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RESEARCH ARTICLE

Pharmacognostical and Phytochemical Screening of Leaves of Medicinal Plants

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ABSTRACT

India is solitary of the richest floristic region of the world and has been a resource of plants and their yield since antique and man uses them in different ways according to his requirements, predominantly as food or as medicine. The preliminary Pharmacognostic study on leaves of medicinal plants plays an incredibly significant role in detection of the purity and quality of crude drugs. Medicinal plants which were originated on earth have notorious medicinal consequence and their usage is growing day by day in our daily life. The present efforts embody the investigation conceded out to establish methods for quality control of herb as per WHO guidelines. Entire botanical valuation which comprises macroscopic, microscopic, phytochemical assessment and physicochemical parameters like extractive value, moisture content, dry weight and ash value have been studied. The shade dried powder and various solvent extracts (viz., methanol, ethanol, aqueous, chloroform and acetone) have been analyzed for their phytoconstituents and fluorescence characters. The occurrence of alkaloid, phenol, steroid, flavonoid, saponin, tannin, and some other chemical constituents were recorded. Exploring the natural products has proved to be the most successful strategy for the discovery of new drugs. The present study has made an attempt to get referential information for the correct identification of the crude drug.

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INTRODUCTION

Plant-derived substances have newly grown to be of great interest due to their multipurpose applications. Medicinal flora are the richest bio-resource of drugs of traditional systems of medicine, current medicines, folk medicines, pharmaceutical intermediates, nutraceuticals, food supplements and chemical entity for man-made drugs. Extraction methods used pharmaceutically involved the partition of medicinally active portion of plant tissues from the immobile/inert components by using selective solvents. During extraction, solvents disperse into the solid plant substance and solubilize compounds with related polarity (Ncube, *et al*., 2008). The purpose of consistent extraction actions for crude drugs (medicinal plant parts) is to accomplish the therapeutically preferred portions and to remove unwanted material by conduct with a selective solvent known as menstrum. These products enclose multifarious mixture of numerous medicinal plant metabolites, such as flavonoids glycosides, alkaloids, terpenoids, and lignin's (Handa, *et al*., 2008). Medicinal plants had been reported to exhibit an antioxidant (Harborne, 1984), leishmanial(Franca, *et al*., 1996), urolithiasis (Baskar, *et al*., 1992 and Jose, *et al*., 2005), antiepileptic (Buznego and Saad, 1999), antitumor andantimutagenic (Annapurani and Priya,1999), neuro pharmacolig - ical (Saad, 2003), radio protective effect (Rao, *et al*., 2006), antimicrobial (Rao, *et al*., 1991), antibacterial, antifungal properties (Harborne, 1984). The evidence collected till now showed the immense potential of the medicinal plants used in traditional system (Saad, *et al*., 2003). In the present study an effort has been made to exact, identify and standardize the leaf extracts of selected medicinal plants for qualitative evaluation.

MATERIALS AND METHODS

Plant material collection

The plants were collected from Covenant Centre for Development (CCD), Sevayoor, Madurai district. Plant species were authenticated by comparing it with herbarium specimens and cramble (Harborne, 1984).

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Preservation by Drying

The plant material (leaves) were preserved by spreading it on the newspaper and dried in shade. It was left for 3-4 days after the collection so as to dry it completely. The Good Agricultural and Field Collection Practices (GACP) of medicinal plants of World Health Organization (WHO) were followed strictly.

Macroscopy and microscopy

Macroscopic and microscopic identity of calendula was based on size, colour, leaf inflorescence and description. A graduated ruler in centimeters was adequate for the measurement of the length and width. Colour of untreated leaf was examined under diffuse daylight and compared with the herbarium specimen for conformation. Macroscopic and microscopic identity was carried out by using simple microscope.

