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RESEARCH ARTICLE

Pharmacognostic characterization and development of quality control standards for *Dictamnus albus*: a comparative study of different parts

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Abstract

Dictamnus albus L. (Rutaceae), commonly known as gas plant, has tremendous medicinal importance. Although the plant has been scientifically evaluated for its various biological activities but no work has not been carried out till date on pharmacognostic characterization of the plant. This study aims to investigate the comparative pharmacognostic and physicochemical standards for different parts of *D. albus* (leaves, stem, root, flower and fruits). The measures taken were macroscopy, organoleptic study, anatomy, powder microscopy, foreign matter analysis, ash values, loss on drying, swelling index, foaming index, pH values, fluorescence analysis and extractive yield. Macroscopic and organoleptic studies revealed that *D. albus* is a herbaceous perennial with thick and branched root; lanceolate, sessile and pubescent leaves; hollow and glabrous stem; terminal paniculate inflorescence and star shaped fruits and each part has a characteristic odor with a bitter taste. Anatomy of *D. albus* revealed some diagnostic characteristics- irregular shaped epidermal cells and unicellular trichomes in leaves; hexagonal pith cells containing secretory cells in stem and cortex containing oil globules in root. The powder analysis showed peculiar features as—wavy epidermal cells, different trichomes, prismatic crystals, oil globules and lignified spiral and pitted vessels in leaf; prismatic calcium oxalate sheath and lignified spiral and pitted vessels in stem; cork cells and sieve elements in root; lignified spiral vessels, stomata, trichomes and secretary glands in flowers; stone cells, secretary glands, glandular trichomes, lignified spiral and pitted vessels, prismatic crystals in fruit. Also, the analysis of pharmacognostic parameters of different parts resulted in a valuable data to establish standards for the plant.The present study for the first time provides a complete pharmacognostic profile of *D. albus*, thereby, acting as a platform for correct identification, authentication and development of quality control parameters of the species. Unlike taxonomic identification, pharmacognostic studies includes those parameters and standards that prove helpful in identifying adulteration in powdered form also. Data obtained may be used a standard for future studies.

Keywords *Dictamnus albus* · Macroscopy · Microscopy · Physicochemical · Fluorescence · Extractive yield

Introduction

Dictamnus albus L. (Rutaceae), perennial herb, commonly known as gas plant, is distributed throughout South and Central Europe, temperate Asia, temperate Himalayas (Singh et al. 2000). In India, it is distributed in Uttar Pradesh, Jammu and Kashmir and Himachal Pradesh (Singh et al. 2000). The plant is esteemed as an ornamental and is often grown in gardens for its bright and beautiful flowers (Singh et al. 2000).

In Indian folk medicine, *Dictamnus albus* has been used as an emmenagogue and abortive agent (Saha et al. 1961; Prakash 1984). The root bark of *D. albus* has been used against jaundice, leprosy, cough, rheumatism, amenorrhea, and some skin diseases (Jung and Shin 1990). In Greek folk medicine it is used as an antispasmodic, tonic, stimulant, and anthelminthic (Souleles 1989). In folk remedy of Turkey, the plant has been used for stomachic, tonic, stimulant and antipyretic activities (Baytop 1989; Velickovic et al. 2012). In Israel, *D. albus* and *D. hispanicus* is used to treat cataracts, conjuctivitis, diabetic retinopathy and antihypertension

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(Raja et al. 1997; Velickovic et al. 2012). In Bulgaria and Korea, the plant is used as an anticancer, antispasmodic, diuretic and sedative agent (Ivanova et al., 2004). In Serbia, *D. albus* is used as tea mixture in the treatment of neurasthenia, hysteria, schizophrenia and other mental diseases (Zivotic and Zivotik 1979).

Despite the tremendous medicinal importance of *Dictamnus albus,* there is paucity of information available on the pharmacognostic parameters for identification and standardization of the species. In this connection, different parts (leaves, stem, root, flowers and fruits) of this plant were examined. The present work is an attempt to provide comprehensive report on the quality control and standardization parameters of *D. albus*. The pharmacognostic constant of plants, the diagnostic microscopic features and standards reported could be useful for the compilation of a suitable monograph for their proper identification.

Material and method

Plant material

Healthy and disease free plants of *D. albus* were collected from Sonamarg area of Jammu and Kashmir. The collected specimens were identified and deposited in Kashmir University Herbarium (KASH) under voucher number 2688-KASH. The plant collections were made quite judiciously throughout the course of the present study. The plant materials were fragmented into different parts (root, stem, leaves and fruits) and dried under shade at room temperature for 15–20 days. After shade drying, the plant materials were powdered and stored under proper conditions for future use.

Macroscopic evaluation

Fresh and healthy plants of *D.albus* were assessed for their external characteristics.

Organoleptic evaluation

It refers to the evaluation of plant material by color, odour, taste, shape, texture etc. Different dried parts of *D.albus* were considered for macroscopical evaluation (Anonymous 1998).

Anatomy

Transverse sections of fresh materials of different parts of *D.albus* were cut with the help of sharp blades. Peels were obtained from fresh leaves by forceps. Different sections/peels were stained with safranine and observed under microscope and photographed.

Powder microscopy

For the analysis of plant powder, pinch of fine powder is taken in a test tube and boiled in chloral hydrate solution for few minutes. A few drops of powder were smeared on a slide mounted with phloroglucinol followed by few drops of concentrated HCl. The prepared slides were then observed under a microscope and photographed (WHO 2011).

Physico-chemical parameters

Various physic-chemical parameters (ash value, moisture content, foreign matter, swelling index, fat content, foaming index, ph, extractive value) were analyzed according to standard procedures (Anonymous 1996, 1987; Mukherjee 2002; WHO 2011).

