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Full Length Research Paper

Physicochemical, phytochemical and pharmacognostical parameters of a herbal plant *Dracaena steudneri* Engl.

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Dracaena steudneri Engl. (family Dracaenaceae) has been used in managing various health conditions. This study evaluated its pharmacognostic, physicochemical and phytochemical parameters. The physicochemical analysis was done using WHO recommended parameters such as moisture content, ash values (total ash, water soluble ash, acid insoluble ash) and extractive values. Phytochemical screening was done by methods described by Sofowora, Kokate and Prashant. The morphological studies exhibited the macroscopic characters while the microscopic study showed the presence of various characteristics such as vascular bundles, calcium oxalate crystals and paracytic stomata. Physicochemical evaluation indicated 13.7% total yield, 9.13% moisture content, 0.17% water soluble ash, 0.17% acid insoluble ash, 3.41% water insoluble ash, 0.84% acid insoluble ash, 16.25% acid soluble extractive value and 20% water soluble extractive value. The qualitative phytochemical screening revealed the presence of alkaloids, flavonoids, terpenoids, saponins, tannins, glycosides and phenols in the extract. The pharmacognostic characters described in this study will help in identifying the plant and crude drug. The standardization parameters obtained will ensure the efficacy of the drug and also distinguish the drug from its adulterants.

Key words: *Dracaena steudneri*, physicochemical, phytochemical, organoleptic evaluation.

INTRODUCTION

Medicinal plants are in demand because they produce a wide variety of drugs (Chen et al., 2016). It has been reported that about 80% of the world's population depends on herbal medicines for treatment of various diseases (WHO, 2022). This is one of the main reasons for research on medicinal plants. Herbal medicines have

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minimum or no side effects and are considered as safe, affordable, and available (Cohen and Ernst, 2010). But, they also have numerous challenges such as absolute identification, knowledge of active principle(s), lack of defined chemical identity, non-availability of universally-acceptable safety and clinical standards for necessary therapeutic evaluation (Ekor, 2014). Herbal medicines are prone to adulteration and substitution which questions their efficacy and integrity. Therefore, quality control for the efficacy and safety of herbal products is essential (Vinotha et al., 2013).

Despite the modern techniques, identification of plant drugs by pharmacognostic studies is still the most reliable, cheapest and simplest technique. The pharmacognostic parameters are necessary for the identification and reproducibility of the crude drugs (Kadam et al., 2012). For a medicinal plant to be considered therapeutically efficacious, it must be of quality and the quantity of its chemical constituents must be enough for it to be efficacious. Wrong identification of the plant is the beginning of misuse of herbal medicine (Peter and De Smet, 2002). The determination of physicochemical and phytochemical constituents plays a significant role in the standardization of crude drugs (Fazal et al., 2011).

Dracaena steudneri is one of the commonly used medicinal plants for child birth in Uganda. The stem bark extract is used traditionally for induction of labour and achievement of relatively painless delivery (Tugume et al., 2016). Traditionally, in Tanzania, the leaf is reportedly used for the treatment of hernia, splenomegaly, asthma and related chest problems in children, fibroids and infertility in women (Moshi et al., 2007). The decoction of the plant is used for malaria (Tabuti et al., 2012) and the treatment of hepatic diseases (Kokwaro, 1993). The decoction of the leaf is also used for the treatment of scars, cough, syphilis, kidney stones and snake bites (Okello and Kang, 2019). The plant reportedly possesses antifungal activity as it was able to inhibit the growth of *Candida albicans*, *Aspergillus* species and *Cryptococcus neoformans* at a concentration ranging from 1.3 to 12 µg/ml *in vitro* (Kisangau et al., 2014). While *in vivo* anti-candida activity of the aqueous extract of the plant showed a dose dependent activity at 100 to 400 mg/kg (Kisangau et al., 2014). This plant is widely used for obstetrics by the traditional birth attendants (TBAs) interviewed under this study in Bususwa Village, Jinja District.

For the useful application of the plant parts in modern medicine, physicochemical, pharmacognostic and phytochemical standardization is very important (Saxena et al., 2012); for the medical benefits of the plant to be used properly and scientifically to achieve the desirable expectations. Therefore, the aim of the present research work was to evaluate the physicochemical, phytochemical constituents and pharmacognostic parameters of *D. steudneri* plant.

