Research Article

Pharmacognostic Evaluation of *Oxalis pes-caprae* L. (Family Oxalidaceae)

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Abstract | The present study was conducted on *Oxalis pes-caprae* L. (Family Oxalidaceae) to analyze its morphological and pharmacognostic features. The results revealed that it leaves are compound, perennial and summer deciduous with upper epidermis followed by mesophyll region with vascular bundle and the lower epidermis. The leaf features showed that palisade ratio was (7.35), vein islets number (9), and vein termination number (9.1), stomata number (47) and stomatal index were (42.72). Transverse section of the root showed outer epidermal cells, cortex and pericycle, xylem and phloem cells. Powder drug microscopy, ash analysis, extractive values and fluorescence analysis were also studied. Preliminary phytochemical screenings of different extracts of *Oxalis pes-caprae* L. showed the presence of carbohydrates, phenols, flavonoids, tannins, saponin, fats and oils.

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Introduction

The word pharmacognosy was initially used between 1811 and 1815 and was formerly concerned to information of medicine constituents (Evans, 1996). Pharmacognosy can also be defined as practical discipline which conducts biochemical, biologic and economical characteristics of natural drug and constituent (Tyler et al., 1988). In current years, investigation in crude drugs has experienced a vast attention (Verpoorte, 2000). Biochemical, chemical, physical and biological characteristics of drugs and exploration of novel drugs from natural sources are studied in field of pharmacognosy (Balunas and Kinghorn, 2005). People have consumed plants as source of food, shelter, clothing, medicine, cosmetics, and for searching release from adversity of life; in a continuous strive to get better their quality of life (Betoni et al., 2006). The pharmacognostic parameters are important for authentication, identity and quality of crude drugs. Pharmacognostic standards are set up to ensure quality and to lessen chances of adulteration and contamination during collection and preparation of drugs (Bhattacharya and Kamaruz, 2009). By stepwise pharmacognostic studies, the procedure of standardization can be accomplished (Ozarkar, 2005). It facilitates in recognition and confirmation of the plant material and ensures quality. Morphological, anatomical and biochemical evaluations are simple pharmacognostic methods employed in standardization of plant material (Anon, 1998). Organoleptic assessment can be made by sense organs. It gives the easiest and fastest way to determine identity, quality and purity of drugs. Morphological observation of plants through naked eye or magnifying lens is called the macroscopic study (Shah et al., 2012). Different ash values are used to detect the pureness and quality of sandy, earthy or

exhausted materials in crude drug. Total ash value shows occurrence of several earthy impurities like carbonates, oxalates and silicates. Water soluble ash is conducted to evaluate presence of exhausted drugs in genuine one, while the acid insoluble ash (comprises of mainly silica) point out adulteration with earthy material (Aron and Mehalingam, 2012).

Oxalis pes-caprae L. is a 12-24 cm tall, perennial, herbaceous plant with bulbiferous and underground stem belonging to family Oxalidaceae (Nasir, 1971). Because of pleasant sour taste, it is also called as "sourgrass" or soursob. High content of oxalic acid is cause of its sourness. The rhizomes and tubers of plants have the ability to increase aeration, water infiltration and decrease the growth of other weeds but is responsible for lessening yield of crops. It is also a weed of pastures, orchards, vineyards, vegetables, fallows, gardens, roadsides and disturbed areas (Peirce, 1997). The present study was carried out to analyze the pharmacognostic profile of *Oxalis pes-caprae* L. Similar studies were made by Simpson and Morris (2014), Maria et al. (2015), Tripoda (2015), Girma and Wurko (2016) and Vasco-correa and Zapata (2017) on various aspects of medicinal plants and pharmacognosy.

Materials and Methods

Fresh plant material of *Oxalis pes-caprae* L. at flowering stage were collected, cleaned, washed and garbled. For macroscopic and microscopic characteristics, fresh samples were used and remaining collection was dried in shade at about 25±3 ^{0}C and powdered with electric grinder. For protecting powder from molds, insects attack and moisture, these were stored in air tight bottles. Morphological observations of the leaf, stem, root and flower of *O. pes-caprae* were examined by organoleptic methods. Leaf observation included nature, size, color, odor, taste, phyllotaxis, insertion, leaf base, stipule, petiole, lamina (venation, texture, composition, apex, base, margin, general outline, surface and incision). Stem was studied for habit, shape, odour, taste, colour, surface, duration, branches and position. Roots were studied for branches, color, odor, taste, size, shape, surface, duration and rootlets. Flowers were studied for type, petals, sepals, filament and flowering period. Bulb was studied for color, shape, taste and size (Wallis, 1985; Evans, 2002). With the help of sharp razor thin transverse sections of selected plants parts were made with large numbers. Thin sections were selected for study to mount on glass slide and studied under Nikon microscope fitted with camera (Chaffey, 2001).