Fluorescent analysis

Many herbs show fluorescence when cut surface or powder is exposed to UV light and this can be useful in their identification. Fluorescence character of the powdered drug was studied as such in daylight and UV light (254 and366 nm) and after treatment with different reagents (Ishtiaq et al. 2018).

Results

Macroscopic description

D. albus is a perennial, herbaceous plant of height 114.1 ± 15.96 cm with thick and branched taproot of 24.6 ± 2.71 cm. The stem is erect, densely branched, hollow, glabrous with lower part green in color and upper part reddish dotted green. The leaves are sessile, opposite, elliptic to ovate to lanceolate, dotted, serrulate, acute to acuminate with leaf dimensions of 2.58 ± 0.25 cm long and 0.64 ± 0.23 cm broad. The flowers are white stripped pink with densely glandular long pedicel. The fruit is a densely glandular capsule, star shaped with black sub-globose seeds (Fig. 1).

Organoleptic study

The organoleptic evaluation of *D.albus* is arranged in a tabulated form (Table 1).

Fig. 1 Macroscopic description of *D. albus*

Table 1 Organoleptic evaluation of *Dictamnus albus*

Characters	Parts			
	Leaf	Stem	Root	Fruit
Color	Green	Lower part green; upper part reddish dotted green (outer side); cream (inner side)	Gray	Brownish cream
Odor	Characteristic	Characteristic	Characteristic	Characteristic
Taste	Bitter	Bitter	Bitter	Bitter
Shape	Elliptic to lanceolate	Cylindrical	Curved	Star- shaped
Texture	Soft	Smooth and slimy	Rough	Coarse

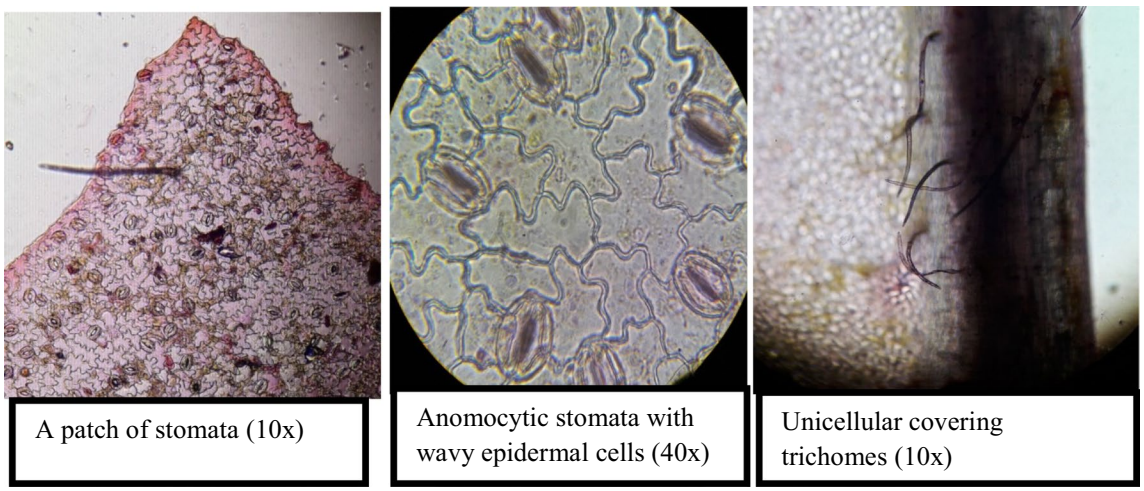


Fig. 2 Anatomy of leaf of *Dictamnus albus*

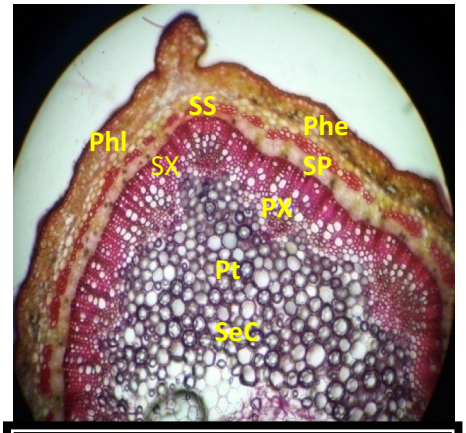
Anatomy

Leaf peel

Peels obtained from fresh leaves revealed a huge number of anomocytic stomata with wavy epidermal cells. Unicellular trichomes also showed their presence (Fig. 2).

Transverse section of stem

The transverse section of stem (Fig. 3) showed the presence of secondary growth leading to the formation of periderm. Vascular bundles are conjoint, collateral and open. The central portion is occupied by large pith of hexagonal cells having secretary functions.



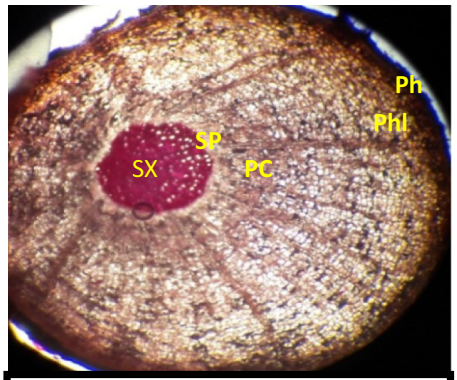
(10x)

Ph-Phellogen; Phe-Phellem; Phl-Phelloderm; SS-Sclerenchymatous sheath; SP-Secondary phloem; SX-Secondary xylem; Pt- Pith; SeC-secretary cells

Fig. 3 T.S. of stem (10x)

Transverse section of root

The outline of transverse section of root (Fig. 4) is circular. There is presence of secondary growth leading to the formation of visible phellogen and phelloderm. The secondary cortex showed the presence of oil droplets. Pith is very small.