Moisture and ash contents

For moisture contents 1–3 gm of fresh leaves were weighed on electrical balance and spread in watch glass for drying in hot air oven for 18–24 hours at 105 ^{0}C. After the complete drying of leaves, they were again weighed and then thepercentage of moisture per gram was calculated. For Ash test 2-4 gm of air dried leaves were accurately weighted and ignited it by gradually increasing the heat until it was white, indicating the absence of carbon. Then it was allowed to cool and then weighed. Content of total ash in mg per gm of air dried leaves were then calculated.

Preparation and extraction of plant extract using different solvents

The extractions were carried out with ethyl alcohol, methyl alcohol, acetone, chloroform and water. 4.0gm of complete air-dried leaves were soaked in 100ml of each ethanol, methanol, acetone, chloroform and water for 10-15 days. Content of extractive values of leaves were then calculated.

Preliminary Phytochemical Screening of plant extracts

Phytochemical screening was performed for the analysis of different phytochemicals like carbohydrates, saponins, oils, fats, flavanoids, terpenoids, alkaloids *etc*., in methanolic extracts of plant samples. The screening was performed with some modifications from the method of Hambone (Salman, *et al*., 1996)

Examination of the Drug powder

Shade dried leaves were ground with wood - grinder and the powder was treated with different chemical reagents and observations were made.

Fluorescence analysis

Small quantity of drug powder mounted in different solvents was analyzed under UV and visible light and also fluorescence Nature of solvent extracts has been analyzed

RESULTS AND DISCUSSION

The Pharmacognostical evaluation on medicinal plant leaves comprising determination of parameters like macroscopical (Tables 1, 2, 3) and microscopic characters were observed (Fig 1.). They showed a characteristic anatomy that could be used to distinguish it from other members of the family. Analytical parameters like ash and extractive values were carried out and the results were tabulated as shown in (Table-4). The outcome of Ash values suggested the purity of drug that is the occurrence or lack of foreign matter such as metallic salt or silica there in the raw material.

The phytoconstituents like carbohydrates, tannins, alkaloids, flavonoids, terpenoids, saponins, steroids, amino acids and glycosides in each extract were identified and the results were tabulated as shown in (Table-9) and these secondary metabolites which revealed their potent therapeutic activity. This signified that the quality and purity of raw material was good enough; Moisture is an unavoidable component of crude drugs, which should be eliminated as far as feasible. The total soluble energetic constituents of crude drugs in any particular solvent or mixture of solvent was firm by extractive value. The alcohol soluble extractive value which signified the nature of the phytoconstituents present in plant in (Table-5). The behavior of powdered leaf drug with different chemical reagents had been observed as shown in (Table -6). The fluorescence nature of leaf powder with different reagents under visible light and UV radiation were observed as shown in (Table -7, 8) and the same for different solvent extracts like aqueous, ethanol, methanol, acetone and chloroform was observed. Employment of these pharmacological properties involved further examination of these active ingredients by carrying out techniques of extraction, purification, separation, crystallization and identification. Characterization of a herbal drug is therefore essential to allow specifications to be established which are both comprehensive and relevant. The observations in the present study have brought out several diagnostic features of the leaf on the basis of which identification of the crude drug could be ascertained. As the drug has been standardized on the basis of certain pharmacognostical characters, such as the powdered drug, besides the leaf characters, inference of other studies could serve characteristic features of the drug. Thus, the present study on Pharmacognostical characters of these medicinal plants could be used as supplement information with regard to its identification and could be helpful in establishing the standardization criteria.

