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NUTRIENT PROFILING OF LEAVES AND SEEDS OF *MOMORDICA CHARANTIA* (BITTER MELON)

Ibrahim B*, Suleiman FU, Balogun EO

Department of Biochemistry, Faculty of Life Sciences,
Ahmadu Bello University, Zaria

***Author for Correspondence:** bashribb@gmail.com,

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 result 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; 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 (Saha et al. 2012; Anjum et al. 2013). 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.2011). 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 though 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, our objective was to determine the proximate, fatty acids, amino acids compositions of the leaves and seed of the plant. In addition, we also 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 and preparation

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

Analytical Methods:

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.

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 (AOAC, 2005).

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).

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.

Crude Fats/ Lipids

The sample was extracted with light petroleum, the solvent was distilled off and the dried extract was weighed.

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.

Fatty Acid Composition

Fatty acid composition was determined bygas chromatography coupled to mass spectrometry (GC-MS) using capillary column (HpInnowax Capillary; 60.0 m × 0.25mm × 0.25 µm). Fatty acid methyl ester was prepared using the method of (Garces and Mancha 1993).

Estimation of Bitter Component

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

Statistical analysis

Data obtained were expressed as mean ± standard deviation and analyzed using statistical package for social science (SPSS version 20). P ? 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

The results of proximate composition of M. charaantia presented in figure 1 suggest that M. charantia leaves and seeds could serve as better sources of dietary carbohydrate, protein and lipids.

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

PEAKS	COMPOUNDS	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

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

PEAKS	COMPOUNDS	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

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

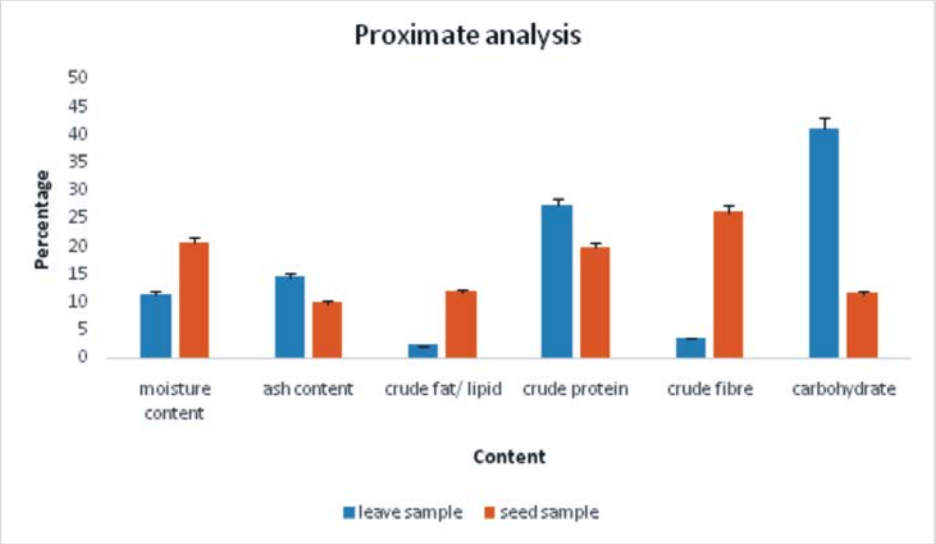

Figure 1: A graph showing proximate analysis carried out on the leaves and seeds samples of *M. charantia.*

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). 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±0.92carbohydrate 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.

