A graph showing fatty acid composition carried out on the seeds samples of *M. charantia.*

Table 1: Fatty acid composition (%) of the seeds samples of *M. charantia*

PEAKS	COMPOUND NAME	MOLECULAR WEIGHT	COMPOSITION (%
1	Palmitic acid	256	11.8
2	Oleic acid	286	13.0
3	Stearic acid	642	29.5
4	14-methyl-8-hexadecyl-1-ol	252	11.6
5	Cis-9-Hexadecenal	238	11.0
6	9,2-octadecadien-1-ol	266	12.0
7	9-Hexadecenal	238	11.0
	Total FFA		99.9
	Total SFA		52.9
	Total USFA		47.0

Leave Sample

The fatty acid composition of *M. charantia* leaves samples showed twelve peaks representing twelve fatty acids of which six were unsaturated fatty acids.

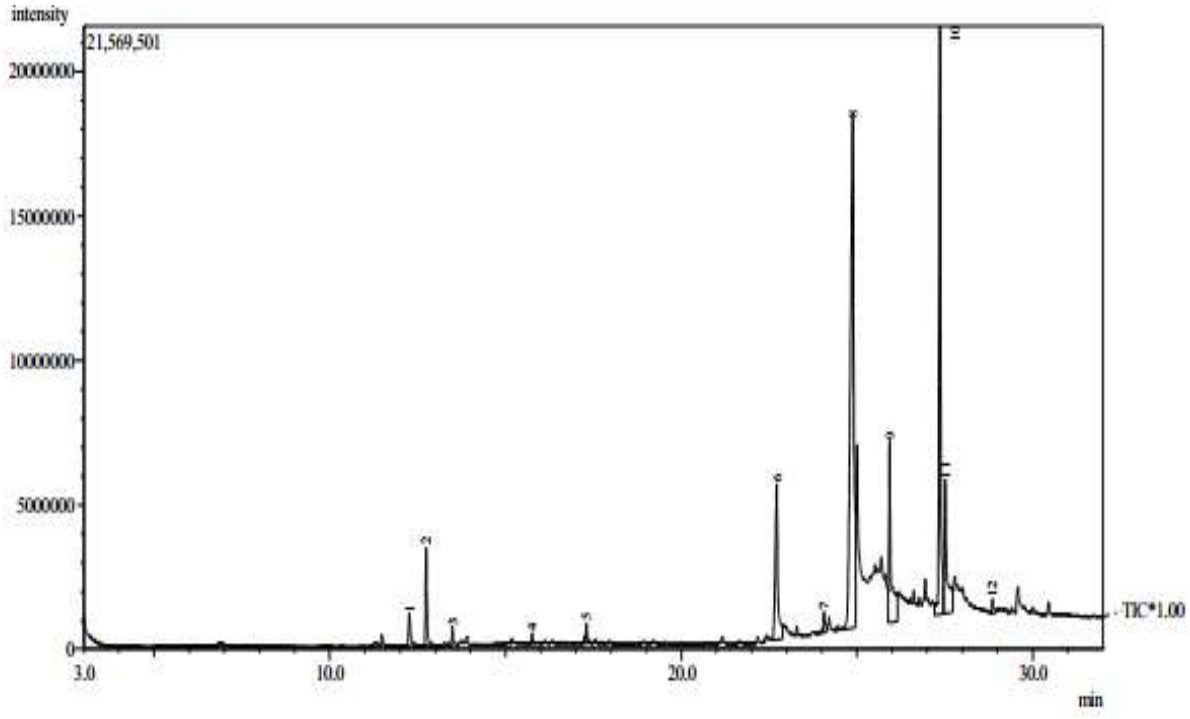

Figure 4: A graph showing fatty acid composition carried out on the leave sample of *M. charantia*

Table 2: Fatty acid composition (%) of leaves samples of *M. charantia*

PEAK (%)	COMPOUND NAME	MOLECULAR WEIGHT	COMPOSITION
1	2,4-Decadienal	152	4.45
2	2,4-Nonadienal	138	4.03
3	2-Undecenal	168	4.92
4	Phenol-3,5-bis(1,1-dimethyiethyl)	206	6.02
5	9-Octadecene	252	7.37
6	n-Hexadecanoic acid	256	7.49
7	Cyclotetracosane	336	9.83
8	Oleic acid	282	8.25
9	Dipalmitin	568	16.62
10	Cis-9-hexadecenal	238	6.96
11	Stearic acid	536	15.68
12	4-Dimethylsilyloxypentadecane	286	8.38
	Total FFA		100
	Total SFA		65.37
	Total USFA		34.63

4.4 Bitter Component Estimation

The chromatogram shows the estimated areas and retention time of the bitter composition of *M. charantia* seeds samples.