TABLES AND FIGURES

Table 1. Scientific classification of medicinal plants

S.No	Botanical name	Vernacular name	Kingdom	Sub Kingdom	Class	Subclass	Order	Family	Genus	Species
1	*Abrus precatorius*	Gundumani	Plantae	Angiosperms	Eudicots	Rosids	Fabales	Fabaceae	*Abrus*	*A.precatorius*
2	*Adhatoda vasica*	Adathodai	Plantae	Angiosperms	Eudicots	-	Lamiales	Acanthaceae	*Adhatoda*	*A.vasica*
3	*Aegle marmelos*	Vilvam	Plantae	Angiosperms	Eudicots	Rosids	Sapindales	Rutaceae	*Aegle*	*A.marmelos*
4	*Aloe vera*	Sothu kathalai	Plantae	Angiosperms	Monocots	-	Asparagales	Xanthorhocaceae	*Aloe*	*A.vera*
5	*Andrographics paniculata*	Siriyanangai	Plantae	Angiosperms	Eudicots	Asterids	lamiales	Acanthaceae	*Andrographics*	*A.paniculata*
6	*Calotropis gigantea*	Akra	Plantae	Angiosperms	Eudicots	Asterids	Gentianales	Apocyanaceae	*Calotropis*	*C.gigantea*
7	*Centella asiatica*	Vallarai	Plantae	Angiosperms	Eudicots	Asterids	Apiales	Mackinlavaceae	*Centella*	*C.asiatica*
8	*Coleus aromaticus*	Omavalli	Plantae	Angiosperms	Eudicots	Asterids	Lamiales	Lamiaceae	*Coleus*	*C.aromaticus*
9	*Costus igneus*	Insulian	Plantae	Angiosperms	Monocots	Commelindis	Zingiberals	Costaceae	*Costus*	*C.igneus*
10	*Eclipta alba*	Manjal karisalankanni	Plantae	Angiosperms	Eudicots	Asterids	Asterales	Asteraceae	*Eclipta*	*E.alba*
11	*Phyllanthus amarus*	Keelanelli	Plantae	Angiosperms	Eudicots	Rosids	Malpighales	Euphorbiaceae	*Phyllanthus*	*P.amarus*
12	*Sesbania aegyptica*	Sithagathi	Plantae	Angiosperms	Eudicots	Rosids	Fabales	Fabaceae	*Sesbania*	*S.aegyptica*
13	*Solanum trilobatum*	Thuthuvalai	Plantae	Angiosperms	Eudicots	Asterids	Solanales	Solanaceae	*Solanum*	*S.trilobactum*
14	*Terminalia chebula*	Thandrikai	Plantae	Angiosperms	Eudicots	-	Scytaminiales	Combrctaceae	*Terminalia*	*T.chebula*
15	*Wrightia tinctoria*	Vetpalai	Plantae	Angiosperms	Eudicots	Asterids	Gentianales	Apocyanaceae	*Wrightia*	*W.tinctoria*

