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Elemental and Fatty Acid Content of Four Medicinal Plants: *Kaiempferia rotunda*, *Cuscuta reflexa*, *Centella asiatica* and *Asparagus racemosus*

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Authors' contributions

This work was performed in collaboration between all authors. Author IAJ designed the research study, wrote the protocol, supervised the whole research, manage the literature and write the manuscript. Author PNA managed the analysis and literature, wrote the manuscript. Authors ME and NA managed the research and analysis and literature searches. Author MRA managed the literature and manuscript writing. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The present study investigates the elemental and fatty acid content of four different medicinal plants, namely *Kaiempferia rotunda*, *Cuscuta reflexa*, *Centella asiatica* and *Asparagus racemosus*, grown in Bangladesh.
Methodology: Macro (Na, K), micro (Mg, Mn, Fe, Cu, Cr) and heavy metal (Cd, As) elements were determined quantitatively by flame photometer and atomic absorption spectroscopy (AAS) in the tubers of *K. rotunda*, the Arial parts of *C. reflexa* and *C. asiatica*, and the roots of *A. racemosus*. For the ascertainment of the fatty acid constituents, a gas chromatograph connected to mass spectrometer was used to analyze the methylated fatty acids.

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Results: The elemental contents of the plants were determined in considerable amounts (Na: 6950-17030 ppm; K: 21460-63310 ppm; Mg: 1.95-1868.07 ppm; Mn: 0.603-26.14 ppm; Fe: 0.1028-0.4394 ppm; Cu: 0.1118-0.2117 ppm; Cd: 0.0005-0.0854 ppm; Cr: 1.844-28.91 ppm, respectively). The essential fatty acids for growth maintenance such as heneicosanoic acid (1.86-12.08%), pentadecanoic acid (0.6-40.15%), hexadecanoic acid (9.17-29.74%), heptadecanoic acid (0.73-4.42%) and octadecanoic acid (7.68-11.11%) were detected in decent amounts in all four of the plants, respectively.

Conclusion: It can be said that the investigated medicinal plants are a good source of the elements Na, K, Mg and Cr, whereas Cu, Cd and Mn are only present in trace amounts. Significant amounts of fatty acids were also detected that come with immense biological properties.

Keywords: Kaiempferia rotunda; Cuscuta reflexa; Centella asiatica; Asparagus racemosus; GC-MS; AAS; elemental analysis; fat content.

1. INTRODUCTION

Kaempferia rotunda Linn (*K. rotunda*) commonly known as bhui champa, is a medicinal plant that belongs to the family of Zingiberaceae and the genus, Kaempferia. Coming from a family comprising of 49 genera and over 1000 species, the *K. rotunda* is widely distributed in the tropical analytical regions, especially in Indomalaysia, India, Myanmar, Srilanka, Thailand and Bangladesh. The plant is basically a stemless, rhizomatus herb with leaves that grow up to 30 cm in length. *K. rotunda* contains flavonoids that exhibit antiphlogistic and vitamin P activity. The tubers of the plant consist of essential oils and crotepoxide [1]. These are used as ointment to heal wounds, stomachic, aphrodisiac and gastric complaints, reducing swellings, cure for mumps, etc [2].

Cuscuta reflexa Roxb (*C. reflexa*) comes from the family of Apiaceae (Umbelliferae). These plants include branched tap roots and green, herbaceous stems [3]. The plant is said to be useful in maintaining homeostasis within the body by altering the process of nutrition and excretion and, in turn, restoring the normal functioning of the body system. It promotes flow of urine, reduces inflammation, purifies blood and soothes the nerves. In addition, it is also used for the treatment of leprosy, skin diseases, chronic inflammation and chronic ulcers, contagious sores, rheumatism, piles and dysentery [4,5]. *C. reflexa* is widely available in many regions of Bangladesh. The plant has been reported to show bradycardia, antispasmodic, anti-steroidogenic, antihypertensive, heamodynamic, anticonvulsant and antiviral activities [6]. Several chemical constituents were isolated from *C. reflexa*, which contains cuscutin, amarbelin, betasterol, stigmasterol, dulcitol, coumarin, myricetin, kaempferol, qurecetin and oleanolic acid [7].