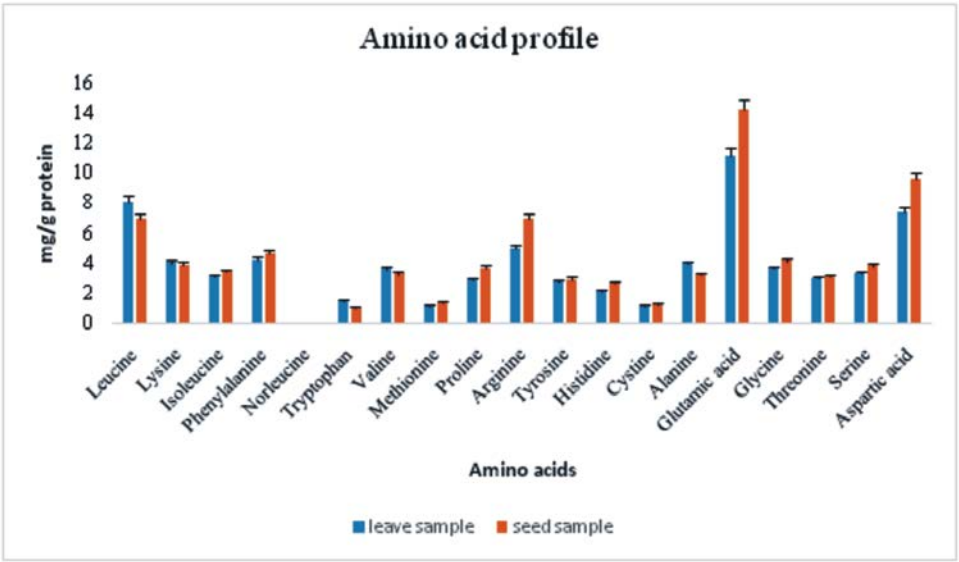

Figure 2: A graph showing the Amino acid profile of the leaves and seeds samples of *M. charantia.*

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.

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 for 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 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 for *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. Furthermore, 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 (figure 1). 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* seed (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 figure 1 (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 (Figure 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 *Blighiasapida* (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 1 and 2; Figures 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.

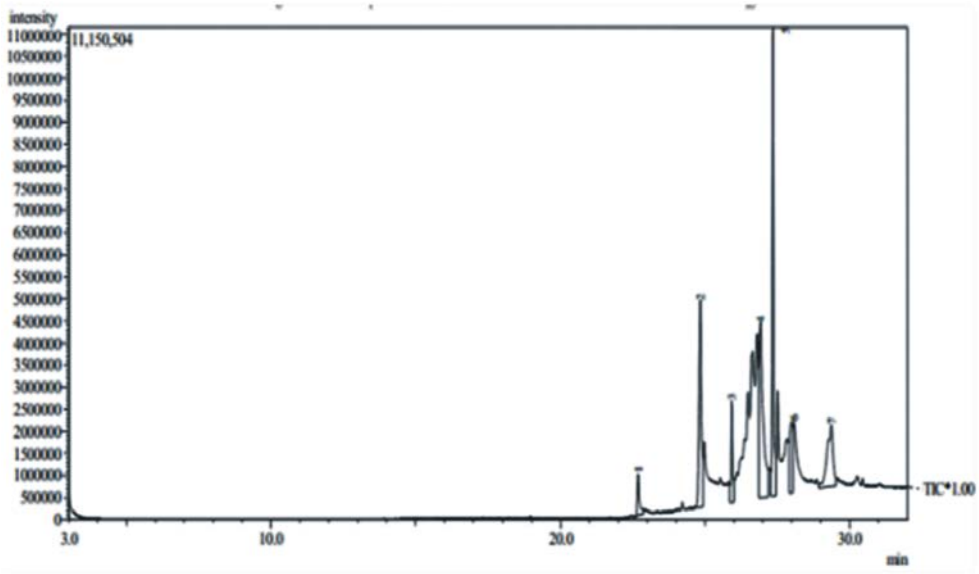

Figure 3: A graph showing fatty acid composition carried out on the seeds samples of *M. charantia.* The fatty acid composition of *M. charantia* seeds samples showed seven peaks representing seven fatty acids of which four were unsaturated fatty acids.