Table 2. List of synonyms for medicinal plants

Language	*Abrus precatorius*	*Adhatoda vasica*	*Aegle marmelos*	*Aloe vera*	*Andrographics paniculata*	*Calotropis gigantea*	*Centella asiatica*	*Coleus aromaticus*	*Costus igneus*	*Eclipta alba*	*Phyllanthus amarus*	*Sesbania aegyptica*	*Solanum trilobactum*	*Terminalia chebula*	*Wrightia tinctoria*
Sanskrit	Rattika	Vrsa, Atarusa	Kayastha, Jivapriya	Kanya, Vipulasrava	Kalameh	Bhanu	Manduki	Karpuravalli	Gandira, Tanduliya	Bhringaraj	Bhumyamalaki	Jayanthi, Jaya	Alarka	Sriphala	Indrajava
Assamese	Rati	Titabahak	Hilika	-	Chiorta	Akan	Manimuri	-	-	Bhringaraja	-	-	-	Bael, Vael	-
Bengali	Kunch, Shonkarinch	Baksa, Vasaka	Haritaki	-	Kalmegh	Akanda, Akone	Jhollkhuri	Paterchur	-	Kesuti	Bhui amla	Jayanthi	-	Bela, Bilva	-
English	Jequirity	Vasaka	Black Myrobalan	Barbados Aloe, Indian Aloe	Green chirayta, indianechinaceae	Madar Tree	Indian pennywort	Country Borage	-	Trailing Eclipta	-	-	Climbing Brinjal	Bengal Quince	Pala indigo plant
Gujarati	Rati, Chanothe	Aduso, Ardusi	-	-	Kariyata	Aakado	Khodabrahmi	-		-	Bhonya ammali	Rajashingan ee	-	Bill, Bilum	-
Hindi	Ratti, Ghungch	Aduss, Arusa	Hara, Harad	Ghee-Kunwar	Kirayat	Aak, Akavana	Brahma Manduki	Patharchur	Keukand	Bhangra	Jaramla, Jangli amli	Jaita	-	Bela, Sriphal	Indarjoe, Kapar
Kannada	Gulugunji	Adsala, Adusoge	-	-	Nelabevu	Ekkadagida	Ondelega		Chelakeerae soppu	Garujalu, Gurugada	Nela nelli, Kiranelli gida	Arinintajinmgi	Mullumusta	Bilva	-
Kashmiri	Kath	Vasa	-	-	-	Acka	-		-	-	-	-	-	Bel	-
Malayalam	Kunni	Attalatakam	-	-	Nilav Epp	Erikku	Kodangal	Panikkurkka	-	Kayyonni,	Kizha nelli	Semp, Atti	Tutavalam	Koovalam	Dhantappala
Marathi	Gunja	Vasa, Adulsa	Hirad	-	Kadu kiayata-oli-kiyata	Rui	Karivana	-	-	Maka, Bhangra	Bhuivali	Jait	-	Bel, Baela	Kala Kunda
Oriya	Kainch	Basanga	Haritaki	-	Bhuinimba	Akakha	-	-	-	-	Bhni aola, Badiank	Jaayantipatra	-	Bela	-
Punjabi	Ratti	Bhekar, Vansa	-	-	-	Ak	Brahmi	-	-	-	-	Jainta	-	Bil	-
Tamil	Kuntri, Gundumani	Vasambu, Adathodai	Thandrikai, Kundukkay	Sothu Kathalai	Nilayambu, siriyanangai	Akra, Erukku	Vallarai	Omavalli, Karpuravalli	Insulian plant	Gaurja, Manjal Karisalankanni	Keelanelli	Karumsempai	Thuduvalai	Vilvam	Vetpalai
Telugu	Guriginja	Addasaramu	-	-	Nelavemaa	Jilledu	Saraswathi aku	Sugandhavalkum	-	Guntakalagara	Nelausirika	Sominta, Jalugu	Telavuste	Maredu	-
Urdu	Ghongch	Adusa, Basa	-	-	-	Aak, Madar	Brahmi	-	-	Bhangra	-	-	-	Bel	-