Many pieces of leaves were cut into 1 sq mm pieces and boiled in chloral hydrate solution. The cleared pieces were mounted on slides and observed under Labomed microscope provided with overhead digital IVU 3100 camera. Beginning at margin all vein islets were counted in the square and on boundary of square. Vein-terminations were counted in square. 10 readings were taken in continuous squares and vein-islets were counted forgetting exact and standard values (Trease and Evans, 2002).

Palisade ratio

Palisade cell ratio is the average number of palisade parenchyma cells present beneath each upper epidermal cell (Trease and Evans, 2002).

Procedure: Small pieces of leaf (2mm square) were cut between midrib and margin, boiled in 100% concentrated chloral hydrate solution. Cleared pieces were mounted and observed under Labomed microscope provided with overhead digital IVU 3100 camera. Many sets of each 4 upper epidermal cells were examined. Then palisade cells lying beneath each set of four epidermal cells were focused with fine adjustment and counted. Palisade ratio was then obtained by dividing the number by four. In order to obtain accurate values, ten readings were taken from various fragments (Trease and Evans, 2002).

Stomatal number and stomatal index

Number of stomata per square mm of epidermis from both surfaces of leaf is known as stomatal number. Percentage measure of stomatal density per unit area taken by epidermal cells is stomatal index (Trease and Evans, 2002).

Procedure: To prevent leaves from dessication dipped them in water. Epidermis from both surfaces of leaf was removed with help of sharp razor blade. Separated epidermis was placed on slide and examined under microscope for following parameter (Choudhary and Imran, 1997).

- Absence and presence of stomata.
- Number of stomata per square mm
- Number of epidermal cells
- Stomatal index was calculated by using formula

$$I = \frac{S}{S+E} \times 100$$

Where;
I= Stomatal index; S= No of stomata per unit area; E= No of epidermal cells per unit area.

Powder drug microscopy

The whole plant powdered material was treated with warm 200% concentrated chloral hydrate solution. Drops from this was taken on slide, covered by cover slip and examined for different structures under microscope fitted with camera (Wallis, 2005).

Physicochemical study

Powder drug fluorescence study: The fluorescence analysis of the whole dry plants powders treated with various reagents (50% HCl, ethanol, methanol, NH_3 solution, 10% $FeCL_3$ solution, acetic acid, 50% HNO_3 and iodine solution) was conducted by examining samples under visible and Ultra Violet light of short and long wave lengths (Evans, 2002).

Ash analysis: Total ash examination

Methodology: Silica crucible having flat bottom was completely washed and for drying kept in oven at 70 ^{0}C for 30 minutes. Crucible was then heated, tarred, cooled in desiccators and weighted (W1). 4gm of plant powder of *O. pes-caprae* was shifted to crucible and then heated on Benson burner. After this shifted to muffle furnace in which temperature was slowly rised to 550 ^{0}C. The process continued up to several hours to burnt carbon in drug becoming white in color. Then crucible having ash was shifted to desiccators cooled and weighted (W2). Calculation of total and percent ash was done by following method (Wallis, 1985).

Weight of empty crucible = W1
Weight of empty crucible + ash = W2
Total ash (mg/g) = W2 – W1 of sample= mg/gram

$$\% \text{ Ash} = \frac{W2 - W1}{\text{Wt of sample}} \times 100$$

Acid insoluble ash analysis

The drugs containing different amount of Calcium oxalate crystal and adulterated with lime, sand, clay and lime are examined by this analysis (Wallis, 1985; Rangari, 2002)

Methodology: To the crucible having known quantity of ash, added 25ml HCl, covered by watch glass and boiled it for five minutes. Watch glass was washed with 5ml of hot distilled water and added the liquid to crucible. On an ash less filter paper, insoluble matter was collected, washed the filter paper with hot water to neutralize the filtrate. Then shifted this filter paper to its crucible, dried on hotplate and heated at 500 ^{0}C in furnace. Then shifted the crucible to desiccator for cooling (30 minutes), weighted without delay. Calculated the acid-insoluble ash by following method (Wallis, 1985).