Centella asiatica (*C. asiatica*) is more commonly known as mandukparni or Indian pennywort or jalbrahmi. These are perennial herbaceous plants belonging to the family of Umbellifere (Apiceae). *C. asiatica* is particularly fond of swampy areas, and is thereby widely available in most tropical and subtropical countries, such as India, Madagascar, Pakistan, South Africa, Sri Lanka, South Pacific and Eastern Europe. The active constituents of *C. asiatica* are flavonoids, saponins, fatty acids, essential acids and phytosterols, to name a few [8,9,10]. The plant comes with medicinal goods that include wound healing properties, venous insufficiency, sedative and anxiolytic properties, antidepressant properties, antiepileptic properties, cognitive and antioxidant properties, antinociceptive and anti-inflammatory properties and several other uses [11,12,13].

Asparagus racemosus (*A. racemosus*) belongs to the family LIliaceae and bears the common name Satawar, Satamuli and Satavari [14]. The plant is found in places with low altitudes, like Sri Lanka, India and the Himalayas. These develop to be around two metres tall and prefer to grow their roots in rocky earth [15]. A few well-known major active constituents of *A. racemosus* are steroidal saponins, essential oils, asparagines, arginine, tyrosine, flavonoids, resin and tannin [16]. In addition, the plant possesses a variety of pharmacological properties, which includes being antioxidants, anti-inflammatory, immune-stimulants, antihepatotoxic, antioxytoxic, antibacterial and reproductive agents. Other beneficial properties of *A. racemosus* are suggested in nervous disorders, diarrhea, tumors, dyspepsia, dysentery, hyper dipsia, inflammations, neuropathy, hepatopathy and several other harmful diseases [17,18].

The objective of this research work is to determine and analyze the elemental and fatty

acid content of four different, yet important, medicinal plants: *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*, and as a final point, suggest possible benefits and applications of these plants to the users.

2. MATERIALS AND METHODS

2.1 Experimental Section

All the chemicals and reagents used were purchased from BDH, E. Merck and were of analytical or laboratory grade.

2.2 Collection of Raw Materials

The plants *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus* were used for the investigation. The tubers of *K. rotunda* and the roots of *A. racemosus* were collected from Natore (Laxmipur, Kholabaria) in the Northern area of Bangladesh, while the plants *C. reflexa* and *C. asiatica* were brought in from Munshiganj, Dhaka, Bangladesh. All the plant materials were identified by an expert of the department of Botany, Haraganga University College, Munshiganj.

2.3 Preparation of Sample

The plant materials (*K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*) were freed from foreign materials by washing them under running tap water. In each case, the samples were first air dried, then shade dried and finally powdered before leaving them to dry in an electric oven at 40℃. The dried powdered samples were stored in an airtight container and left to stand in a cool place until further analysis.

2.4 Determination of Ash Content

The method of Premnath et al. [19] was employed for the determination of ash content of the plants. Furnace PLC/MBC/W1/32 was used to find the ash value.

2.5 Elemental Analysis of Samples by Atomic Absorption Spectroscopy (AAS)

The ashes collected from the plant samples were subjected to the elemental analysis using Flame Photometer and Atomic Absorption Spectroscopy (AAS).

2.5.1 Preparation of sample

The samples (*K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*) were prepared by adding 1:1 nitric acid to each of them at low flame to get rid of any carbonaceous matter present in the ash. Once they have cooled, 2-3 drops of concentrated nitric acid were added to completely dissolve the plant materials. The solutions were then leveled to the volume mark with distilled water and used as stock solutions for analysis of minerals by AAS.

2.5.2 Calculations

A standard was used to plot a calibration curve for each of the elements. The curve for experimental sample was determined with respect to this standard curve.

A definite volume of the stock solution was passed through the AAS and a corresponding curve was observed. If the value of any of the minerals exceeded the standard curve, the stock solution was diluted by adding solvent to it and reused.

Data collected from the AAS method were converted to obtain the percentage elemental contents in dry samples. The elemental contents were then calculated by using the following equation:

Ppm (mg/kg) of elemental content = [Elemental content obtained (ppm)/Sample taken (g)] x 1000.

2.6 Fatty Acids Analysis by Gas Chromatography Mass Spectrometry (GC-MS)

Fatty acids (FA) are nonvolatile polar compounds. The analyzed sample needs to be volatile for gas chromatographic technique [20]. Fatty esters were formed by methylation to convert the nonvolatile fatty acids into volatile fatty acids methyl esters or FAMEs. Fats were saponified and esterified in presence of borontrifluoride catalyst. For further analysis, GC-MS method was applied [21].