Morphological Identification

Table 3. Macroscopic observation

S.No	Botanical name	Observation
1	*Abrus precatorius*	Slender, perennial climber, legume, Indonesia, glossy surface, oval or sub-globular, 5-8 cm long, 4-5 cm broad.
2	*Adhatoda vasica*	Sub-Himalayan tracts, 10-30 cm long, base tapering 8-10 pairs of lateral vein bearing few hairs.
3	*Aegle marmelos*	Bangladesh, Iran, sub-opposite, simple, exstipulate, lamina broad, margin entire25-30m high.
4	*Aloe vera*	Succulent, perennial herb, leaves 3050 cm long, 10 cm broad, 25-35 cm length arranged in a slender loose spikes, astern Africa, Venezuela.
5	*Andrographics paniculata*	Simple, opposite,2-12 cm long, 1-3 cm wide, apex acute, margin entire, upper leaves-bractiform, lamina crumpled, south east Asia.
6	*Calotropis gigantea*	Sub- sessile, ovate oblong, 6-15 cm, pubescent when young and glabrous on both sides on maturity
7	*Centella asiatica*	Annual plant, Reniform with rounded apics, palmately netted veins, pericardial petiole around 2 cm, India, srilanka, northern Australia.
8	*Coleus aromaticus*	Found on tropics, large succulent aromatic perennial herb with hispidly villous or tomentose fleshy stem, simple, opposite, ovate, crenate.
9	*Costus igneus*	Build up insulin in human body, America, laves are spiral, height of plant 2 feet, leaves length 18-25 cm, parallel equally with thick veins.
10	*Eclipta alba*	Opposite, sessile, Lanceolate, 3-5 cm length, 2-3 cm wide thickness 0.2-0.3 cm strigose with appressed hairs on both sides, china, Brazil.
11	*Phyllanthus amarus*	Simple, alternate, obovate to oblong-lanceolate, 4-9 mm length, 3-4 mm width, glabrous, reticulate pinnate, sub-tropical regions.
12	*Sesbania aegyptica*	Pinnately compound opposite, linear, oblong, mucronate to acuminate, very shortly stalked, 1-3.3 cm long.
13	*Solanum trilobatum*	South and western India, prickly, diffuse, perennial under herb, ovate oblong, hairy, armed with mid rib
14	*Terminalia chebula*	Mid-sized, slender, aromatic, armed, gum-bearing, Myanmar, Thailand,3-foliate arrangement of leaves, acute.
15	*Wrightia tinctoria*	Coromendal coast, Deccan, leaves variable, Puberlous beneath, base acute, petiole 3-4 mm long.

Table 4. Physio-chemical observation

S.No	Parameter	Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	**Organoleptic Character**															
	a.Appearance	Glossy surface	Lanceol ate	3-foliate arrange ment	Succule nt	Lanceol ate	Glaboro us	Reni form	Broadly ovate smooth surface	-	Sessile	Entire	Glaboro us entire	Pricky diffuse	Puberlo us	Margin entire
	b. Colour	Bright scarlet, black patch	Green	Green	Green pea	Green	Green	Greyish green	Pale green	Dark green	Brownis h green	Green	Light green	Bright green	Dark green	Dark green
	c. Smell	Characte ristic	Characte ristic	Characte ristic	-	Characte ristic	Characte ristic	Characte ristic	Characte ristic	-	Characte ristic	Characte ristic	-	Characte ristic	Characte ristic	Characte ristic
	d. Taste	Bitter	Bitter	Sour	Bitter sour	Intensiv ely bitter	-	Bitter sweet	Bitter	-	Bitter	Bitter	Bitter	Bitter	Bitter	Bitter
2.	**Moisture Content (%) w/w**															
	Loss in weight on drying at 105°c (%)	4.0	13.0	7.6	10.0	10.0	9.0	1.8	7.04	12.0	12.0	2.5	9.8	3.8	9.0	22.2
3.	Alcohol soluble matter (%)	2.0	12.7	13.0	15.0	13.0	18.0	9.5	8.5	12.0	5.0	16.0	0.8	12.6	43.8	12.5
4.	Water soluble matter (%)	15.0	32.3	28.0	23.0	18.0	31.0	28.2	1.0	3.0	15.1	19.0	4.0	24.0	56.0	10.7
5.	**Ash value**															
	a. Total ash	3.0	8.0	7.6	2.0	5.0	6.7	12.0	15.04	2.0	18.0	4.0	1.0	2.2	2.67	15.5
	b. Water soluble ash	11.8	12.0	20.7	40.0	12.0	13.6	17.0	24.0	19.1	21.0	6.0	0.5	16.8	62.8	10.98
	c. Acid soluble ash	5.0	4.0	3.0	10.0	2.0	9.2	6.0	1.68	6.8	10.0	7.0	0.1	7.2	2.45	0.80

Table 5. Extractive values (%)