Weight of empty crucible = W1
Weight of empty crucible + sample = W2
Acid insoluble ash = W2 –W1 = X mg/gm

Water-soluble ash analysis

For detection of water exhausted material, this test is conducted (Jarald and Jarald, 2007).

Methodology: To pre-weighted crucible (W1) having known quantity of ash (W2), added 25ml water, covered by watch glass and boiled it for five minutes. Watch glass was washed with 5ml of hot distilled water and added the liquid to crucible. On an ash less filter paper, insoluble matter was collected, and then shifted this filter paper to its crucible, dried on hot plate and heated at 500 ^{0}C for 15minutes in furnace. Then shifted the crucible to desiccator for cooling (30 minutes), weighted without delay (W3), from which insoluble matter was calculated (X mg/gm). The amount of water-soluble ash (Y mg/gm) was then calculated by subtracting this amount from total ash (Wallis, 1985).

Weight of empty crucible = W1
Weight of empty crucible + sample = W3
Weight of sample = W3 - W1 = X mg/gm
Water soluble ash = W2 – X = Y mg/gm

Extractive value

Extractive value is the amount of the extractable or soluble material of a drug in a specific solvent.

Methodology: By following methodology of Ansari et al. (2006) extractive values were investigated. In airtight bottles, 500ml of different solvents and 100gm powder of plants were mixed and kept for 7 days with occasional shaking. After this extracts were filtered and in rotary evaporators filtrates were dried. Calculation for percent extractive values were done by following formula:

$$\text{Percent (\%) extractive value } \left(\frac{W}{W}\right) = \frac{\text{Weight of extract}}{\text{Wight of sample}} \times 100$$

Phytochemical screening

For detection of alkaloids, carbohydrates, phytosterols, proteins, flavinoids, triterpenoids, saponins, phenols, tannins, fat and oil in various extracts of *O. pes-caprae*, different qualitative phytochemical tests were carried out.

Tests for carbohydrates

Molisch test: To extract solutions, some drops of alcoholic α-napthol were added. To sides of test tube, 0.2 ml of concentrated H_2SO_4 was added. Appearance of purple to violet color ring at junction, indicate the existence of carbohydrates (Evans, 2002).

Benedict test: Some drops of Benedict reagent added to extract solutions and boiled on water bath. Reddish brown precipitate indicated existence of reducing sugar (Evans, 2002).

Fehling test: Some drops of sample solutions was treated with equal volumes of Fehling's A and Fehling's B and boiled. Brick red precipitate of cuprous oxide formation showed the existence of reducing sugar (Evans, 2002).

Detection of protein

Millon test: To extracts, 2ml of Millon's reagent was added. The appearance of white precipitate in solution which turned red by heating confirms the presence of protein (Evans, 2002).

Ninhydrine tests: 0.2% solution of Ninhydrine was boiled with extract solutions in test tube. Proteins were indicated by violet color appearance (Kumar and Kiladi, 2009).

Tests for alkaloid

Mayer test: Some drops of Mayer reagent were added to extract solution. The appearance of creamy white precipitates confirms the presence of alkaloids (Khandelwal, 2004).

Wagner test: Some drops of Wagner reagent were added to extract. Formation of reddish brown precipitate indicates existence of alkaloids (Khandelwal, 2004).

Hager test: To extract solution some drops of Hager reagent were added. Appearance of yellow precipitates confirmed existence of alkaloids (Khandelwal, 2004).

Tests for phytosterol and triterpenoid

Libermann-Burchard test: Some drops of acetic anhydride were added to extracts, boiled, cooled and then from sides of test tube, concentrated H_2SO_4 was added. At junction of 2 layers if brown ring made, green color of upper layer confirmed existence of sterol and deep red color of lower layer confirmed existence of triterpenoid (Harborne, 1998).

Detection of phenol

Ferric chlorides test: In test tube, 2ml extract solution and 2ml $FeCl_3$ were mixed. Phenols indicated by production of deep bluish solution (Dahiru et al., 2006).