2.6.1 Chemicals and reagents used

Methanol (10%), 0.5N methanolic sodium hydroxide (NaOH) solution, boron trifluoride solution (BF_3), sodium chloride (NaCl), n-hexane, helium gas (99.99%), fatty acid methyl esters (FAMEs), tridecanoic acid methyl ester and n-hexane extract of the plants were used.

2.6.2 Preparation of standards

The internal standard was prepared by dissolving 13.7 mg tridecanoic acid methyl ester in 1 ml hexane. Next, n-hexane extract (10 mg) was diluted in FAMEs mix standard (10 ml) with dichloromethane ($CHCl_2$) for make the external standard.

2.6.3 Preparation of sample

The powdered plant materials of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. rasemosus* were extracted separately with n-hexane for 6 hours in soxhlet apparatus to obtain the corresponding fractions. Solvents were filtered through Whatman filter paper No. 1 (Bibby RE200, Sterilin Ltd., UK) and the filtrates were evaporated to dryness under reduced pressure using a rotary vacuum evaporator (R-215, Buchi, Switzerland). The extracted crude fats were taken for analysis. The procedure was carried out thrice to calculate the mean value of the samples.

2.6.4 Methodology used in GC-MS analysis

Analysis was carried out by GC-MS electron impact ionization (IE) method no. GC-17A. A gas chromatograph (Shimadzu, Japan) coupled to mass spectrometer QP 5050A (Tokyo, Japan) fused with a silica column having specifications, 30 m x 0.25 mm I,d Coated with Db-1 (j & w) and 0.25 µm film thickness was used. The carrier gas consisted of helium. The column temperature was maintained between 40℃ (2 min) to 250℃ at the rate of 1 min per injection. The port temperature was held at 250℃ at a constant pressure of 100 Kappa and a flow rate of 20 ml/min. The acquisition parameters full scan range between 40-450 amu.

The standard procedure was used for the determination of fatty acid content. 0.1 ml of the internal standard and 80 ml methanolic NaOH (0.5 N) were added in 500 mg sample. The solution was heated for 1 hour by refluxing it in boiling water. Extra base, when required, was added to neutralize the HCl. The samples were then cooled and 20 ml of BF_3-methanol complex was added to each. Sample solutions were again heated in a boiling water bath for about 45 minutes. Once cooled, the methyl ester of the fatty acid was isolated by partitioning it twice with n-hexane and water before being filtered, dried and subjected to GC-MS scheme [22].

2.7 Statistical Analysis

Each experiment was performed in triplicate and results are expressed as mean ± standard deviation (n = 3).

3. RESULTS

3.1 Determination of ash content

The ash values of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus* were found to be 13.7481%, 6.8420%, 16.8534% and 10.5010%, respectively.

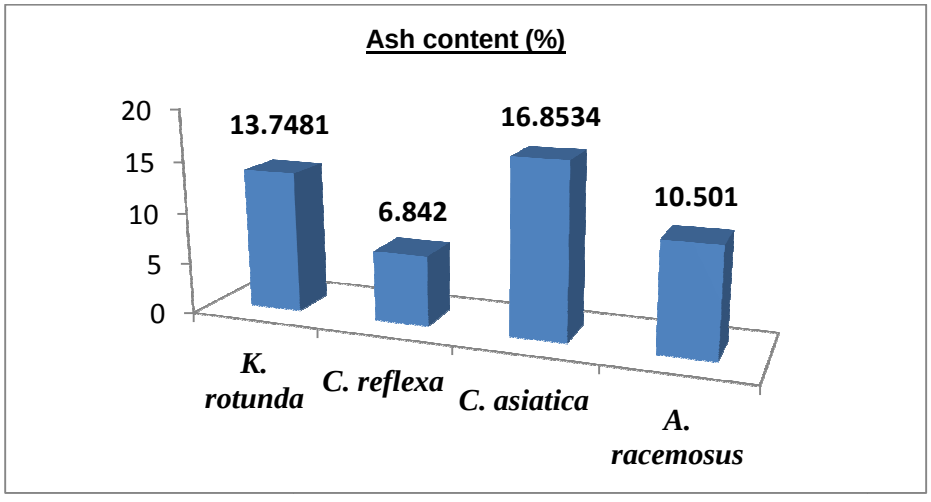

Fig. 1. Determination of ash content (dry weight basis) of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*

3.2 Elemental Analysis

The elemental contents of the plants *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus* are summarized in Table 1.