MATERIALS AND METHODS

Collection of plant material

Fresh *D. steudneri* Engl., stem bark was collected from Bususwa Village in Jinja District (0.5990° N, 33.1239° E), Uganda. Identification and authentication of the plant was done at the Herbarium of Makerere University, Kampala, by a taxonomist, Mr. Protase before the voucher specimen was deposited and given a voucher number: 001/MGT.

Preparation of *D. steudneri* Engl. stem bark extract

Stem bark of *D. steudneri* was washed with water to remove dirt, and chopped into small pieces for quick and easy drying. It was oven dried at 50°C for 48 h and pulverized mechanically into coarse powder. The powdered material was extracted by decoction method in which 250 g of powdered material was weighed into a round bottomed flask containing 1 L of distilled water. Then, it was boiled at 80°C for 45 min (Sofowora, 1983). The decocted extract was filtered using muslin cloth and later Whatman filter paper No. 1. It was concentrated *in vacuo* using a rotary evaporator (IKA® RV10) at 55°C to dryness and stored at 4°C until required for further analyses.

High performance liquid chromatography (HPLC) analysis of *D. steudneri* extract

The high-performance liquid chromatography (HPLC) analysis of the aqueous extract of *D. steudneri* stem bark was performed to establish its reproducibility using a Shimadzu Prominence UFLC system (Tokyo, Japan) at the Analytical and Pharmaceutical Laboratory, Mbarara University of Science and Technology, Uganda. The machine comprises a LC-20AD pump, a Phenomenex Luna C_{18} column (250 × 4.6 mm. 5 µm), temperature-controlled sample trays, an online degasser DGU-20A5R and an ultraviolet (UV) detector.

HPLC analysis was carried out at a column temperature of 30°C in a binary isocratic elution manner using a mixture of ethanol/acetonitrile/0.01% trifluoroacetic acid (6:1:3) at a flow rate of 1.0 mL/min with wavelength of 370 nm.

Pharmacognostic study

Macroscopic study

This study was carried out using the organoleptic evaluation method including the evaluation of colour, odour, taste, texture, touch, shape, base, margin, arrangement, size and apex (Kanakiya et al., 2018).

Microscopic study

The microscopic study was carried out by sectioning of the stem bark and leaf using a microtome. The thin sections were further washed with running water, stained with safranin for clear observation and confirmation of lignifications. Microscopic examination was done at magnifications of 10 and 40× (Pande et al., 2018).

Physicochemical analysis

The physicochemical parameters like loss on drying, total ash, acid-

insoluble ash, water-soluble ash, and extractive values were determined as per WHO guidelines (WHO, 2011).

Moisture content/loss on drying

Petri dishes were thoroughly washed and rinsed with water before drying at 80°C for 2 h in an electric hot air oven. After drying, each Petri dish was allowed to cool in a desiccator before weighing. Into each Petri dish, 4 g of the powdered plant material was weighed and transferred into an electric hot oven to dry at 105°C for 5 h (WHO, 2011). This was carried out at the Pharmaceutical Chemistry/Analysis Laboratory, Mbarara University of Science and Technology (MUST), Mbarara. After oven drying, each Petri dish was transferred into a desiccator glass jar absorbent for cooling. On cooling, each Petri dish was reweighed and the percentage of moisture content was calculated as follows:

Percentage moisture content = (Wt. loss /Wt. of raw material) × 100

Total ash value

The ash and total ash values were determined by the WHO (2011) methods. Each porcelain crucible with 30 cm diameter was thoroughly washed and rinsed with water before drying at 80°C for 2 h in an electric hot air oven. After drying, each crucible was allowed to cool in a desiccator before weighing. Into each crucible, 3 g of the powdered plant material was weighed, covered and transferred into an electric furnace (Memmert) at the Pharmaceutical Chemistry/Analysis Laboratory, MUST. It was incinerated at <600°C until it was free from carbon which is indicated by the whiteness of the ash (AP, 1986; WHO, 2011). After ashing (forming of ash), each crucible was transferred onto an asbestos tile for cooling. After cooling, each crucible was reweighed and the percentage of total ash value was calculated as follows:

Percentage total ash = (Wt. of total ash / Wt. of powdered drug) × 100

Soluble extractives

Determination of alcohol extractive

Coarsely powdered stem bark (4 g) was weighed into a 250 mL glass-stoppered conical flask and was macerated with 100 ml of 70% ethanol for 24 h. The mixture was shaken continuously for 6 h and allowed to stand for 18 h. The mixture was filtered, using Whatmann No.1 filter paper rapidly to prevent solvent loss. The filtrate (25 ml) was dispersed into a tarred flat-bottomed dish on a water bath and evaporated to dryness. The dish was transferred into an electric oven to dry further to constant weight at 105°C (WHO, 2011). The dish was then transferred into a desiccator to cool. Each dish was weighed till constant weight was observed and the percentage of the extractive value was calculated as follows:

Alcohol extractive = (Wt. of extract / Wt. of drug) × 100

Soluble extractives indicate the measure of the amount of extractable matter which is extractable by the specified solvent under specific conditions.