Detection of flavonoid

Alkali reagents test: NaOH solution was mixed with extract solutions. Yellow to red precipitates indicates existence of flavonoid (Kokate, 1994).

Tannins

Ferric chlorides test: Extract solutions and $FeCl_3$ were mixed. Blue green colouration confirmed existence of tannins (Kokate, 1994).

Alkali reagents test: Extract solutions and NaOH solution were mixed. Yellow to red precipitates production in short time confirmed existence of tannins (Kokate, 1994)

Dtection of saponins

Frothing test: In test tube, 5ml aqeous solution of extracts was shaken. Saponin indicated by production of froth for some time (Chaouche et al., 2011).

Detection of fats and oil

Spot test: Extracts were individually pressed between 2 filter papers. Existence of fixed oil indicated by formation of oil stains on papers (Gomathi, 2010).

Results and Discussion

In pharmacognostic studies *Oxalis pes-caprae* was evaluated for identification and standardization.

Macroscopic (Morphological) features

Macroscopic parameters such as shape, surface, size and organoleptic parameters such as taste, odor, color etc of leaf, stem, root, flower and bulb of *O. pes-caprae* was conducted for identification and standardization.

Leaf: Macroscopic study of leaf depicted that the leaf of *O. pes-caprae* is palmate compound, perennial summer deciduous. Upper surface is medium green in color with purple spots and lower surface is paler. Leaflets are cuneate-obcordate in shape with deeply notched apex, obcordate base entire margin and 5-15 mm in length, 10-30 mm in breath with reticulate venations (Figure 1A, B, C). More characteristics of leaf are listed in (Table 1).

Figure 1: A, *Oxalis pes-caprae;* **B,** *Adxial surface of leaf;* **C,** *Abaxial surface of leaf.*

Stem: Macroscopical characteristics of stem revealed that it is hollow; pale brown in color. Subterranean, bulbous in nature with slight sour taste. Some other features of the stem are listed in Table 1.

Root: Morphological feature of *O. pes-caprae* root showed that it is cylindrical in shape, white to brown in color and 2-5 cm long with no odor and sour in taste (Figure 2).

Figure 2: *Showing root and bulb of O. pes-caprae.*

Flower: Inflorescence is of subumbellate type, petals 15-20 mm long yellow in color, sepals 5-7 mm long lanceolate. Flowering period is from January to April (Table 1).

Table 1: *Various morphological features of leaf, stem, root, flower and bulb of Oxalis pes-caprae.*

Part	Feature	Oxalis pes-caprae
Leaf	Nature	Perennial summer deciduous, bulbiferous plant
	Size	5-15mm long, 10-30mm broad
	Color	Medium green and often purple zoned or spotted on upper surface, paler beneath
	Odor	Odorless
	Taste	Sour
	Phyllotaxis	No definite phyllotaxy
	Insertion	Radical
	Stipule	Exstipulate
	Petiole	4-25cm long
	Venation	Reticulate
	Apex	Deeply notched
	Base	Obcordate
	Surface	Upper glabrous, lower sparsely apressed-hairy
	Texture	Soft
	Margin	Entire
	Shape	Leaflet broadly cuneate-obcordate and sub-bilobed or rarely triangular in outline and deeply lobed
	Type	Compound
	Fracture of dry leaf	Brittle
Stem	Habit	Subterranean, bulbous, aerial stem absent
	Shape	Hollow
	Odor	Odorless
	Taste	Sour
	Color	Pale brown
	Surface	Rough
	Duration	Perennial
	Branches	Present
	Position	Underground
Root	Branches	Filiform branches present
	Color	White to brown
	Odor	Odorless
	Taste	Sour
	Size	2-5 cm long
	Shape	Cylindrical
	Surface	Rough
	Duration	Perennial
	Rootlets	Present
Inflorescence	Type	Subumbellate
	Petals	15-20 mm long, yellow
	Sepals	5-7 mm long, lanceolate
	Filament	Glabrous
	Flowering period	January- April
Bulb	Color	White to brown
	Shape	Tear shape
	Taste	Sour
	Size	Small

Bulb: Bulbs are small, white to brown in color, tear shape and sour in taste (Table 1).