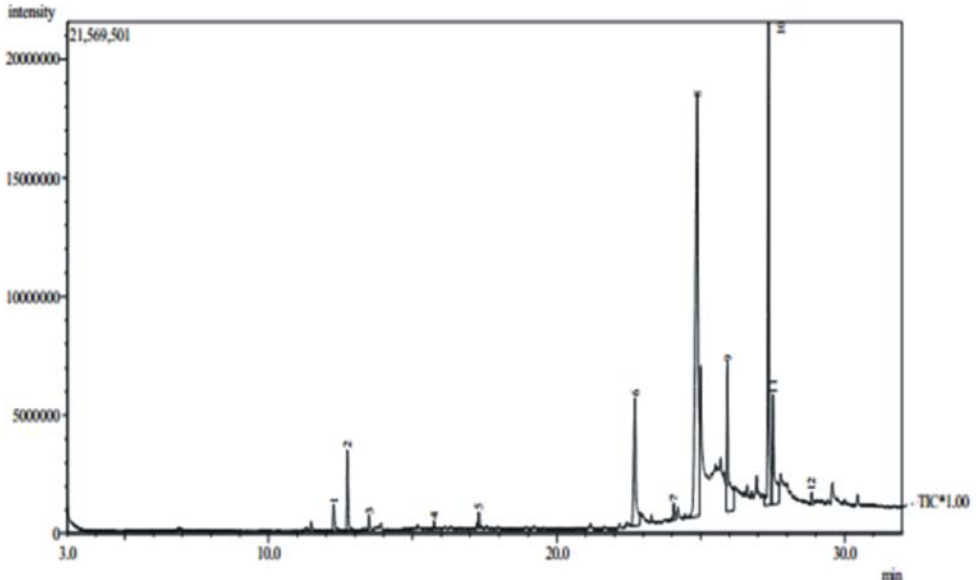

Figure 4: A graph showing fatty acid composition carried out on the leave sample of *M. charantia.* The fatty acid composition of *M. charantia* leaves samples showed twelve peaks representing twelve fatty acids of which six were unsaturated fatty acids.

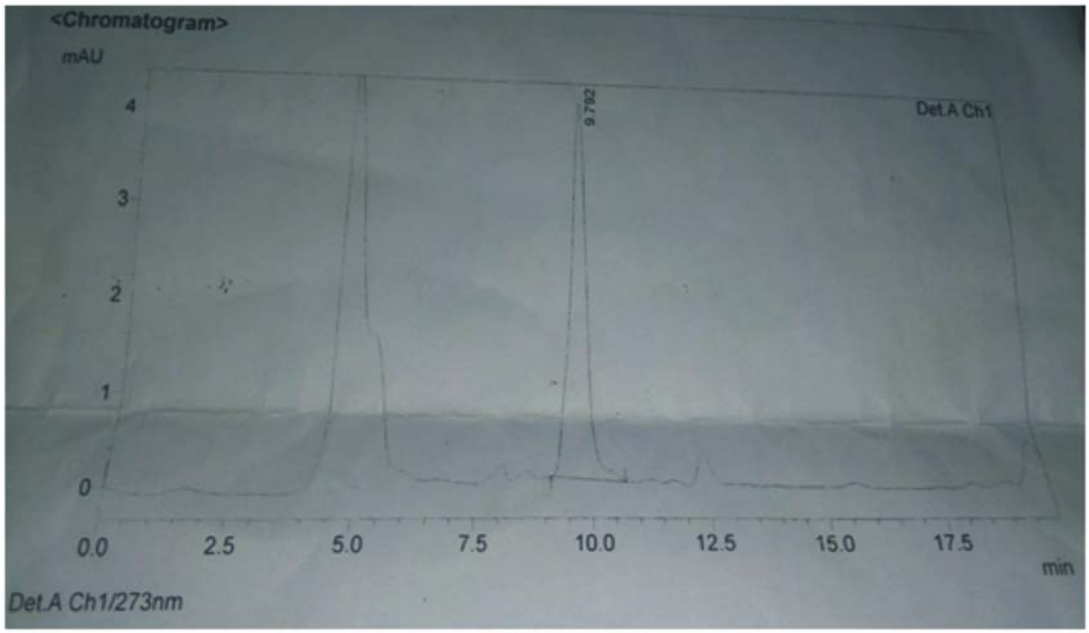

Figure 5: A chromatogram showing bitter component estimation of *M. charantia* seeds. The chromatogram shows the estimated areas and retention time of the bitter composition of *M. charantia* seeds samples.

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 have been shown to lower HDL production and also improve immunity, rheumatoid arthritis, vision, and heart well-being. 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 (Figure 5) 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 (Table 3).

CONCLUSION

The results of the analyses have 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 leaves 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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