S.No	Extracts	Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Ethyl alcohol	12.8	15.5	17.0	0.7	5.6	11.6	2.8	11.9	9.17	7.9	1.5	5.3	8.6	21.8	10.9
2.	Chloroform	4.9	7.8	9.0	0.2	2.6	3.2	0.8	3.4	8.5	5.8	7.6	2.9	1.8	11.3	14.4
3.	Acetone	6.5	4.2	8.0	1.2	7.8	5.5	1.2	5.6	12.9	6.3	5.3	0.9	2.3	16.6	15.9
4.	Methyl alcohol	9.1	9.8	11.7	9.6	11.0	7.8	4.7	10.0	18.6	7.2	7.5	5.6	7.8	20.3	17.8
5.	Aqueous (Water)	17.6	10.2	17.9	18.7	13.9	13.3	12.3	17.5	23.0	8.2	9.2	8.9	6.6	21.8	25.3

Table 6. Behaviour of drug with different reagents

S.No	Chemical treatment	Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	**Powder treated with Conc. HCL**	Grass green	Pale green	Green	Light green	Thick dark green	Dark green	Pale green	Green	Green	Dark green	Olive green	Dark green	Light green	Pale green	Dark green with brownish tinch
2.	**Powder treated with Conc.H_2SO_4**	colourles s	Thick brown ring at top layer	Pale green	colourles s	colourles s	Greenish brown	Light green tinch	Light brown ring	Brownis h ring at top layer	colourles s	colourles s	Light brown ring	Thin brown ring	Brownis h ring	colourless
3.	**Powder treated with 5% aqueous NaOH**	Grass green	Light green	Pale green	Slight green shade	Pale green	Light brown	Slight green tinch with colourles s	Green	Pale green	Brownis h green	green	colourles s	Green tinch shade	Brown	Transparent pale green
4.	**Powder pressed between two filter papers for 24 hours**	Negative (no spots)	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Positive (spots on filter paper)	Negative	Negative
5.	**Powder treated with iodine solution**	Light green yellowis h tinch	Brownis h green	Greenish tinch	Grass green	Pale green	Green with brownish tinch	Light brownish green	Light brown+ greenish tinch	Olive green	Olive green	Pale green tinch	Yellowis h green	Green	Light pale green	Light green

Table 7. Fluorescence behaviour of different plant extracts under ordinary light

S.No.	Extractives	Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Ethyl alcohol	Light green	Pale green	Light olive green	Light green	Green	Pale green	Light green	Light green	Light brown shade with green	Green	Pale green	Light green	Light green	Light green	Pale green
2.	Chloroform	Green	Pale green	Dark green	Pale green	Green	Green	Green	Light green	Light green	Dark green	Green	Pale green	Light green	Light green	Green
3.	Acetone	Light green	Green	Green	Light brown with green tinch	Light green	Light green	Olive green	Light green	Pale green	Dark green	Green	Green	Dark green	Light green	Pale green
4.	Methyl alcohol	Green	Pale green	Light green	Green	Green	Green	Green	Green	Green	Light green	Dark green	Dark green	Green	Dark green	Light green
5.	Aqueous (water)	Green	Dark green	Dark green	Light green	Light pale green	Green	Light pale green	Green	Light green	brown	Light green	green	Green	Pale green	Pale green