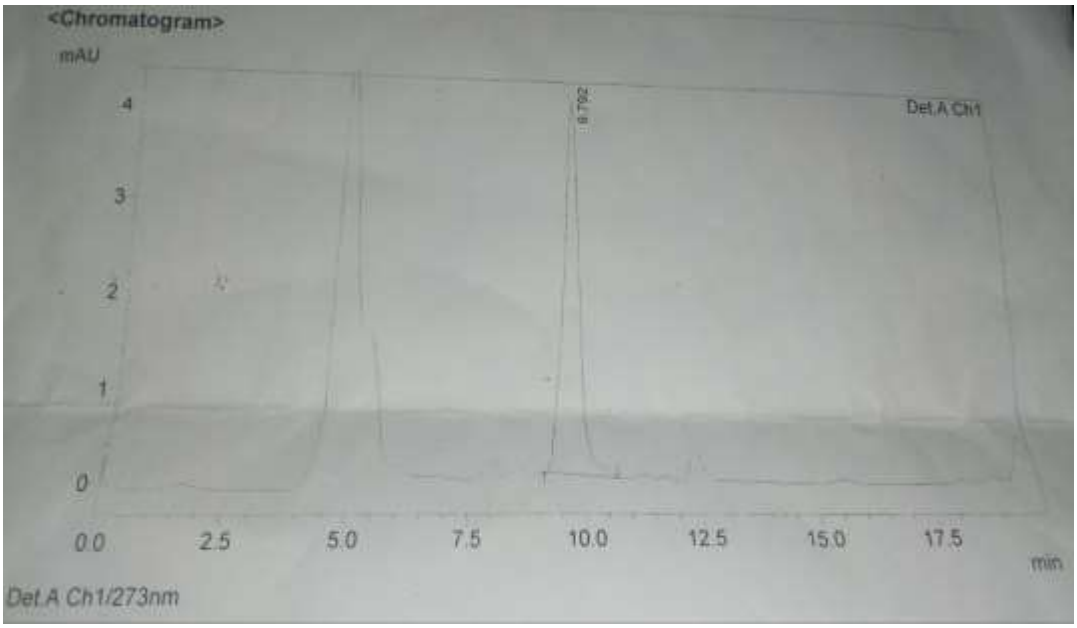

Figure 5: A chromatogram showing bitter component estimation of *M. charantia* seeds.

Table 3: Bitter component estimation in the seeds samples of M. charantia.

Peaks	Retention time	Area	Height
1 (STD)	10.027	111051	4192
2 (SAMPLE)	9.792	102355	4092

Discussion.

The results of proximate composition of *M. charaantia* are presented in table 1. The results of this study suggest that *M. charantia* leaves and seeds could serve as better sources of dietary carbohydrate, protein and lipids. The results revealed that there was significant differences in moisture content between the leaves samples (11.48%) and seeds samples (20.69%) at $P<0.05$ and this value is high when compared to (5.98%) value observed in *Hibiscus sabdariffa* seeds

(Anhwange *et al*., 2006). The values are low when compared to that reported in Afang seed (31.16%) and fluted pumpkin seed (54.8%) (Ekop, 2007) and *Annona muricata* leave (11.01%) (Usunobun *et al*., 2014). The low moisture content of *M. charantia* leaves indicates that it can be stored for a long time without spoilage compared to that of the seeds . The low moisture content would therefore hinder the growth of spoilage microorganisms and enhance shelf life in the leaves (Ruberto and Baratta, 2000). Ash content indicates the level of mineral deposits in plant material. The result of this study revealed that there was significant difference between leave sample (14.39%) and seed sample (9.83%) at $P<0.05$. The ash content of the samples were observed to be high compared to Gnetum Africanum (1.20%) (Ladan *et al*., 1996). The value of the seeds sample are low when compared to that reported in *Annona senegalensis* seed (12.1%) (Yisa *et al*., 2010) and Moringa oleifera (15.09%) (Antia *et al*., 2006). The results therefore suggest a slightly high deposit of mineral elements in *M. charantia* leaves and seeds sample. From the results of this study, the value of crude fat for both leaves and seed sample was observed to be (2.19%) and (11.88%) respectively at $P<0.05$. The values showed that there was significant differences between leaves and seeds samples. The values are low when compared to that reported in *A. senegalensis* seeds (24.0%) (Yisa *et al*., 2010). Thus, the crude fat value contributes to the energy value *M. charantia*. Dietary fat increases the palatability of food by absorbing and retaining flavours (Antia *et al*., 2006). The leaves and seeds samples of *M. charantia* contained crude protein value of (27.38%) and (19.78%) respectively. There was significant difference between these values at $P<0.05$. The values are high when compared to the value observed in *A. senegalensis* leaves (8.80%) (Yisa *et al*., 2010) and *Momordica foecide* (4.6%) leaves consumed in Nigeria and Swaziland (Hassan and Umar, 2006).). High amount of protein is essential for animal growth and increased milk production (Bailey, 2008). Plant proteins are a source of food nutrient especially