Sodium: The plant with the highest sodium content was found to be *K. rotunda* (17030 ppm) followed by *C. asiatica* (14180 ppm). The rest of the plant specimens also showed moderate to sodium contents: *C. reflexa* (7260 ppm) and *A. racemosus* (6950 ppm).

Potassium: The richest source of potassium was *K. rotunda* (63310 ppm). The potassium content of all other plant species ranged from a high value of 43090 ppm (*C. asiatica*) to a relatively lower 27160 ppm (*A. racemosus*) and 21460 ppm (*C. reflexa*), respectively.

Magnesium: The highest percentage content of magnesium was obtained by *C. asiatica* (1868.07 ppm). The other plant minerals held a magnesium content somewhere between 1.95 and 996.85 ppm (*K. rotunda*: 1.95 ppm, *C. reflexa*: 5.58 ppm and *A. racemosus*: 996.85 ppm, respectively).

Manganese: With the exception of *C. reflexa*, which was found below the detectable levels of <10 µg/g, the three other plants were detected to contain a manganese content ranging from 0.603 ppm to 26.14 ppm. That being said, *C. asiatica* showed the highest manganese content (26.14 ppm) followed by *A. racemosus* (13.07 pppm) and K. rotunda (0.603 ppm).

Iron: *C. reflexa* was found to have the highest iron content (0.4394 ppm) followed by *C. asiatica* (0.1028 ppm). The rest of the plants (*K. rotunda* and *A. racemosus*) showed values lower than detectable levels of iron (<10 µg/g).

Copper: Levels of copper fell in the range of 0.1118-0.2117 ppm with *C. reflexa* demonstrating the highest amount (0.2117 ppm), followed by *K. rotunda* (0.2111 ppm), A. racemosus (0.1293 ppm) and then *C. asiatica* (0.1118 ppm).

Cadmium: All four plants indicated low cadmium contents with the order being *C. asiatica*: 0.0854 ppm> *A. racemosus*: 0.0179 ppm> *K. rotunda*: 0.0105 ppm> *C. reflexa*: 0.0005 ppm.

Chromium: For all the plants analyzed, *K. rotunda* was found to hold the highest relative percentage content for chromium (28.91 ppm). This was followed by *C. reflexa* with a second highest value of 13.27 ppm. The third plant in the row is *A. racemosus*, consisting of approximately 6.638 ppm chromium. The plant with the lowest chromium content was *C. asiatica* comprising of a low amount of 1.844 ppm.

Arsenic: The arsenic content of all the plants were found below the detectable levels of 10 µg/g.

3.3 Fatty acids analysis by Gas Chromatography Mass Spectrometry (GC-MS)

Table 2 lists the names of the fatty acids as well as their relative percentage composition obtained from the gas chromatography mass spectrometry (GC-MS) analysis of the n-hexane extracts of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*. The plant samples contain a fairly good fatty acid content with pentadecanoic acid and hexadecanoic acid being present in significant amounts. Heneicosanoic acid, heptadecanoic acid, stearic acid and octadecanoic acid were also obtained in moderate amounts in all four of the plants. All other fatty acids were either only detected in moderate to trace quantities in one plant or the other, or not detected at all.

Table 1. Determination of elemental content (dry weight basis) of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*

Name of plants	Elemental content (ppm)								
	Na	K	Mg	Mn	Fe	Cu	Cd	Cr	As
K. rotunda	17030	63.310	1.95	0.603	NF	0.2111	0.0105	28.91	NF
C. reflexa	7.260	27.160	5.58	NF	0.4394	0.2117	0.0005	13.27	NF
C. asiatica	14.180	43090	1868.07	26.14	0.1028	0.1118	0.0854	1.844	NF
A. racemosus	6.950	21.460	996.85	13.07	NF	0.1293	0.0179	6.638	NF

**NF= Not found*

Table 2. Compositions of methylated fatty acid of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*