(10x)

Ph-Phellogen; Phl-Phelloderm; PC-Primary cortex; SP- Secondary phloem; SX-Secondary xylem;

Fig. 4 T.S of root (10x)

Powder microscopy

Leaf powder

The leaf powder of *D. albus* is dark green in color with lemony smell and astringent taste. Its microscopy revealed the presence of anomocytic stomata with irregular shaped epidermal cells. The unicellular as well as glandular trichomes were also seen. Prismatic calcium oxalate crystals and lignified spiral as well as pitted vessels also showed their presence in the powder of the leaves (Fig. 5).

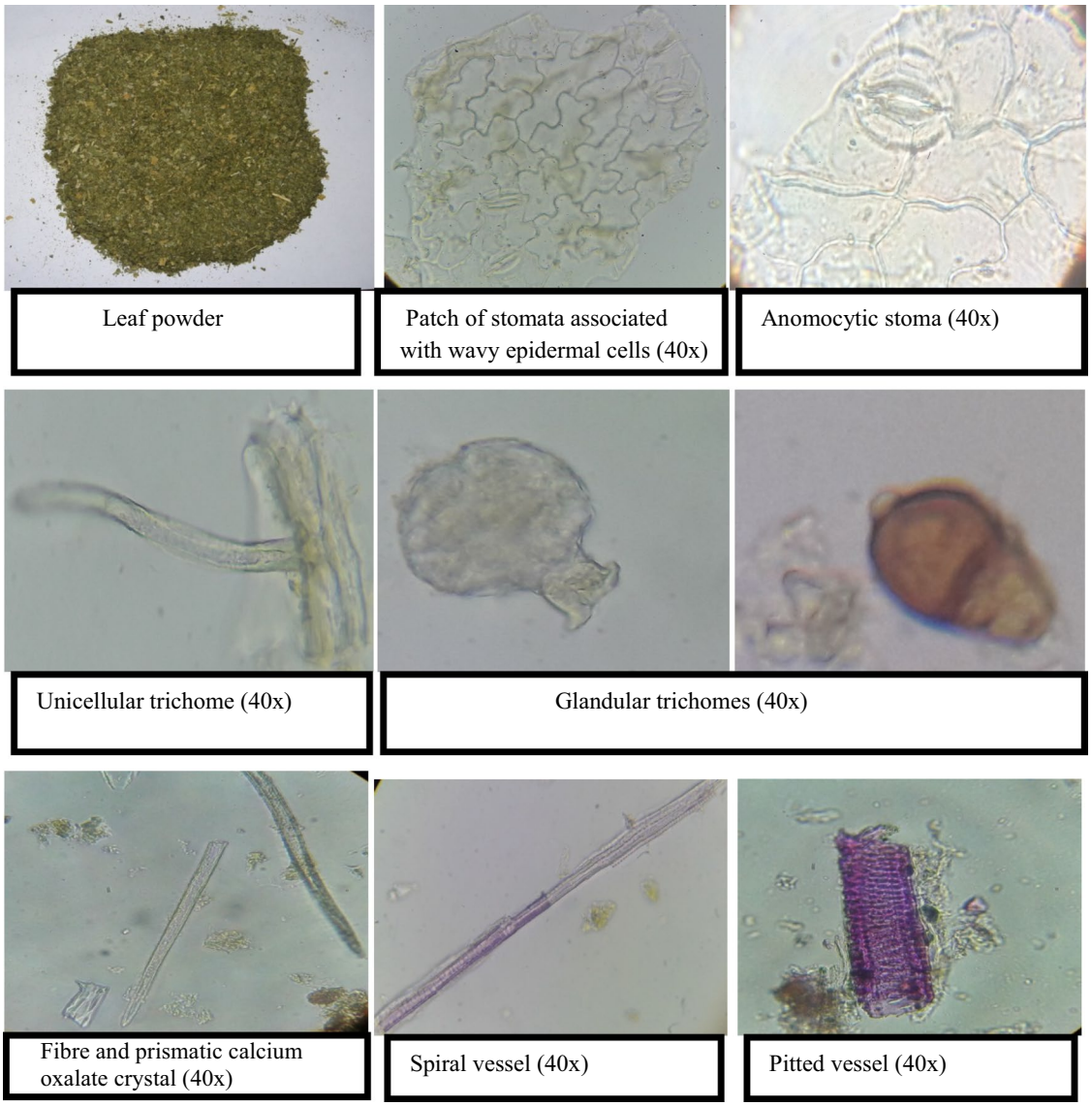


Fig. 5 Powder microscopy of leaves of *Dictamnus albus*

Stem powder

The stem powder is creamish yellow in color with characteristic taste and smell. The powder miscroscopy features revealed the presence of lignified cork cells, lignified spiral as well as pitted vessels and circular parenchymatous cells. The presence of prismatic calcium oxalate sheath in the powder can be considered as the one of the important features of *D. albus* (Fig. 6).

Root powder

The root powder is creamish yellow in color with characteristic odor and taste. The powder microscopy showed the presence of sieve elements and lignified cork cells (Fig. 7).