Determination of water-soluble extractive

Coarsely powdered stem bark (4 g) was weighed into a glass-stoppered conical flask of 250 mL and was macerated with 100 ml of 0.05% chloroform for 24 h. The mixture was shaken continuously for 6 h and allowed to stand for 18 h. The mixture was filtered, using Whatman No.1 filter paper rapidly to prevent solvent loss. 25 mL of filtrate was dispersed into a tarred flat-bottomed dish on a water bath and evaporated to dryness. The dish was transferred into an electric oven to dry further to constant weight at 105°C (WHO, 2011). The dish was then transferred into a desiccator to cool. Each dish was weighed till constant weight was observed and the percentage of the extractive was calculated as follows:

Water soluble extractive = (Wt. of extract / Wt. of drug) × 100

Phytochemical screening

The preliminary phytochemical screening of the *D. steudneri* extract was carried out using standard laboratory procedures, to detect the presence of different secondary metabolites (phytochemical constituents) such as alkaloids, flavonoids, saponins, tannins, glycosides, phenols and terpenoids. These preliminary tests were carried out following the procedures described by Sofowora (1993), Kokate et al. (1995) and Prashant et al. (2011).

Test for saponins

One gram of plant material was boiled with 5 mL of distilled water and filtered using Whatman filter paper No 1. About 3 mL of distilled water was further added to the filtrate and shaken vigorously for about 5 min. Frothing which persists on warming showed the presence of saponins.

Test for flavonoids

About 0.5 g of plant material was boiled with distilled water and then filtered. To 2 mL of the filtrate, few drops of 10% ferric chloride solution (Sigma Aldrich) were added. A green-blue or violet coloration was an indication of the presence of a phenolic hydroxyl group (Sigma Aldrich).

Test for tannins

About 0.5 g of plant material was stirred with about 10 mL of distilled water and then filtered. Few drops of 1% ferric chloride solution were added to 2 mL of the filtrate and occurrence of a blue-black, green, or blue-green precipitate indicated the presence of tannins.

Test for steroids

To about 0.2 g of plant material, 2 mL of acetic acid was added, and the solution was cooled in ice followed by the addition of conc. H_2SO_4 (Sigma Aldrich). Violet to blue or bluish green was an indication of the presence of a steroidal ring.

Test for terpenoids

A little of plant material was dissolved in ethanol (Absolute from Sigma Aldrich). 1 mL of acetic anhydride (Sigma Aldrich) was added, followed by the addition of conc. H_2SO_4. A change in color from pink to violet showed the presence of terpenoids.

Table 1. HPLC analysis signals obtained in aqueous extract of *Dracaena steudneri* stem bark.

Peak#	Ret. Time	Area	Height	Peak Start	Peak end	Area%
1	2.215	3877	298	1.725	2.308	0.2543
2	2.631	463199	64197	2.308	2.792	30.3807
3	2.952	305327	23631	2.792	3.042	20.0260
4	3.107	288880	20409	3.042	3.433	18.9474
5	3.525	190487	11825	3.433	3.917	12.4938
6	4.110	231679	7906	3.917	14.883	15.1956
7	6.868	22281	552	6.283	7.867	1.4614
8	8.450	3594	244	8.117	8.767	0.2357
9	9.291	1486	83	9.133	9.467	0.0974
10	9.817	4924	264	9.550	10.108	0.3230
11	10.135	1386	79	10.108	10.475	0.0909
12	12.632	1983	63	12.067	12.783	0.1301
13	12.821	1347	62	12.783	13.208	0.0883
14	19.715	1612	78	19.233	19.758	0.1057
15	19.898	2587	84	19.833	20.825	0.1697