Similar studies were also conducted by many of the researchers e.g. Reddy and Lakshmi (2012) carried out macroscopic studies of *Oxalis corniculata*. Wahab (2013) analyzed physico-chemical and pharmacognostical properties for *Averrhoa carambola*. Shailajan et al. (2014) worked on the leaf bud of *Ficus benghalensis* L. Sonkar et al. (2014) carried out morphological investigation on leaves of *Momordica dioica* Roxb. These studies confirm that pharmacognostic investigation of crude drug is chief requisite for identification and authentification, determining quality and purity of drugs.

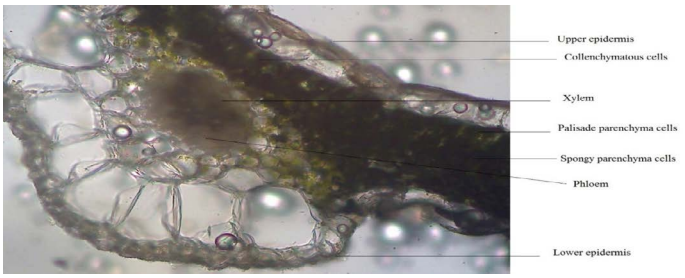

Figure 3: *Tranverse section of Oxalis pes-caprae leaf through midrib.*

Microscopic study

Anatomical study: In the present study anatomical study of *O. pes-caprae* was carried out as given below.

Leaf anatomy: Transverse section of *O. pes-caprae* leaf depicted that it is comprised of upper epidermis followed by mesophyll region having vascular bundle in midrib region and lower epidermis. Upper epidermis is single layered consist of wavy shaped cells. Collenchymatous cells are existing below upper epidermis. Leaf has unicellular covering trichomes. Shape of palisade parenchyma cells is cylindrical which arranged in single layer. Spongy parenchyma cells are round shaped cells arranged with intercellular spaces. Vascular bundle is consisting of xylem and phloem present in midrib region (Figure 3 and 5).

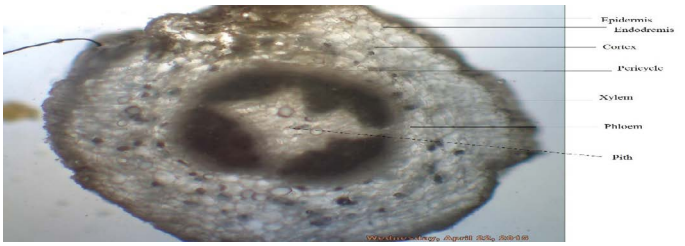

Figure 4: *Tranverse section of Oxalis pes-caprae root.*

Root anatomy: Tranverse section of the root showed that it is composed of single layered of outer epidermal cells. The epidermal cells are slightly wavy. Inner the epidermis is a two layered endodermal cells which are round in shape and closely packed. After endodermis is a cortex which is many layered, round and compact cells. Inner to cortex pericycle exists. Pericycle consists of xylem and phloem cells and pith. Xylem cells are arranged in star shape and in the arms of xylem, phloem cells are present which small rounded shape are. In the centre of pericycle, pith cells are present (Figure 4).

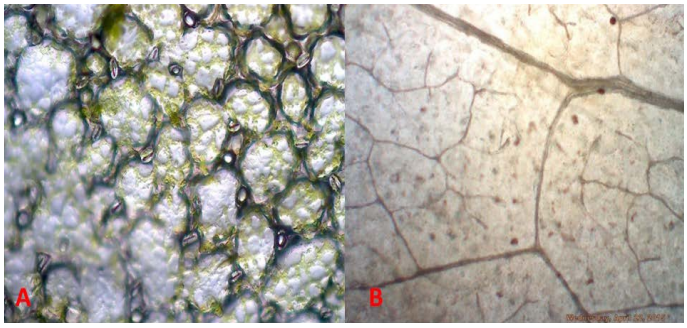

Figure 5: A, *Epidermal cells with underlying plisade cells;* **B,** *Vein islets and vein terminations.*

Zalke et al. (2014) examined microscopy of roots of *Combretum albidum* G. Don. Gatade et al. (2015) investigated the microscopical characters of leaves of *Blumea eriantha* DC. Shende et al. (2015) worked on leaves of *Strobilanthes sessilis* for microscopic characters. Pulate et al. (2015) conducted pharmacognostic studies on *Canthium parviflorum*. Observations of the present microscopical study of *O. pes-caprae* are in line with the result of these workers.