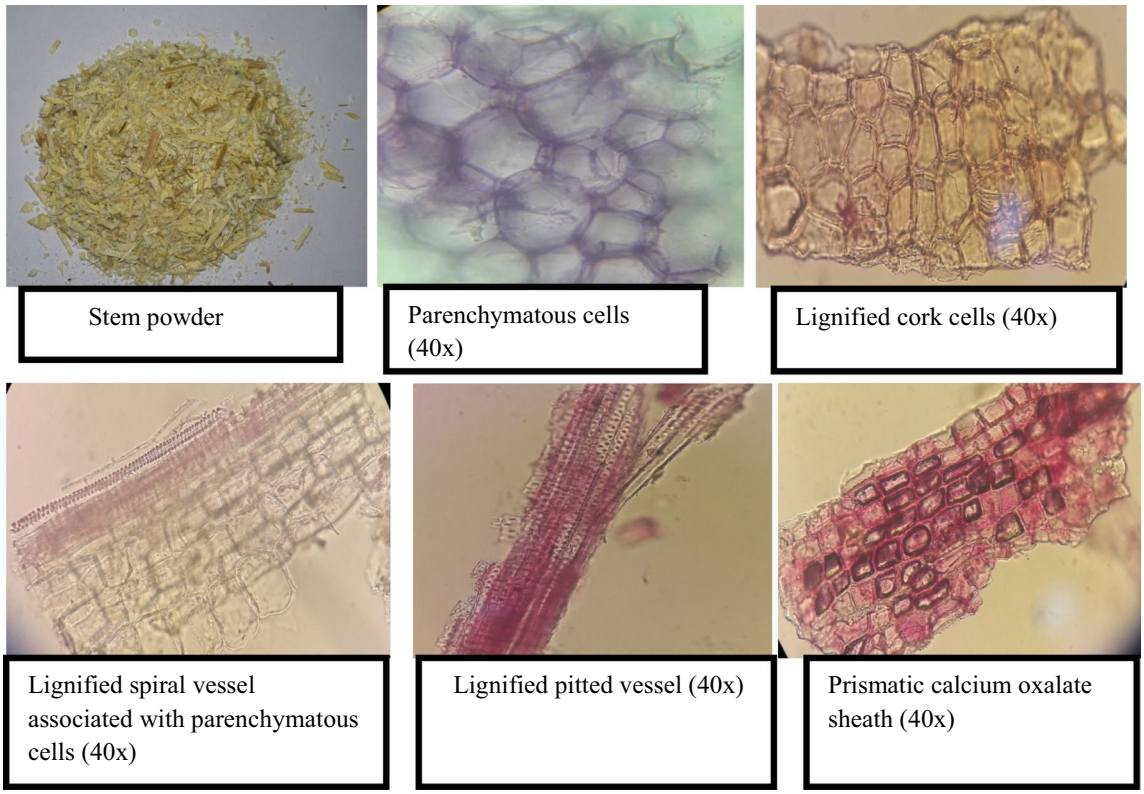


Fig. 6 Powder microscopy of stem of *Dictamnus albus*

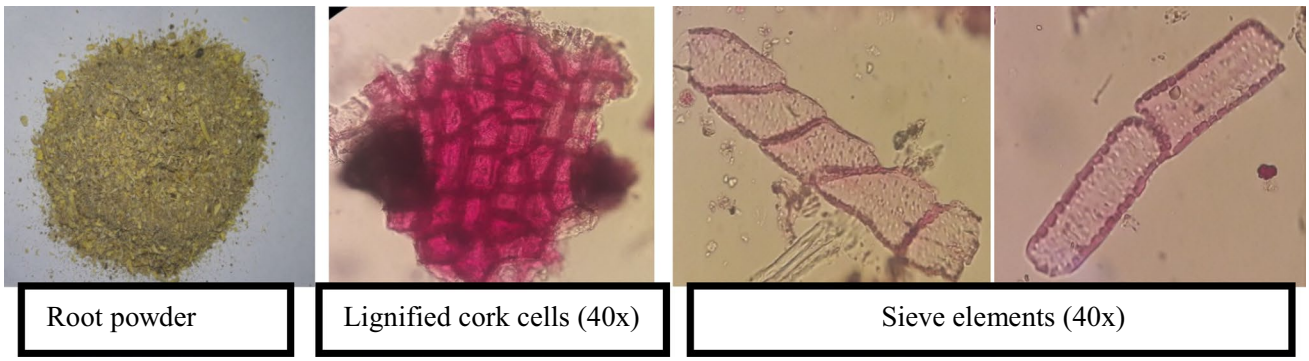


Fig. 7 Powder microscopy of root of *Dictamnus albus*

Flower powder

The flower powder is creamish brown in color with characteristic odor and taste. The microscopic powder features showed the presence of stomata and trichomes; lignified spiral vessels; oval shaped pollen grain; spouting sectetary glands (Fig. 8).

Fruit powder

The fruit is creamish black in color with characteristic odor and taste. The powder microscopy revealed the presence of elongated epidermal cells with cluster of calcium oxalate crystals; fibres and sclereids were also observed. Lignified spiral as well as pitted vessels also showed their presence. Many secretary glands were seen in the powder microscopy of the fruit. Some secretary glands associated with unicellular and uniserate trichomes were also observed. The sclerenchymatous fruit wall with prismatic calcium oxalate crystals were also seen in the powder (Fig. 9).