for the less privileged population in developing countries including Nigeria. *M. charantia* leave and seed can thus be considered a good source of protein because they provide more than 12% of caloric value from protein. Therefore, the protein content of the *M. charantia* leaves and seeds will go a long way in meeting the protein requirement of the local people. Further more, the protein content of *M. charantia* can make a significant contribution to dietary intake.

M. charantia leaves and seeds samples contained crude fibre value of (3.14%) and (26.09%) respectively. These values indicates that there is significanct difference between leaves and seeds samples at $P<0.05$. It reflects the high crude fibre content of *M. charantia* seed than in the leave. The values obtained are higher when compared to the values observed in some seed vegetable consumed in Nigeria such as Afang seed (0.80%) and fluted pumpkin seed (4.60%) (Ekop, 2007; Anhwange *et al*., 2006). The value for the seed is also higher when compared to that reported in *Annona senegalensis* s eed (17.60%) (Yisa *et al*., 2010). While the values are low compared to some leafy vegetable such as *Balanites aegyptiaca*(30.75%). Fibre cleanses the digestive tract by removing potential carcinogens from the body and prevents the absorption of excess cholesterol. Fibre also adds bulk to the diet and prevents the intake of excess starchy food (Mensah *et al.*, 2008) and may therefore guard against metabolic conditions such as hypercholesterolemia and diabetes mellitus (Henry, 2004). The substantial amount of fibre in *M. charantia* shows that they can help in keeping the digestive system healthy and functioning properly.

The carbohydrate value as shown in the result (41.08%) for leave sample and (11.54%) for seed sample are significantly different at $P<0.05$. This could be due to difference in crude fibre content, since carbohydrate is calculated by difference. However, the values are lower than reported values for *Corchorus tridens* (75.0%) and sweet potatoes leaves (82.80%) (Asibey – Berko and Taiye,

1999). Carbohydrates produced by plants are one of the three main energy sources in food, along with protein and fat.

Twenty amino acids are commonly known as components of protein. However, eighteen amino acids were recorded in all the samples (Table 2). Out of the eighteen amino acids identified, nine (9) are essential namely; tyrosine, Leucine, Isoleucine, lysine, cysteine, phenylalanine, valine, methionine and threonine and eight (8) are non-essential namely; proline, arginine, histidine, Alanine, glutamic acid, glycine, and serine. The results therefore show that the seeds and leaves proteins of *M. charantia* could compliment well with those protein sources that are low in some essential amino acids. These results are similar to those reported by (Onwuka, 2005) and those of *V. colorata* and *V. calvoana* (Adeyeye *et al.*, 2005). Comparatively, among the non-essential acids glutamic is high in the entire sample when compared to those of *C. nudiflora* 2.2 g/100 g and *Blighia sapida* (2.76 mg/100 g) (Beynen *et al.*, 2005). It is observed that glutamic acid, aspartic acid and leucine are the most abundant amino acid in the sample. Similar observation has been reported by (Olaofe and Akintayo, 2000).

The result of the fatty acid composition of *M. charantia* leaves and seeds (Tables 3 and 4) shows the presence of twelve e fatty acids for the leaves samples while that of the seed sample shows the presence of seven fatty acids. *M. charantia* leave and seeds samples has a total saturated fatty acid composition of (65.37%) and (52.90%) respectively, this means high consumption of *M. charantia* leaves can lead to elevation of LDL causing increased blood cholesterol, heart disease etc. compared to the seeds which is good to human health. The *M. charantia* seed is composed of more unsaturated fatty acids with a total value of (47.00%) compared to the leaves samples with value (34.63%) of the total fatty acids. The seeds of *M. charantia* has been shown to lower HDL production from its value and has shown to improve immunity, rheumatoid arthritis, vision, and

heart health. Linoleic acid (Omega-6-fatty acid) is an essential polyunsaturated acid and plays very important roles in human nutrition.

The result for the estimation of bitter component shows that Momordicin was the major compound responsible for the bitterness of *M. charantia* seeds from literature review. It was found that in 1 g of the powdered seeds samples, 3.8% (*w/w*) of Momordicin is present.

Conclusion

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

Conflicts of interest

None

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