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ESSENTIAL OIL COMPOSITIONS OF *BASELLA ALBA* LINNAEUS AND *CNIDOSCOLUS ACONITIFOLIUS* (MILL.) JOHNSON

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ABSTRACT

Basella alba Linnaeus and *Cnidoscolus aconitifolius* (Mill.) Johnson are vegetable plants that play important roles in human diet for maintenance of health and prevention of diseases. Essential oils (EOs) of fresh samples obtained by hydro-distillation method in an all-glass clevenger apparatus gave percentage yields of 0.03, 0.08 and 0.18 for *Basella alba* leaf, *Basella alba* stem and *Cnidoscolus aconitifolius leaf* respectively. The essential oils were characterized using gas chromatography (GC), gas chromatography-mass spectrometry [GC-MS]. Leaf and stem EOs of *B. alba* showed ten and twelve compounds accounting for 96.65% and 97.93% of the oils respectively. Major constituent of *B. alba* leaf was phytol (57.40%) while that of *B. alba* stem was 2-bornene (71.73%). *B. alba* stem was dominated by hydrocarbon monoterpenes (75.11%) while *B. alba* leaf was rich in oxygenated diterpenes (57.40%). *B. alba* stem has the highest total terpenes of 87.52% while *B. alba* leaf has total terpene of 60.81%. Twenty-five compounds were identified in *C. aconitifolius* leaf essential oil accounting for 92.26% with 2-methylhexacosane (30.80%) having the highest composition. The leaf essential oil of *C. aconitifolius* has total terpenes of 3.23%. Various bioactive compounds present in essential oils of these vegetable plants and varieties in their chemical structure may be responsible for their biological activities and hence justifies their nutritive and medicinal uses.

KEYWORDS: Essential oils, *Basella alba*, *Cnidoscolus aconitifolius*, Terpenoids, Gas Chromatography-Mass spectrometry, Hydro-distillation.

1. INTRODUCTION

Plant sources has been used in medicine in time past and thus play vital role among the rural dwellers and are used in the treatment and prevention of specific diseases that affect man and animals. Some of these medicinal plants are known to be good vegetables, having both medicinal and nutritional properties.[1] They contain variety of bioactive compounds such as terpenes, which are composed in essential oils. Terpenoids found in greatest abundance in essential oils are the monoterpenes and sesquiterpenes; however, diterpenes may be present mostly when the essential oils are extracted with organic solvents.[2] Nigeria is blessed with abundant supply of both cultivated and non-cultivated vegetables that grow seasonally. Fruits and vegetables are the greatest sources of phytochemicals and facts have emerged that some nutritional content of these vegetables have potentials in reducing some diseases in man, some of these diseases includes high blood pressure, heart attack, stroke and other cardiovascular diseases.[3,4] *Basella alba* and *Cnidoscolus aconitifolius* are vegetable plants known for their therapeutic values, notably in Nigeria and India.

Basella alba Linnaeus belong to the family Basellaceae. It is an important green leafy vegetable found in tropical region of the world with great ethno-medicinal importance.[5] It is locally called "efo Amunututu" among the yorubas in western part of Nigeria. It has been used for the treatment of anaemia in women, coughs and cold related infections.[6] Root and leaves of *B. alba* have been used for the treatment of after-birth stomach pains and to increase milk production. The purple sap from fruits is used as a colouring agent in pasteries and sweets.[7] *B. alba* contains flavonoids, ascorbic acid and phenolic compounds and also possesses antioxidant and anticancer activities.[8,9]

Cnidoscolus aconitifolius (Mill.) Johnson belong to the family Euphorbiaceae. It is a large, fast growing leafy perennial shrub, common to Yacutan Peninsula of Mexico in Central America.[10] The plant is commonly called Chaya, Iyana-paja, or tree spinach depending on the regional source. *C. aconitifolius* is commonly eaten in Nigeria as vegetable, it is an essential source of protein, vitamins, minerals and antioxidants.[11] *C. aconitifolius* shoots and leaves have been taken as laxatives, diuretic and circulatory stimulant. These have also been used to improve digestion, stimulate lactation and harden the fingernails.[12] It has been recommended for a number of ailments including digestion, kidney stones, hemorrhoids, eye problems, atherosclerosis, gall stone, high cholesterol, insomnia and brain impairment.[13,14,15,16] The aqueous leaf extract has been used as a female contraceptive.[17]