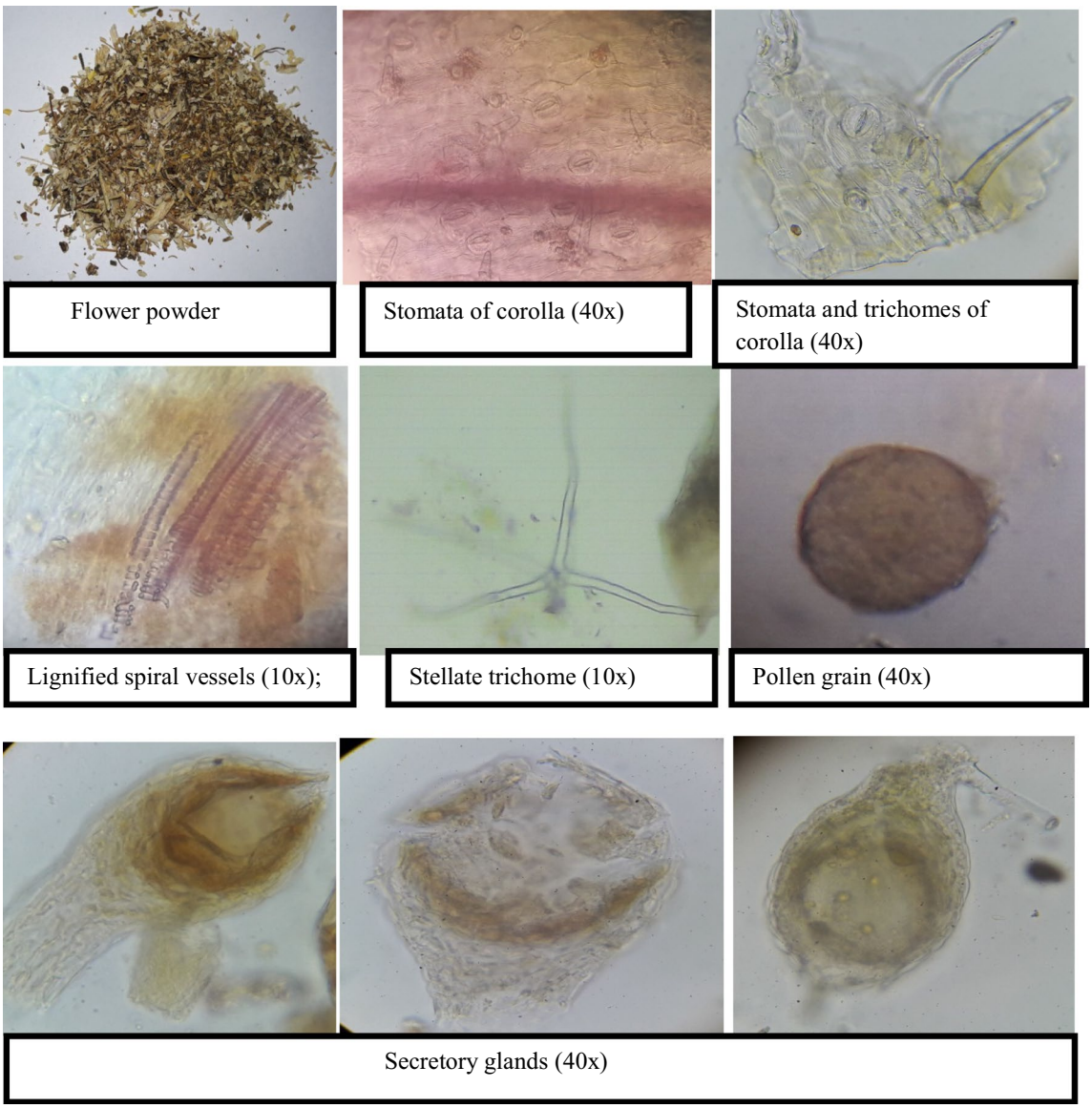


Fig. 8 Powder microscopy of flower of *Dictamnus albus*

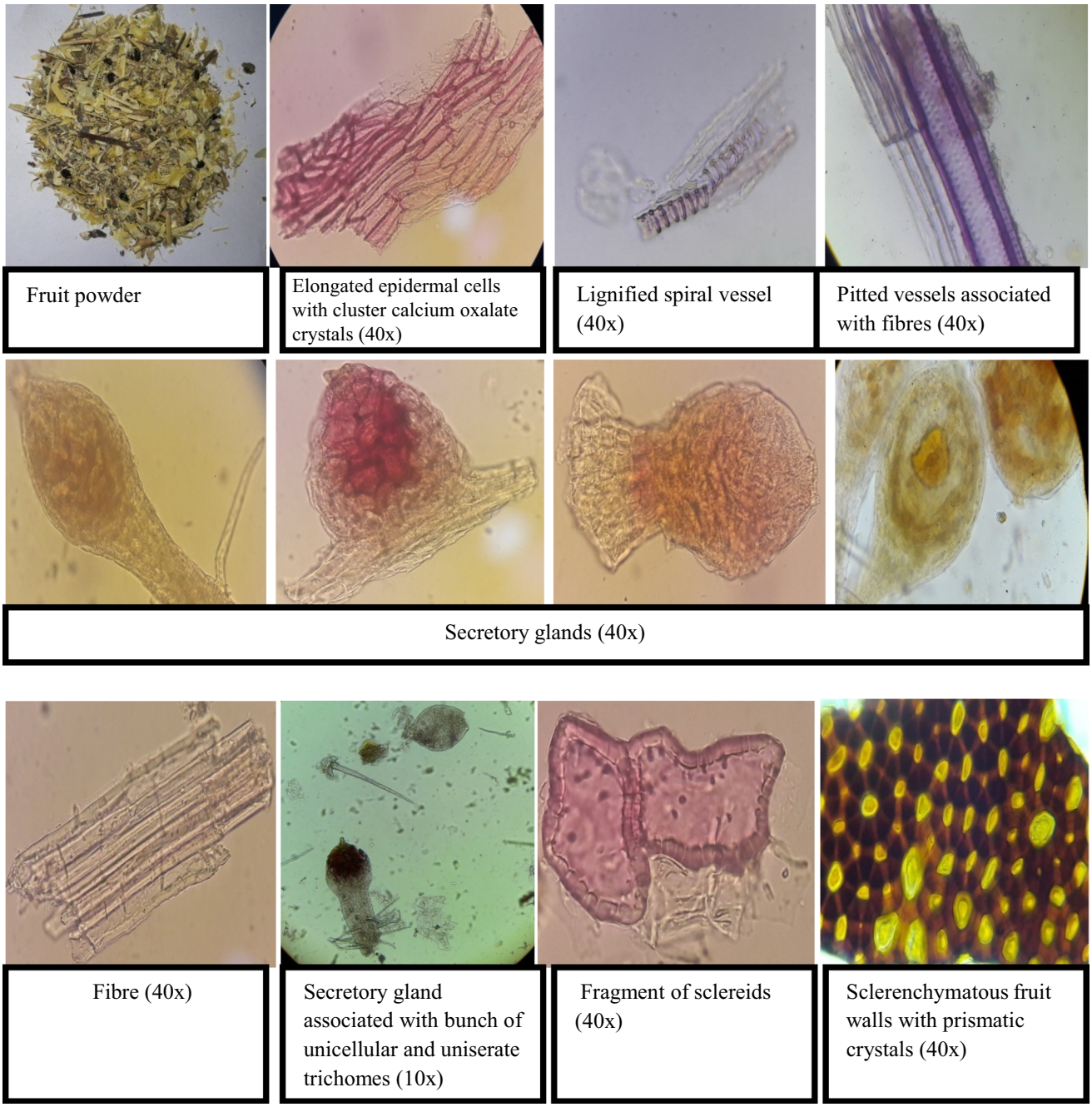


Fig. 9 Powder microscopy of fruit of *Dictamnus albus*

Physico-chemical parameters

The different parts of *D. albus* were analysed for various physico-chemical parameters which included ash values (total ash, acid insoluble ash**,** water soluble ash), foreign matter, loss on drying, swelling index, foaming index fat content, pH value and extractive yield. The results are recorded in a tabulated form (Tables 2 and 3).

Table 2 Physico-chemical parameters of *Dictamnus albus*

Parameters	Leaf	Stem	Root	Fruit
Total ash (%)	7.076	4.14	6.489	3.889
Acid insoluble ash (%)	0.114	0.081	2.541	0.269
Water soluble ash (%)	5.223	2.163	3.991	2.129
Foreign matter (%)	0	0	0.27	0
Loss on drying (%)	10.68	9.83	9.56	11.95
Swelling index	1.7	0.05	0.1	1.5
Foaming index	< 100	< 100	< 100	< 100
Fat content (%)	3.2	0.8	1.8	7.9
pH (1%)	6.29	6.37	6.63	6.46
pH (10%)	5.97	6.09	6.38	6.08

Table 3 Extractive yield (%) of *Dictamnus albus*

Plant Part	Solvent	Cold extraction	Hot extraction	Successive extraction
Leaves	Hexane	3.12	1.57	3.15
	Chloroform	4.52	6.97	2.92
	Ethyl acetate	4.60	7.22	2.82
	Methanol	16.67	30.73	19.41
	Aqueous	20.08	25.85	13.19
	Hydro alcohol	18.18	25.56	–
Stem	Hexane	0.34	0.41	0.82
	Chloroform	0.32	2.37	1.07
	Ethyl acetate	0.63	3.71	1.28
	Methanol	5.14	16.88	10.19
	Aqueous	10.34	12.1	2.95
	Hydro alcohol	8.74	15.33	–
Root	Hexane	1.99	0.89	1.77
	Chloroform	0.74	3.07	1.59
	Ethyl acetate	2.39	4.01	0.85
	Methanol	3.43	15.56	8.96
	Aqueous	7.42	14.81	7.54
	Hydro alcohol	9.53	21.54	–
Fruit	Hexane	1.54	3.93	7.86
	Chloroform	2.32	1.94	0.99
	Ethyl acetate	1.92	3.41	0.97
	Methanol	11.24	5.33	5.99
	Aqueous	15.92	6.38	8.03
	Hydro alcohol	6.44	15.89	–

Fluorescent analysis

The powdered samples of different parts of *D. albus* on treatment with different reagents under visible and UV light produce different color reactions. The results are arranged in tabulated forms Tables (4, 5, 6 and 7).

Discussion