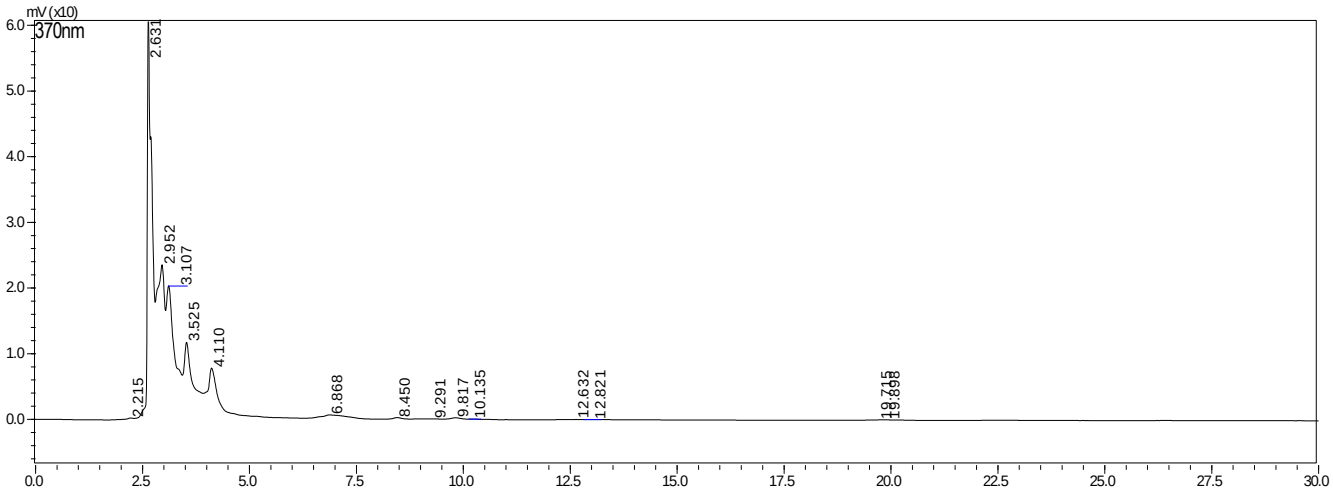

Figure 1. HPLC analysis of aqueous extract of *D. steudneri* stem bark.

Phenols

To 5 ml of extract 3 ml of 10% lead acetate solution was added and mixed gently. The production of bulky white precipitate was positive for phenols.

Glycosides

One milliliter of conc. H_2SO_4 was prepared in a test tube and 5 mL of aqueous extract from the plant material was mixed with 2 mL of glacial CH_3COOH (Sigma Aldrich) containing 1 drop of $FeCl_3$ (Sigma Aldrich). The mixture was carefully added to 1 mL of conc. H_2SO_4. A brown ring appearance indicates the presence of cardiac glycoside.

Test for alkaloids

To 5 mL of extract 2 ml of HCL was added. Then, 1 mL of Dragendroff's reagent was added an orange or red precipitate showed a positive result for alkaloids.

RESULTS

HPLC analysis of *D. steudneri* stem bark extract

The HPLC chromatogram of the aqueous extract of *D. steudneri* stem bark showed 15 characteristic signals, as shown in Figure 1. This chromatogram showed diagnostic peaks at the retention time of 4.1, 19.7 and 19.89 min which guided in identifying and confirming any of this extract following the same process of extraction and at the same conditions (Table 1 and Figure 1).

Table 2. Morphological characters of the stem and leaf of *Dracaena steudneri* Engl. plant.

Part	Stem bark	Leaves
Size	45 cm	40-130 cm (length), 4-16 cm (diameter)
Shape	Cylindrical	Narrowly lanceolate
Colour	Gray	Glossy with deep green
Odour	Characteristic smell	Herbaceous
Taste	Sweetish	Blunt
Arrangement	Single	Clustered
Appearance	Rhizomatous	Smooth fleshy
Apex	---	Acuminate
Margin	---	Smooth
Base	--	Clasping
Texture	Smooth	Smooth

(---) None.

Table 3. Physicochemical results of *Dracaena steudneri* Engl.

Parameter	% composition
Moisture content	9.13 ± 0.56
Ash value water soluble	0.17 ± 0.00
Ash value acid insoluble	0.17 ± 0.00
Acid insoluble ash	0.84 ± 0.05
Water soluble ash	3.41 ± 0.02
Acid soluble extractive value	16.25 ± 0.63
Water soluble extractive value	20.0 ± 0.0

Table 4. Qualitative phytochemical results of *Dracaena steudneri.*

Phytochemicals	Plant extract
Alkaloids	+ + +
Tannins	+ +
Saponins	+ +
Glycosides	+/-
Steroids	-
Phenols	+ + +
Terpenoids	+/-
Flavonoids	+ + +

(+ + +) Appreciable amount, (+ +) average amount, (+/-) trace amount, (-) absence.