Antibacterial, antidiabetic and ameliorative effects of various extracts of *C. aconitifolius* on anaemia and osmotic fragility induced by protein energy malnutrition have been reported.[18,19,20] The leaf is used as amethystic agent in reducing alcohol absorption.[21] There has been a report on GC-MS analysis of the leaf aqueous extract of *C. aconitifolius*.[22] but no information on the essential oil compositions. Hence, this study investigated the chemical constituents of the essential oils from leaf and stem of *Basella alba* and leaf of *Cnidoscolus aconitifolius.*

2. MATERIALS AND METHODS

2.1 Sample Collection and preparation

Fresh samples of *Basella alba* (leaf - 1297 g, stem - 1436 g) and *Cnidoscolus aconitifolius* leaf (602 g) plants were collected in Bodija Ibadan Nigeria, identified and authenticated at Forest Research Institute of Nigeria (FRIN), Ibadan where herbarium specimens were deposited with herbarium numbers: FHI 112011 and FHI 112010 respectively for future references. The surface area was increased by cutting the fresh parts of these plants into smaller portions.

2.2 Extraction the essential oils

Each of the plant parts was hydro-distilled separately using an all glass-Clevenger apparatus for 3 hours.[23] Oils were collected under iced condition with distilled n-hexane (1.5 mL), which the analyzing GC corrected. The oils obtained were stored under refrigeration at 4^{o}C until ready for analysis.

2.3 Gas Chromatography - Mass Spectrometry (GC – MS)

Essential oils were analyzed by GC-MS using a Shimadu GCMS-QP2010 Ultra operated in the electron impact (EI) mode (electron energy = 70 eV), scan range = 40-400 atomic mass units, scan rate = 3.0 scans/s and GC-MS solution software. The GC column was a ZB-5 fused silica capillary column with a (5% phenyl)-polymethylsiloxane stationary phase and film thickness of 0.25 µm. the carrier gas was helium with a column head pressure of 525 kPa and flow rate of 1.37 mL/min. Injector temperature was 250^{o}C and the ion source temperature was 200^{o}C. The GC oven temperature program was programmed for 50^{o}C initial temperature, temperature increased at a rate of 2^{o}C/min to 260^{o}C. A 5% w/v solution of the sample in CH_2Cl_2 was prepared and 0.1 µL was injected with a splitting mode (30:1). Identification of the oil components was based on their retention indices and retention time determined by reference to a homologous series of *n*-alkanes and by comparison of their mass spectral

fragmentation patterns with those reported in the literature and stored in our in-house MS library.

3. RESULT AND DISCUSSION

3.1 Results

Essential oils from *Basella alba* (leaf and stem) and *Cnidoscolus aconitifolius* leaf gave colourless leafy aroma. The percentage yields obtained were 0.03, 0.08 and 0.18 for *Basella alba* leaf, *Basella alba* stem and *Cnidoscolus aconitifolius* leaf respectively [Table 1]. The chromatograms obtained from the gas chromatography [GC], gas chromatography-mass spectrometry [GC-MS] analysis were presented in figures 1, 2 and 3. Ten, twelve and twenty-five compounds were identified in *B. alba* leaf, *B. alba* stem and *C. aconitifolius* leaf essential oils respectively [Table 2 and 3]. Comparison of the amount of the classes of compounds found in the plants essential oils studied was presented in table 4. Ten and twelve compounds identified in *B. alba* leaf and stem accounted for 96.65% and 97.93% of the essential oils respectively. Twenty-five compounds identified in *C. aconitifolius* leaf are responsible for 92.26% of it. Dominant compounds (in %) of leaf essential oil of *B. alba* were phytol (57.40), 3-dodecanol (7.08) and pentyl isobutanoate (7.03) while major compounds (in %) of stem essential oil of *B. alba* were 2-bornene (71.73), n-nonanal (7.31) and isoborneol (4.74). Abundant compounds (in %) of leaf essential oil of C. *aconitifolius leaf* were 2-methylhexacosane (30.80), eicosanal (11.56) and 2E-hexenal (10.43). Classes of compounds (in %) evaluated in the leaf essential oils of *B. alba* were hydrocarbon monoterpenes (3.41) and oxygenated diterpenes (57.40) accounting total terpene of 60.81%. Classes of compounds (%) in the stem essential oils of *B. alba* are hydrocarbon monoterpenes (75.11), oxygenated monoterpenes (7.09) and oxygenated sesquiterpenes (5.32) which gave total terpene of 87.52% while classes of compounds (%) evaluated in the leaf essential oils of *C. aconitifolius* were oxygenated monoterpenes (1.55) and oxygenated sesquiterpenes (1.68) that yielded total terpene of 3.23%.