Undoubtedly, the demand for plant-derived products has increased across the globe due to their reduced toxic and harmful effects. In the past two decades, nearly two thirds of approved new drugs were obtained from natural plant products (Newman and Cragg 2007). However, the major drawback to the use of herbal medicine is the lack of standardization which in turn paves way for wrong identification, unintentional substitution of closely related species and intentionaTablel adulteration of genuine herbs with low grade ones, in order to meet the growing demands of the market (Chanda 2014; Aslam 2018). So, in order to overcome these hurdles, WHO emphasized the need of taking certain suitable steps that ensure the quality of medicinal plants and their products by applying various parameters and standard procedures (Arya 2011). With this perspective pharmacognostic standardization of different parts of *D. albus* was carried out.

Macroscopic and organoleptic description of a medicinal plant is the initial move towards establishing its identity and should be completed before any tests are undertaken (Anonymous 1996). In the present endeavor, macroscopic and organoleptic characters of different parts of *D. albus* were recorded with the aim of instantaneous identification of the plant in the natural habitat as well in its dried form. Microscopic evaluation of the plant material includes anatomy as well as powder microscopy, which in turn is indispensible for the identification of raw materials. The anatomical features are used as a criteria for separating the species, genera and even families. The anatomy gives the idea of the internal study of the plant parts which forms the important parameters for the quality control and standardization of herbal drugs. In the present investigation, anatomical studies of leaf, stem and root of *D. albus* revealed some diagnostic characteristics like wavy epidermal cells and unicellular trichomes in leaves; hexagonal pith cells containing secretory functions in stem and oil globules in the root.