Pharmacognostic evaluation

Macroscopic characteristics

The morphological characters of the plant are described in the Table 2 and Figure 2 below.

Physicochemical analysis

The values of various physicochemical parameters evaluated include extractive values of *D. steudneri* plant (Table 3). The moisture content of the plant was 9.13%. The ash value of the plant powder water and acid value was 0.17% for both values; while water soluble ash and acid insoluble ash values were 3.41 and 0.84%, respectively. The water soluble extractive was 20.0% while that of acid soluble extractive was 16.25%. Percentage yield was 13.7%.

Phytochemical screening

The qualitative phytochemical screening of the plant extract of *D. steudneri* plant is shown in Table 4; alkaloids, phenols and flavonoids were in appreciable amounts, tannins and saponins were present in average amounts, glycosides and terpenoids were in trace amounts while steroids were seen to be absent.

DISCUSSION

Plants are significant in drug development since time immemorial as sources of natural products. They potentially have bioactive constituents for the development of new therapeutic agents (Veeresham, 2012) and this leads us to the initial steps of subjecting the plant to pharmacognostic evaluation which determines its dentity (Jain and Shukla, 2011). Pharmacognostic studies also ensure standardization which ensures reproducible quality of herbal products and leads to the safety and efficacy of products (Chanda, 2014).

The macroscopic evaluation is based on the study of morphological and organoleptic profiles of drugs. In this study, the macroscopic evaluation of *D. steudneri* showed that the stem bark was gray brown, leaves were glossy with deep green colour, the leaves were alternately arranged, stem bark was long, odour was characteristic