Table 1: Essential oils extracted from *Basella alba* and *Cnidoscolus aconitifolius.*

Plant part	Weight of samples (g)	Weight of essential oil (g)	% yield of essential oil
Basella alba leaf	1297	0.39	0.03
Basella alba stem	1436	1.15	0.08
Cnidoscolus aconitifolius leaf	602	1.08	0.18

3.2 Discussion

The presence of oxygenated compounds (terpenoids) in these oils are important quality determining factor, they are known to have flavouring and pharmacological properties as well as being important precursors in acetate and shikimate biosynthesis of important metabolites.[24] The leaf oil of *B. alba* had phytol (57.40%), an oxygenated diterpene as the most prominent compound. Phytol is a precursor for vitamins E and is used along with simple sugar as a hardener in candles. Phytol is also an important compound used in cosmetics, shampoos, toilet soaps and household cleaners. It possesses antimicrobial, anticancer, antidiuretic, antioxidant, anti-inflammatory, anti-allergic, antinociceptive and chemopreventive properties and used in vaccine formulations.[25,26,27] Phytol has also been reported to shown antimicrobial activity against *Mycobacterium tuberculosis* and *Staphylococcus aureus.*[28,29] Bornylene also called 2-bornene (71.73%) is a bicyclic monoterpenes which are very useful, not only in pharmaceutical but also in food and cosmetic industry. Bicyclic monoterpenes possess very useful biological activities such as anticancer, antibacterial, antifungal and antioxidant activities.[30] An alcohol, 3-methyl pentanol was common to both the leaf and stem essential oils of *B. alba*. Leaf essential oil of *Cnidoscolus aconitifolius* contains 2- methylhexacosane (30.80%) which has been reported to decrease blood cholesterol in the body and also possesses antimicrobial activity.[31] The constituents identified in *B. alba* and *C. aconitifolius* could be responsible for the medicinal and nutritional values of the plants.

Table 2: Chemical composition of essential oils from *Basella alba* leaf and stem.

S./N.	RI	Compound	% Composition	
			Leaf	stem
1	838	3-methyl Pentanol	5.70	0.84
2	850	7-methyl Oct-1-ene	2.91	-
3	892	2-Bornene	-	71.73
4	933	Cyclofenchene	-	1.22
5	937	Tetrahydrocitronellene	-	0.15
6	950	Camphene	-	1.36
7	978	β-Pinene	-	0.65
8	987	Myrcene	3.41	-
9	1053	Pentyl isobutanoate	7.03	-
10	1058	3-methyl Decane	2.72	-
11	1104	n-Nonanal	-	7.31
12	1279	Octen-3-ol butanoate (1-)	2.60	-
13	1397	Tetradecane	2.95	-
14	1150	Trans-Beta Terpineol	-	2.35
15	1155	Isoborneol	-	4.74

16	1172	2-methoxy-3-(2-methylpropyl)Prazine	-	2.26
17	1411	Geosmin	-	2.31
18	1579	Caryophyllene oxide	-	3.01
19	1593	Hexadecane	4.85	-
20	2000	Phytol	57.4	-
21	2049	3-Dodecanol	7.08	-
% identified			**96.65**	**97.93**