Table 4 Fluorescent analysis of leaf samples of *Dictamnus albus* with different reagents

Treatments to powdered drug	Visible light	UV	
		254 nm	366 nm
Powdered drug	Light green	Gray	Light Gray
Powdered drug + distilled water	Dark green	Grayish brown	Light brown
Powdered drug + 10% aq. NaOH	Blackish green	Light brown	Greenish Gray
Powdered drug + NH_3	Dark green	Light brown	Greenish Gray
Powdered drug + Conc. H_2SO_4	Reddish black	Dark brown	Grayish brown
Powdered drug + Dil. H_2SO_4	Blackish green	Brown	Purplish Gray
Powdered drug + Conc. HCl	Black	Grayish brown	Olive green
Powdered drug + Dil. HCl	Dark green	Moderate brown	Blackish Gray
Powdered drug + Conc. HNO_3	Brown	Moderate orange	Greenish Gray
Powdered drug + Dil. HNO_3	Light brown	Light orange	Bluish Gray
Powdered drug + Iodine	Olive green	Grayish brown	Bluish Gray
Powdered drug + 5% ferric chloride	Blackish green	Light brown	Grayish black
Powdered drug + Picric acid	Moderate green	Light brown	Greenish Gray
Powdered drug + Picric acid + water	Moderate green	Light brown	Blackish Gray
Powdered drug + GAA	Blackish brown	Light brown	Gray
Powdered drug + Petroleum ether	Moderate green	Moderate brown	Gray
Powdered drug + Chloroform	Dark green	Blackish brown	Pinkish Gray[a]
Powdered drug + Ethyl acetate	Moderate green	Dark brown	Light pink[a]
Powdered drug + Methanol	Dark green	Dark brown	Pinkish brown[a]
Powdered drug + 5%Potassium dichromate	Brownish green	Light brown	Grayish black
Powdered drug + Alcoholic KOH	Moderate green	Grayish brown	Greenish Gray

[a]Diagnostic color

Table 5 Fluorescent analysis of stem samples of *Dictamnus albus* with different reagents

Treatments to powdered drug	Visible light	UV	
		254 nm	366 nm
Powdered drug	Cream	Moderate brown	Greenish Gray
Powdered drug + distilled water	Dark cream	Moderate brown	Bluish Gray
Powdered drug + 10% aq. NaOH	Light yellow	Light brown	Grayish green
Powdered drug + NH_3	Light yellow	Brown	Grayish green
Powdered drug + Conc. H_2SO_4	Reddish brown	Blackish brown	Grayish black
Powdered drug + Dil. H_2SO_4	Black	Grayish brown	Bluish Gray
Powdered drug + Conc. HCl	Brown	Blackish brown	Olive green
Powdered drug + Dil. HCl	Light brown	Blackish brown	Olive green
Powdered drug + Conc. HNO_3	Moderate orange	Light orange	Blackish Gray
Powdered drug + Dil. HNO_3	Light orange	Light orange	Gray
Powdered drug + Iodine	Light yellow	Moderate orange	Blackish Gray
Powdered drug + 5% ferric chloride	Brown	Moderate orange	Grayish black
Powdered drug + Picric acid	Yellow	Light orange	Blackish green
Powdered drug + Picric acid + water	Light brown	Moderate orange	Greenish Gray
Powdered drug + GAA	Light brown	Moderate orange	Greenish Gray
Powdered drug + Petroleum ether	Moderate brown	Grayish brown	Greenish Gray
Powdered drug + Chloroform	Brown	Brown	Purplish Gray[a]
Powdered drug + Ethyl acetate	Light brown	Grayish brown	Greenish gray
Powdered drug + Methanol	Light brown	Brown	Greenish gray
Powdered drug + 5%Potassium dichromate	Brownish yellow	Light orange	Grayish black
Powdered drug + Alcoholic KOH	Brown	Moderate brown	Greenish gray

[a]Diagnostic color

Table 6 Fluorescent analysis of root samples of *Dictamnus albus* with different reagents

Treatments to powdered drug	Visible light	UV	
		254 nm	366 nm
Powdered drug	Light gray	Blackish brown	Brown
Powdered drug + distilled water	Brown	Blackish brown	Bluish brown
Powdered drug + 10% aq. NaOH	Dark brown	Blackish brown	Blackish Gray
Powdered drug + NH_3	Moderate brown	Brown	Brownish Gray
Powdered drug + Conc. H_2SO_4	Reddish black	Light black	Grayish black
Powdered drug + Dil. H_2SO_4	Black	Brown	Greenish gray
Powdered drug + Conc. HCl	Grayish black	Blackish brown	Blackish gray
Powdered drug + Dil. HCl	Moderate brown	Greenish brown	Light olive green
Powdered drug + Conc. HNO_3	Orangish brown	Moderate orange	Grayish black
Powdered drug + Dil. HNO_3	Brown	Moderate orange	Greenish gray
Powdered drug + Iodine	Yellowish brown	Brown	Blackish gray
Powdered drug + 5% ferric chloride	Moderate gray	Light brown	Blackish gray
Powdered drug + Picric acid	Yellow	Brown	Greenish black
Powdered drug + Picric acid + water	Yellow	Blackish brown	Brownish black
Powdered drug + GAA	Brown	Brown	Greenish gray
Powdered drug + Petroleum ether	Brown	Blackish brown	Gray
Powdered drug + Chloroform	Dark brown	Blackish brown	Purplish gray
Powdered drug + Ethyl acetate	Light brown	Brown	Bluish gray
Powdered drug + Methanol	Moderate brown	Light brown	Purplish brown[a]
Powdered drug + 5%Pottasium dichromate	Yellow	Brown	Grayish black
Powdered drug + Alcoholic KOH	Moderate brown	Blackish brown	Greenish gray

[a]Diagnostic color

Table 7 Fluorescent analysis of fruit samples of *Dictamnus albus* with different reagents