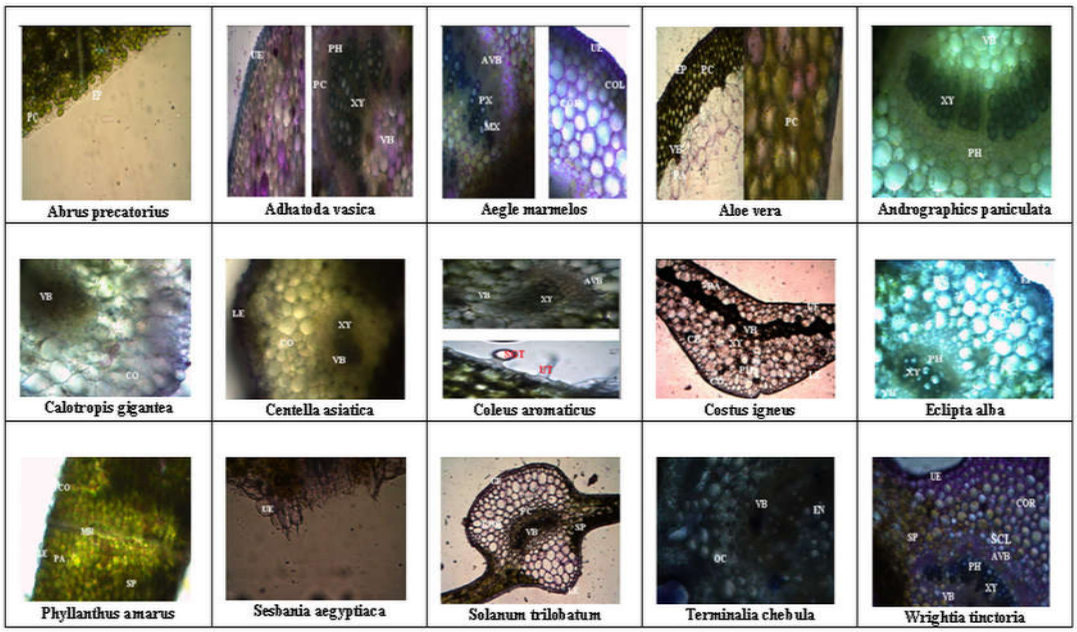
Table 8. Fluorescence behaviour of different plant extracts under UV light

S.No.	Extractives	Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ethyl alcohol	Dark green	Thick dark green	Dark green	Light green	Dark green	Dark green	Light green	Pale light green	Brownish green	Dark green	Dark green	Olive green	Light green	Brown	Green
2	Chloroform	Green	Green	Dark green	Light green	Green	Dark green	Dark green	Light green	Light green	Thick dark green	Green	Green	Dark green	Green	Thick green
3	Acetone	Thick dark green	Green	Pale green	Brown	Green	Thick olive green	Grass green	Green	Light green	Dark green	Green	Light green	Greenish brown tinch	Pale light green	Greenish brown
4	Methyl alcohol	Green	Dark green	Dark green	Light green	Dark green	Green	Green	Light green	Pale green	Olive green	Dark green	Dark green	Green	Olive green	Thick green
5	Aqueous (water)	Green	Thick green	Dark green	Thick dark green	Thick green	Green	Light pale green	Light pale green	Thick green	Brownish green	Thick green	Light green	Green	Light green	Green

Table 9. Phytochemical Screening of plant extracts

S.No	Test	Aqueous extract														
		Samples														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Quinones	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
2	Flavonoids	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-
3	Alkaloids	-	-	+	-	-	-	-	+	-	+	+	-	+	-	+
4	Carbohydrates	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
5	Proteins &	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Amino acids	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Cardio glycosides	-	-	+	-	-	-	-	-	-	-	+	+	+	-	+
7	Tannin	-	+	-	-	-	-	-	-	-	-	-	+	-	+	-
	Phenolic compounds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Saponins	-	-	+	+	+	-	-	+	-	-	-	-	+	-	+
9	Terpenoids	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
10	Oils and fats	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-

Whereas + shows presence of constituents - shows absence of constituents



(I-I 0.5mm)

Fig. 1. Microscopic observation EP- Epidermis COL- Collenchyma XY-Xylem PH-Phloem PC-Parenchyma cells containing chloroplast TR-Trichome VB-Vascular Bundle PA-parenchyma (water storage tissue) SP-Spongy tissues PA-Palisade LE-Lower epidermis MR-Mid rib CB-Cortical Bundles AVB-Arc shaped vascular bundles UT-Uniseriated Trichome SCL-Sclerenchyma SGT-Stunted Glandular Trichome COR-Cortex OC-Oil Content EN-Endodermis MX-Meta xylem PC-Pericycle PX-Protoxylem.

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