RI = Retention index, - indicates not detected

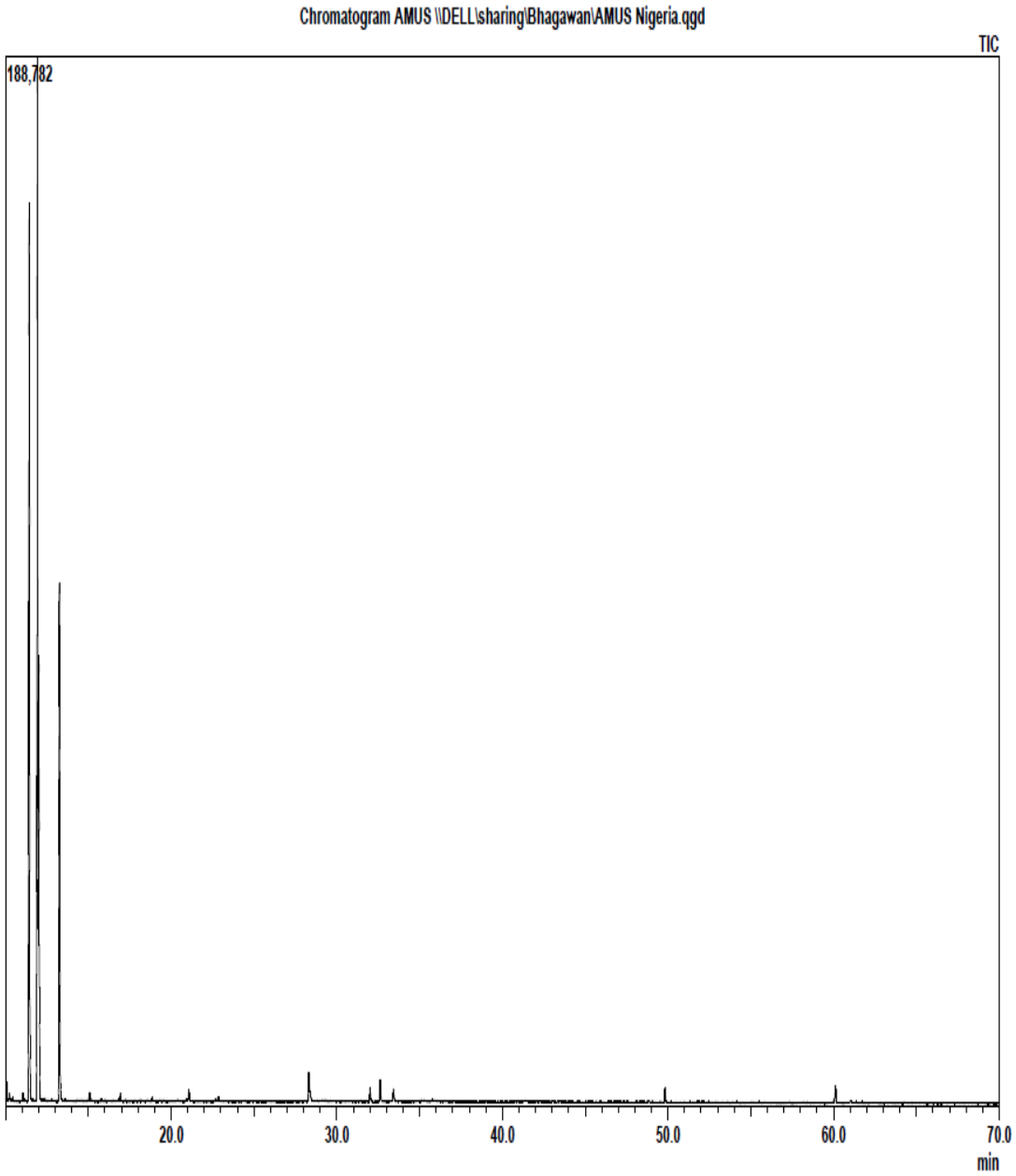

Fig. 1: Gas chromatogram of stem essential oil of *Basella alba* (see GC conditions under experimental procedure).