Treatments to powdered drug	Visible light	UV	
		254 nm	366 nm
Powdered drug	Cream	Blackish brown	Greenish gary
Powdered drug + distilled water	Light brown	Brown	Purplish Gray
Powdered drug + 10% aq. NaOH	Dark brown	Brown	Light olive green
Powdered drug + NH_3	Yellowish brown	Light brown	Olive green
Powdered drug + Conc. H_2SO_4	Reddish black	Blackish brown	Greenish black
Powdered drug + Dil. H_2SO_4	Blackish brown	Brown	Light purple[a]
Powdered drug + Conc. HCl	Chocolate brown	Light orange	Dark olive green
Powdered drug + Dil. HCl	Pinkish brown	Moderate orange	Olive green
Powdered drug + Conc. HNO_3	Orangish brown	Moderate orange	Grayish black
Powdered drug + Dil. HNO_3	Brown	Moderate orange	Blackish gray
Powdered drug + Iodine	Light brown	Orange	Bluish gray
Powdered drug + 5% ferric chloride	Greenish black	Light brown	Grayish black
Powdered drug + Picric acid	Yellow	Moderate orange	Greenish black
Powdered drug + Picric acid + water	Yellow	Moderate orange	Grayish black
Powdered drug + GAA	Pinkish brown	Brown	Purplish cream
Powdered drug + Petroleum ether	Brown	Brown	Greenish gray
Powdered drug + Chloroform	Blackish brown	Blackish brown	Purplish gray[a]
Powdered drug + Ethyl acetate	Brown	Light brown	Light purple[a]
Powdered drug + Methanol	Yellowish brown	Brown	Light purple[a]
Powdered drug + 5%Potsasium dichromate	Yellowish brown	Blackish brown	Black
Powdered drug + Alcoholic KOH	Greenish brown	Brown	Purplish black

[a]Diagnostic color

Herbal characterization by powdered analysis is based on the cyto-morphological parameters of the plant material such as collenchyma, parenchyma, sclereids, trichomes, vessels, secretory cells etc.; and cell inclusions viz., pollen grains, starch grains, calcium oxalate crystals etc. In the present investigation, various powdered materials (leaf, stem, root, flower and fruit) of *D. albus* were examined. The peculiar features observed were wavy epidermal cells, prismatic crystals, oil globules and lignified spiral and pitted vessels in leaf; prismatic calcium oxalate sheath and lignified spiral and pitted vessels in stem; lignified cork cells and sieve elements in root; stomata, trichomes and secretary glands in flowers and lignified spiral vessels; stone cells, secretary glands, lignified spiral and pitted vessels and prismatic crystals in fruit.

Physico-chemical parameters prove to be vital for the standardization and quality control of crude drugs. Foreign matter analysis of powdered drugs is an important physic-chemical parameter in order to check the purity of herbal drugs. The results revealed that majority of the samples were free from any visible foreign matter. Loss on drying is a commonly used procedure for analyzing the moisture content in the powdered materials which in turn can be regarded as a quality control function. It was observed that the moisture content ranges from 9.56% to 11.95% in all the studied plant samples, clearly indicating that moisture content is within the limits in all the plant samples. Thus it could avoid any kind of microbial contamination as the general requirement for moisture content in crude drug should not be more than 14% (African Pharmacopoeia 1986). Ash content of the drug represents the inorganic salts, naturally occurring in the drug or adhering to it or intentionally added to it for the purpose of adulteration. For analyzing crude drugs different methods of ash values are considered viz., total ash, acid insoluble ash and water soluble ash. The total ash value is the total amount of material that remains after incineration and includes both physiological (obtained from plant material itself) ash as well as non physiological (extraneous matter sticking to the plant material) ash. In acid insoluble ash, amount of silica and earthy material contaminants is measured. Water soluble ash values gives the idea of water soluble portion of total ash (WHO 1998). In the present study water soluble ash content was more as compared to acid insoluble ash content in all the samples thereby indicating very less silica and earthy material contaminants. Swelling index of the plant material is due to the presence of gums and mucilage, hemicellulose or pectin. In this investigation swelling index of leaves of *D. albus* is more in comparison to other parts studied. Some plants contain saponins which are responsible for persistent foam and this foaming ability is measured as foaming index. All the samples studied showed less foaming index i.e., less than 100 clearly indicating that *D. albus* contains less saponins. The pH value indicates the acidic or basic nature of the constituents present in the sample. During the present investigation it was observed that pH value of all the samples is less than 7 clearly indicating the acidic nature of phyto-constituents in all the parts of *D. albus*.

Extractive value gives an idea about the active constituents present in the drug. The amount of the yield depends on the type of extraction method and the solvent system selected. This helps to identify the presence of several types of adulteration and exhausted materials. In the present study three different extraction methods were used- cold maceration, hot soxhlet extraction and successive soxhlet extraction. Also, six different solvents (hexane, chloroform, ethyl acetate, methanol, water and hydro-alchol) were used in the extraction process. The results revealed that methanolic solvent gives the highest yield in all studied samples as compared to other solvents using hot soxhlet extraction method. This in turn revealed that there are more number of polar compounds in the studied plant samples.

Fluorescence analysis is an important pharmacognostic parameter that depends on the nature of chromophores present in a source material. Some of the constituents in the plant samples show fluorescence in the visible range in daylight while as some other constituents are responsible for fluorescence character under ultraviolet light. With the aid of this technique quality of the crude drug can be evaluated which ultimately can check for its adulteration. This parameter can be used for standardizing the quality of the drug and hence, this property can be used as a fingerprint for identification of plant material (Reddy and Chaturvedi 2010). In the present study all the samples were analyzed for their florescence character both under visible light as well as UV light. The results depicted that some of the samples showed characteristic florescence when treated with specific reagents and hence can be considered as a diagnostic color for the plant material.

Conclusions

The present study for the first time provides a complete pharmacognostic standardization of *D.albus*, thereby, acting as a vital diagnostic tool for correct identification, authentication and standardization of the plant material. The pharmacognostic constant of plants, the diagnostic microscopic features and standards reported could be useful for the compilation of a suitable monograph for their proper identification.

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Compliance with ethical standards

Ethical statement This article does not contain any studies with human participants or animals performed by any of the authors

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