Quantitative microscopy of leaf surface

The vein islets number for *O. pes-caprae* was in the range of 5-14 with an average of 9. The vein termination was in the range of 7-15 with an average of 9.1 (Table 2, Figure 6). The upper epidermal cells were slightly wavy shape and closely packed having no space between them. Stomata were present only on lower epidermis (hypostomatic). Epidermal cells of lower epidermis were rounded and loosely arranged having space between them. Both unicellular and multicellular trichomes were present (Figure 6c). Stomatal number is in range of 32-60 with the average of 47 (Table 2). Stomatal index ranged from 40-45 with average number 42.5 (Table 2). The palisade ratio was in the range of 5-10 with the average of 7.35 (Table 2, Figure 6).

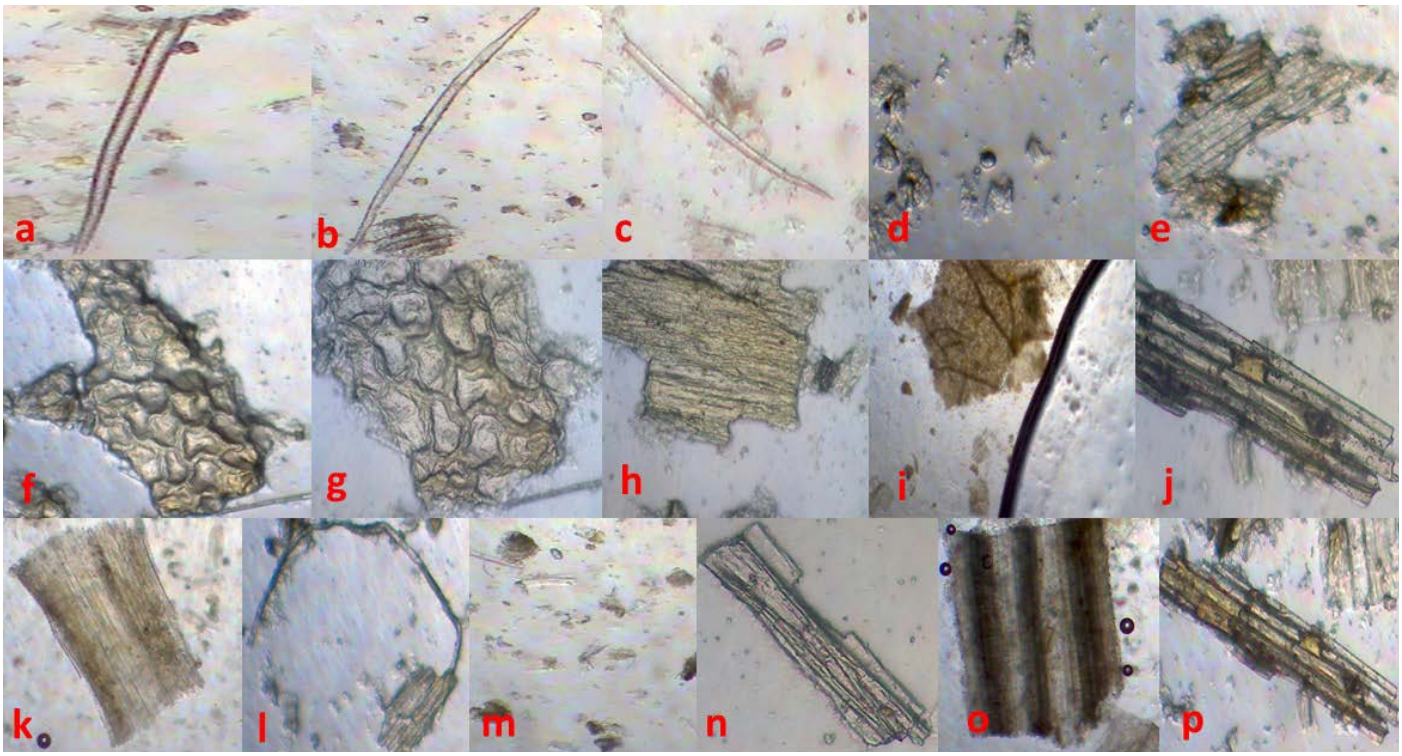

Figure 6: *Powder drug microscopy of Oxalis pes-caprae (Microphotography).*
Key: *a, b, c, unicellular and multicellular trichomes; d, calcium oxalate crystals; e, columnar palisade cells; f, epidermis with palisade cells; g, fragment of epidermal cells; h, fragment of ground tissue; I, fragment of leave showing vein islet; j, needle shape crystals; k, parenchyma cells; l, phloem fibers; m, starch grains; n, vessels with annular thickening; o, xylary trachieds; p, xylem vessels.*