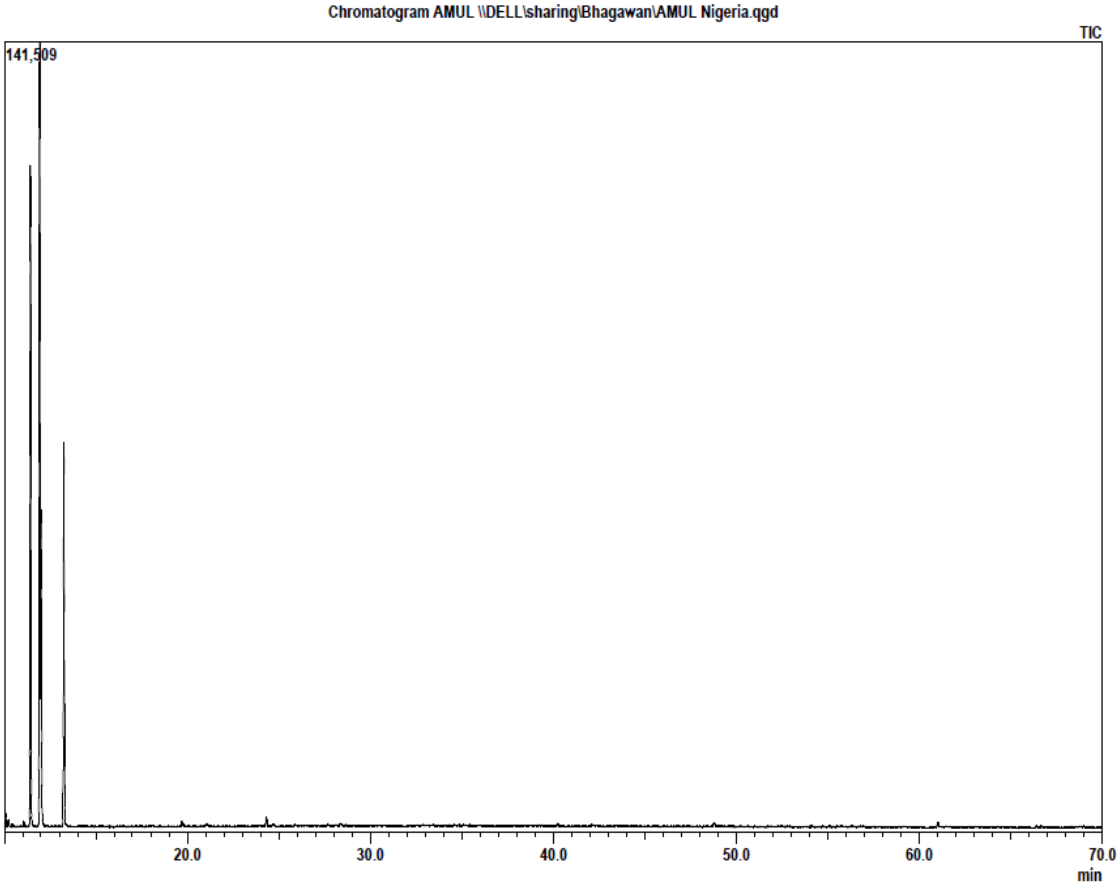

Fig. 2: Gas chromatogram of leaf essential oil of *Basella alba* (see GC conditions under experimental procedure).

Table 3: Chemical composition of essential oils from *Cnidoscolus aconitifolius* leaf.

S/N	RI	Compound	% Composition
1	835	Methyl 3-methyl-2-butenoate	3.19
2	838	3-methyl pentanol	2.01
3	841	2,6- Dodecadien-1-al	0.90
4	850	7-methyl-oct-1-ene	1.34
5	852	2E-Hexenal	10.43
6	863	n-Nonane	0.77
7	864	2-methyl-5-isopropenylfuran	0.56
8	871	n-Heptanol	2.08
9	888	1-Octen-3-ol	1.14
10	895	6-methyl-Hept-5-en-2-one	1.32
11	933	2-Pentyl-furan	1.70
12	960	2,2,6-trimethyl- Cyclohexanone	0.76
13	974	5-methyl-Octadecane	0.48
14	986	Octanol	0.79
15	989	n-Nonanal	4.68
16	1036	n-Nonanol	2.73
17	1074	β-Cyclocitral	1.55
18	1104	n-Decanol	0.79

19	1167	4Z-Hexenyl angelate	2.35
20	1219	Dodecanyl acetate	4.37
21	1268	6,10,14-trimethyl-2-pentadecanone	1.68
22	1329	(Z,Z,Z)-1,8,11,14-Heptadecatetraene	3.77
23	1480	1,6-Hexanediol	0.51
24	1702	Eicosanal	11.56
25	2230	2-Methylhexacosane	30.80
% idenitified			**92.26**