Fatty acid	Common name	Structural formula	Lipid numbers	Relative percentage content (%)			
				K. rotunda	*C. reflexa*	*C. asiatica*	*A. racemosus*
Heneicosanoic acid	Heneicosylic acid	$CH_3(CH_2)_{19}COOH$	C21:0	1.86	5.05	2.19	12.08
Dodecanoic acid	Lauric acid	$CH_3(CH_2)_{10}COOH$	C12:0	NF	NF	NF	0.49
Tetradecanoic acid	Myristic acid	$CH_3(CH_2)_{12}COOH$	C14:0	NF	0.92	2.53	1.97
Pentadecanoic acid	Pentadecylic acid	$CH_3(CH_2)_{13}COOH$	C15:0	0.60	23.04	37.31	40.15
Hexadecanoic acid	Palmitic acid	$CH_3(CH_2)_{14}COOH$	C16:0	25.11	9.17	9.96	29.74
Heptadecanoic acid	Margaric acid	$CH_3(CH_2)_{15}COOH$	C17:0	0.73	1.48	3.28	4.42
9,12-Octadecadienoic acid	Linolenic acid	$CH_3CH_2CH=CHCH_2CH=CHCH_2CH=CH(CH_2)_7COOH$	C18:0	19.32	NF	NF	NF
Eicosanoic acid	Arachidic acid	$CH_3(CH_2)_{18}COOH$	C20:0	1.48	NF	1.39	NF
Nonanoic acid	Pelargonic acid	$CH_3(CH_2)_7COOH$	C9:0	NF	NF	1.03	NF
Nonadecanoic acid	Nonadecylic acid	$CH_3(CH_2)_{17}COOH$	C19:0	NF	4.36	NF	2.72
Octadecanoic acid	Stearic acid	$CH_3(CH_2)_{16}COOH$	C18:0	11.11	7.68	8.34	8.08

**NF=Not found*

4. DISCUSSION

Table 1 refers to the elemental content (dry weight basis) of *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*. Looking into previous studies on ash content determination of the currently investigated medicinal plants (*K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus*), it was found that the plants have always reported to demonstrate decent percentage ash content. Based on previous investigations, the percentage ash contents of the plants ranged from as low as 4.3% to a relatively high 12%. On average, the *K. rotunda* plants tend to show a percent ash content of 5.261%, whereas we detected a value close to 14% [23]. The *C. reflexa* plants are usually not over 5.2% w/w when it comes to ash content, while an approximate value of 6.8% was obtained in the present study [24]. Reports on the *C. asiatica* plants were found to state nearly 12% [25]. In comparison to previously reported literatures, our analysis of *C. asiatica* presented an even higher ash content of roughly 17%. The last in the row is *A. racemosus*. These plants are usually rich in Ca, Mg, Fe, Cu, Zn and a few other elements. Previous investigations report an ash content of close to 4.3%, while we detected something around 10.5% [26].

Table 2 presents the elemental concentrations in the plant samples considered in this study. The results of the elemental analysis clearly show that the investigated plant parts have considerable amount of mineral elements. Nonetheless, these results become all the more important when the usefulness of such minerals like Na, K, Mg, Mn, Fe, Cu, Cd, Cr and As is considered in the human body.

Sodium (Na) is one of the chief extracellular ions in the human body. The relatively low Na content in the investigated plants is an added advantage because of the direct relationship of sodium intake with hypertension in human [27].

Potassium (K) is the principal intracellular cation and helps to regulate osmotic pressure and pH level. Elements such as potassium (K), chromium (Cr) and magnesium (Mg) play an important role in the maintenance of normal glucose-tolerance and in the release of insulin from beta cells of islets of langerhans [28]. The plants investigated are all a good source of potassium. *C. asiatica* and *A. racemosus* are rich in magnesium, while *K. rotunda* and *C. reflexa* are a good source of chromium. These may facilitate the efficient release of insulin from beta-cells keeping blood pressure in control and thus, protecting against diabetes [29].

Manganese (Mn) is a mineral naturally occurring in our bodies in very small amounts. Manganese is a real component of the enzyme manganese super oxide dismutase. The enzyme acts as a powerful antioxidant that seeks out the free radicals in the human body and neutralizes these harmful particles, thus safeguarding against so many of the potential dangers they cause.

Iron (Fe), when consumed in balanced amount in the human diet, provides a handful of benefits that include hemoglobin formation, muscle function, brain function, regulation of body temperature and synthesis of neurotransmitters, to mention a few.

The health benefits of copper (Cu) are vital for an overall healthy existence, as this mineral enables normal metabolic process in association with amino acids and vitamins.

Cadmium (Cd) is a toxic element and was detected in the samples in very low concentration. Based on pharmacological and toxicological reports, the concentrations of this element present in the samples analyzed is low enough to not cause any kind of harmful effects.