Same work has done by researchers such as Nagar et al. (2013), Ukwubilec (2013) and Deepthy et al. (2015) examined *Tephrosia collina* var *lanuginocarpa, Ficus abutilifolia.* and *Tamilnadia uliginosa.* These studies strengthen our present study. These parameters are very important for establishing pharmacognostic parameters of medicinal plants, because these help in the identification and evaluation of medicinal drugs.

Table 2: *Leaf surface study of Oxalis pes-caprae.*

Parameters	Oxalis pes-caprae	
	Range	Mean
Stomatal frequency	32-60	47
Stomatal index	40-45	42.5
Vein islet No.	5-14	9
Vein termination No.	7-15	9.1
Palisade ratio	5-10	7.35

Powder drug microscopy

Powder microscopy of the whole plant powder of *O. pes-caprae* showed unicellular and multicellular trichomes, calcium oxalate crystals, columnar palisade cells, epidermis with palisade cells, fragment of epidermal cells, fragment of ground tissue, fragment of leave showing vein islet, needle shape crystals, parenchyma cells, phloem fibers, starch grains, vessels with annular thickening, xylary trachieds and xylem vessels (Figure 6). Shailajan et al. (2014), Zalke et al. (2014), Gatade et al. (2015) and Pulate et al. (2015) carried out powder drug microscopy of *Ficus benghalensis* L., *Combretum albidum* G. Don., *Blumea eriantha* DC. and *Canthium parviflorum* Roxb. All these studies supported our present findings.

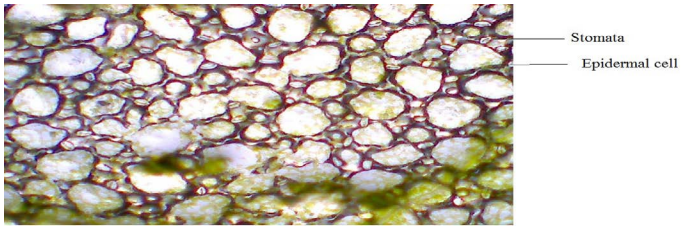

Figure 7: *Stoamata on abaxial surface of leaf.*

Physicochemical study

In the present study powder drug of *O. pes-caprae* was examined for the following physicochemical studies.

Powder drug fluorescence study: Through UV light, crude drugs are evaluated qualitatively. It is an essential parameter for pharmacognostic assessment of crude drug (Zhao et al., 2011). In the present study fluorescence study of *O. pes-caprae* was conducted by treating with various chemical reagents and observing under visible and both UV-254 and UV-310 for

characteristic fluorescence. Untreated powder was light green in visible light, light brown in both UV-256 and UV-310. The results for other reagents are shown in Table 3.

Fluorescence study performed by many researchers. Gatade et al. (2015), Sonkar et al. (2014) and Zalke et al. (2014) examined *Blumea eriantha*, *Momorica dioica* and *Combretum albidum* for fluorescence study under visible and both UV-254 and UV-310. Our current results are in line with these findings.

Table 3: *UV and visible florescence study of powder of Oxalis pes-caprae with different chemical reagents.*

S. No	Treatment	Oxalis pes-caprae		
		Visible light	UV 256	UV 310
1.	Untreated	Light green	Light brown	Light brown
2.	50% HCl	Blackish green	Grayish brown	Grayish black
3.	50%HNO_3	Whitish orange	Light orange	Orange
4.	NH_3 Sol.	Yellowish green	Yellowish brown	Dark brown
5.	$FeCl_3$ Sol.	Light green	Yellow	Light brown
6.	Iodine Sol.	Light brown	Brown	Grayish brown
7.	Ethanol	Dark brown	Dark brown	Blackish brown
8.	Methanol	Dark brown	Brown	Blackish brown
9.	Acetic acid	Reddish black	Dark brown	Purplish brown

Ash analysis: In the current work ash analysis (total ash, acid insoluble and water soluble ash) were conducted for *O. pes-caprae*. Values of this study are listed in Table 4. Total ash, acid insoluble ash and water-soluble ash was 28%, 0.17w/w and 19.27w/w respectively.