RI = Retention index

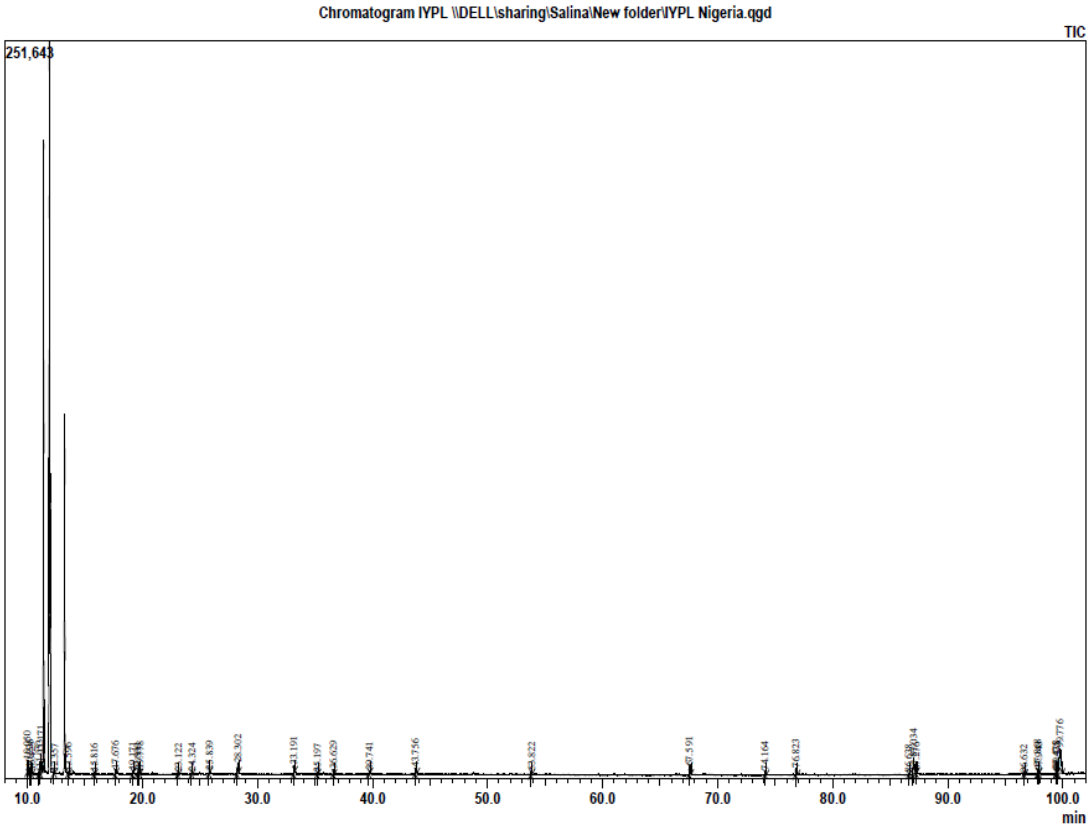

Fig. 3: Gas chromatogram of leaf essential oil of Cnidoscolus aconitifolius (see GC conditions under experimental procedure).

Table 4: Percentage composition of classes of compounds of the essential oils.

Classes of compounds	BAL (%)	BAS (%)	CAL (%)
Hydrocarbon monoterpenes	3.41	75.11	-
Oxygenated monoterpenes	-	7.09	1.55
Oxygenated sesquiterpenes	-	5.32	1.68
Oxygenated diterpenes	57.40	-	-
Total terpenes	**60.81**	**87.52**	**3.23**
Non-terpenes	**35.84**	**10.41**	**89.03**

BAL = *Basella alba* leaf, BAS = *Basella alba* stem, CAL = *Cnidoscolus aconitifolius leaf*, - indicates not detected.

CONCLUSION

We have presented the essential oils compositions of leaf and stem of *Basella alba* and leaf of *Cnidoscolus aconitifolius* which have not been reported in literature. The essential oils from these vegetable plants are rich in terpenes and terpenoidal compounds which have been reported to possess antioxidant, anti-inflammatory, antitumor and antituberculosis hence, contribute to medicinal and nutritive properties of these plants.

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