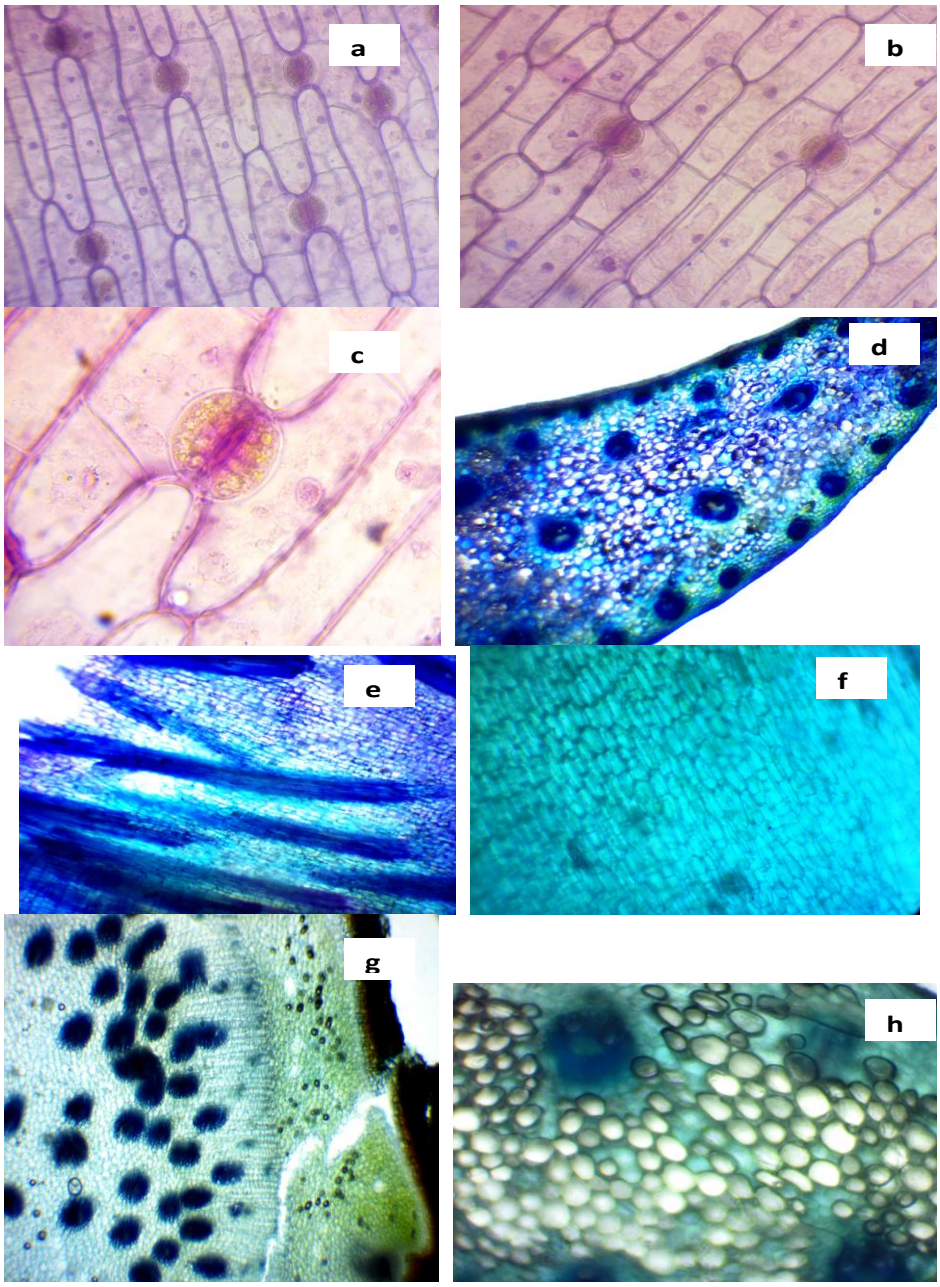

Figure 2. (a) Abaxial surface of leaf with Paracytic stomata, b) Adaxial surface of leaf with paracytic stomata, c) Paracytic stomata, d) TS of midrib, e) TS of stem bark with vascular bundles, f) TS of stem bark, g) TS of stem bark with epidermis, and h) calcium oxalate crystals.

woody for the stem bark and herbaceous for the leaves, and apex was acuminate. Therefore, the macroscopic characters of *D. steudneri* studied can serve as diagnostic parameters especially its organoleptic characteristics (Abdullahi et al., 2018). Microscopic evaluation is one of the simplest methods used to establish the correct and accurate identity for a plant drug (Patel and Zaveri, 2011). The microscopic evaluation showed the presence of the leaf margin as smooth, palisade parenchyma on both the adaxial and abaxial surface; vascular bundles were seen to be scattered which are significant for their transportation of critical substances like water, minerals and sugars to different parts of the plant. The presence of paracytic stomata is indicative of efficient gaseous exchange for photosynthesis and loss of water (Shaukat et al., 2010); calcium oxalate crystals could be significant for dispersing light to the chloroplasts in the photosynthetic parenchyma cells of the leaves, and for

regulating calcium, homeostasis and heavy metal detoxification (Franceschi and Nakata, 2005).

Determination of the physicochemical parameters is one of the important measures as this helps in identifying adulterants (Kalidass et al., 2009). The physicochemical parameters like moisture content, ash value acid insoluble, ash value water soluble, water soluble extractive, acid soluble extractive value, and percentage yield were determined. *D steudneri* had a moisture content of 9.13% which is indicative that the drying process was efficient. This is an important parameter because it measures the efficiency of the drying process of the plant, indicating the stability of the drug during storage (Vinotha et al., 2013). Moisture content should always be minimal in order to avoid microbial contamination and this should range from 10 to 20%. Also, the extractive values are useful to evaluate the chemical constituents of the crude drug as well as a measure of the stability of phytochemical compounds in the plant drug in a given solvent/solution (Magbool et al., 2018).

D. steudneri plant was seen to contain phytochemical compounds like saponins, alkaloids, glycosides, flavonoids, terpenoids, phenols and tannins. The different preliminary studies give an idea regarding the use of the plant for a particular pharmacological activity. Tannins are also reported to exhibit antiviral, antibacterial and anti-tumor activities (Heslem, 1989); flavonoids have demonstrated the presence of anti-inflammatory, antiallergenic, anti-viral, antioxidant, and anti-carcinogenic activity (Mark, 1998). Saponins have expectorant action which is very useful in the management of upper respiratory tract inflammation, cardiotonic, anti-diabetic and anti-fungal properties (Magbool et al., 2018). Alkaloids are reported for antiplasmodial and oxytocic (Sanon et al., 2003), antiprotozoal activity (Tempone et al., 2005), and antimicrobial activity (Erdemoglu et al., 2007).

Conclusion

In the present study, the pharmacognostic parameters, physicochemical and phytochemical analysis of *D. steudneri* will be helpful in the authentication and can be used as a reference standard in the preparation of a monograph.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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