Table 4: *Ash analysis of Oxalis pe-caprae powder.*

Powder	Total Ash %	Acid insoluble ash (mg/g)	Water soluble ash (mg/g)
Oxalis pes-caprae	28	0.17	19.27

Similar studies were conducted by various researchers like Nagar et al. (2013), Shailajan et al. (2014) and Sonkar et al. (2014) examined *Tephrosia collina, Ficus benghalensis* and *Momordica dioica*. The findings of these workers confirming our current studies.

Extractive value: For determination of crude drugs, extractive values are helpful. These values also provide information about nature of chemical constituents existing in drug. Solvents also have the ability to dissociate the quantities of desired substances. Percent extractive values of *O. pes-caprae* were analyzed using different solvents including ethanol, methanol, acetone, n-hexane and chloroform. Highest extractive value was obtained in methanol (20.6 %), followed by chloroform (8.43 %), ethanol (5.31 %), acetone (2.76 %) and n- Hexane (1.75 %) (Table 5). Many studies have been done on this subject like Zalke et al. (2014), Gatade et al. (2015), Pulate et al. (2015) and Shende et al. (2015) determined *Combretum albidum* G. Don., *Blumea eriantha* DC., *Canthium parviflorum* and *Strobilanthes sessilis* for extractive value. This proposes that extractive values estimation is an essential mean for assessment of drugs and for finding a range of intentional and unintentional adulterations in drug. It also gives us clue for the selection of best solvent for extraction.

Phytochemical screening: Qualitative preliminary phytochemical screenings of *O. pes-caprae* in ethanolic, methanolic, acetone, n-hexane and chloroform extracts were tested with various chemical reagents to notice phytoconstituents existing in each extract. All extracts exhibited occurrence of carbohydrates, phenols, flavonoids and tannins. Saponin were present in ethanolic, methanolic, acetone and chloroform extract while absent in n-hexane extract. Fat and oil were present in ethanolic and n-hexane extract. Proteins, alkaloids, phytosterols and triterpenoids were absent in all the extracts (Table 6).

Table 5: *Percent extractive value of Oxalis pes-caprae with various solvents.*

Plant	Solvent	% Extracts
Oxalis pes-caprae	Ethanol	5.31
	Methanol	20.6
	Acetone	2.76
	n-Hexane	1.75
	Chloroform	8.43

Similar studies were done by various workers. Nagar et al. (2013) analyzed stem, leaf and root of *Tephrosia collina* for phytochemical screening. Sonkar et al. (2014) tested the extracts of leaves of *Momordica dioica* Roxb for preliminary phytochemical analysis. Our study is in line with these workers.

Table 6: *Qualitative chemical analysis of extracts of Oxalis pes-caprae.*

S. No	Constituents	Test name	Ethanolic extract	Methanolic extract	Acetone extract	n-Hexane extract	Chlorofrom extract
1.	Carbohydrate	Molish test	+	+	+	+	+
		Benedict test	+	+	+	+	+
		Fehling test	+	+	+	+	+
2.	Protein	Millon test	-	-	-	-	-
		Ninhydrin test	-	-	-	-	-
3.	Alkaloids	Mayer test	-	-	-	-	-
		Wagner test	-	-	-	-	-
		Hager test	-	-	-	-	-
4.	Phytosterols and triterpenoids	Libermann-Burchard test	-	-	-	-	-
5.	Phenol	Ferric chloride test	+	+	+	+	+
6.	Flavonoids	Alkali test	+	+	+	+	+
7.	Tannins	Ferric chloride test	+	+	+	+	+
		Alkali test	+	+	+	+	+
8.	Saponins	Frothing test	+	+	+	-	+
9.	Fat and oil	Spot test	+	-	-	+	-

Novelty Statement

The present research work will contribute a lot in understanding the Macro- and Microscopic feature of *Oxalis pes-caprae* and different organic molecules, which indicates the importance of this plant in the fields of pharmacognosy and medicines.

Author's Contribution

Syeda Naila: Carried out the reserach work.
Muhammad Ibrar: Supervised the overall research and helped in experiments.
Fazal Hadi: Designed the researcha nd wrote the manuscript.
Muhammad Nauman Khan: Collected and compiled the data and helped in writing the manuscript.

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