Chromium (Cr) is a mineral required by our bodies in small amounts for healthy body functions. The element aids in moving blood sugar (glucose) from the bloodstream into the cells to be used as energy and to convert carbohydrates, fats, and proteins into energy.

Arsenic (As) is a poisonous element that not only increases risks of cancer in the skin, lungs, bladder and kidney, but it also causes other skin changes such as hyperkeratosis and pigmentation.

The difference in the medicinal plants is mostly ascribed to the differences in the preferential absorption of the plants and also the mineral composition of the soil in which the plants inhabit. Few other factors that explain for the variations in concentration may include use of fertilizers, the climatic conditions and irrigation water.

The analysis of fatty acid from *K. rotunda*, *C. reflexa*, *C. asiatica* and *A. racemosus* by GC-MS showed that it contains various bioactive

constituents including heneicosanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, stearic acid and octadecanoic acid in major concentration.

Heneicosanoic acid (HEA) is a fatty acid found in the fat in human milk. The fatty acid plays a part in the phospholipids of the articular cartilage boundary lubricant. HEA is a constituent of red blood cell fatty acids.

Myristic acid, also known as tetradecanoic acid is a fatty acid that comes with a range of uses in the beauty industry. It is used as an opacifying agent, fragrance ingredient, cleansing agent, surfactant and emulsifier. Myristic acid has a high rate of absorption by the skin and therefore acts as a good lubricant.

Palmitic acid is a major component in the oils from palm trees, such as palm oil, coconut oil, etc. Regular intake of this fatty acid can increase risk of cardiovascular diseases. However, if took in moderate amounts, the compound is capable of demonstrating antioxidant and anti-atherosclerotic properties.

Heptadecanoic acid or more commonly known as the margaric acid is currently of great interest to scientists and researchers. In a recent study on saturated fatty acid consumption to reduce coronary risk, it was revealed that the circulating margaric acid (a diary fat) significantly reduced the risk of cardiovascular disease.

Linoleic acid is essential for maintenance of growth and shown to be potent cycloxygenase-2 (COX-2) catalyzed prostaglandin biosynthesis inhibitors [30].

Stearic acid is used to produce margarines and spreads, and is a popular ingredient for baked food items. Regardless of stearic acid being a saturated fat, results from previous workings suggest that the fatty acid has very little effect on blood cholesterol levels. This is due to the fact that such a high proportion of stearic acid is converted to oleic acid. For this reason, fats rich in stearic acid might be used in place of those high in palmitic acid in cholesterol-lowering diets [31].

Another name for eicosanoic acid is arachidic acid or arachic acid. It is a kind of omega-6 fatty acid that pays a role in inflammation. It is particularly vital to health because it helps to maintain brain functions, regulate growth and lowering the risk of heart disease.

Phytochemical analysis by GC-MS revealed presence of fatty acid esters and amides, diterpene alcohols, terpenoids, and phytols as major compound groups in the hexane fractions. Compositional variation in structural features and quantities may affect compound behavior on GC-MS, and bioactivities of their previous fractions.

5. CONCLUSION

The main components of human body are carbon, oxygen, hydrogen and nitrogen. These four elements comprise the 96% of human body weight. The remaining percentage comes as mineral such as sodium, potassium, magnesium, manganese, iron, copper and chromium, etc. These minerals are required in trace amounts from day to day for building tissues and maintaining the life process of the body cells. Nevertheless, the concentration of the minerals present in these plant sources varies to great extent with changing geographical conditions i.e. soil, climate, etc.

Considerable amount of macro (Na, K) and micro (Mg, Mn, Fe, Cu, Cd and Cr) elements are present in the investigated plants. The presence of these elements can make the plants a potential source of food and drug. These will be helpful in the synthesis of new ayurvedic drugs that will have use in controlling or containing various diseases. However, further study is necessary to quantify, isolate, characterize and to evaluate biological activity of the particular compound for drug development.

Fatty acids are of great significance when it comes to food nutrition evaluation, pharmacology and disease diagnosing [32]. The saturated fatty acids aid in reducing cardiovascular risks and improving liver, lungs and brain health, while the unsaturated (monounsaturated or polyunsaturated) fatty acids are frequently used for declining heart diseases and inflammation and increasing the total body immunity [33,34]. From the results of this study, it could be concluded that the plants under investigation contain appreciable amounts of fatty acids, which may serve as beneficial health sources and if consumed regularly can be used as food supplements.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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