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Original Article

Pharmacognostic and Phytochemical Characteristics of *Ailanthus altissima* (Mill.) Swingle Stem and Root Bark: A Comparative Study

Weekar Younus Raja, Zulfiqar Ali Bhat, Ishtiyaq Ahmad Chashoo

ABSTRACT

Introduction: *Ailanthus altissima* (Simaroubaceae) is a large tree indigenous to China. It is known as the "Tree of Heaven", used in traditional medicine in many parts of Asia, including China to treat cold, gastric diseases, diarrhea and endoparasites. It is also used as a bitter aromatic drug and as an antitumoral. **Objective:** The present study deals with comparative pharmacognostical parameters for the bark of stem and root of *Ailanthus altissima*, Mill. Swingle. **Materials and Methods:** The stem and root bark were collected, shade dried and powdered plant material was studied for its proximate values by standard methods. The extracts were subjected to a preliminary phytochemical screening for the detection of various phytoconstituents. **Results:** Proximate analysis revealed that the dry plant powder of stem bark has 6.48 **%** total ash, 0.42**%** acid insoluble ash, 4.60 **%** water soluble ash and for root bark 7.22 **%** total ash, 0.74**%** acid insoluble ash, 5.98 **%** water soluble ash. The Loss on drying for stem and root bark were found out to be 6.62 **%** and 10.46 **%** respectively. The stem and root bark of plant powder were found to possess phytoconstituents. Fluorescence analysis revealed the behaviour of the plant powder when treated with different chemical reagents. **Conclusion:** The present study reveals the preliminary phytochemical and proximate analysis of stem and root bark of *Ailanthus altissima*. Information obtained from these studies can be used as markers in the identification and standardization of this plant as a herbal remedy and also towards monograph development on the plant.

Key words: Tree of Heaven, Simaroubaceae, Proximate analysis, Fluorescence analysis, Alkaloids.

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INTRODUCTION

The plant *Ailanthus altissima* commonly known as "tree of heaven" or "smoke tree" belongs to the family simaroubaceae. This is locally known in Kashmir as "Alamthar" or "Handoon". *Ailanthus altissima* is native to China, North Vietnam[1] and Indian part of Kashmir.[2] The bark of this tree is smooth and light grey, often becomes rougher with light and dark fissures as the tree ages.[3] The plant parts have a distinguishing strong odour like that of peanuts and cashews.[4] *Ailanthus altissima* is used in traditional medicine in many parts of Asia, in China the bark and leaves of this plant had been used for their bitter-tonic, astringent, vermifuge and antitumor properties. The dried bark is still an official drug, listed in the modern Chinese materia medica as chun bai pi meaning "white bark of spring". The plant is used in the treatment of leucorrhoea, menorrhagia, spermatorrhea, as a vulnerary and in various gastric diseases as anti diarrhoeal, in dysentery, endoparasites, intestinal hemorrhage and to treat cold.[5] The plant is known to have an anti malarial activity due to presence of active chemical constituents that include ailanthone an allelopathic chemical.[6] The roots and leaves contain allelopathic and herbicidal compounds.[7,8] The root bark has been used in treating cardiac palpitation, asthma and epilepsy.[9] *Ailanthus altissima* has potent anti-anaphylactic and anti-inflammatory properties.[10] The stem and root bark are antispasmodic, bitter, diuretic, emetic, febrifuge, rubefacient and vermifuge.[11,12,13] Despite the medicinal importance of *Ailanthus altissima* there is paucity of information available on the pharmacognostical parameters for identification and standardization of this species in whole and powdered form. The present study is aimed at the standardization and monograph development and to investigate the macro morphology, microscopical, pharmacognostical evaluation and phytochemical screening of the stem and root bark of *Ailanthus altissima*.

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MATERIALS AND METHODS

Plant material Collection and identification

The stem and root bark of *Ailanthus altissima* was collected from the Gulmarg, Srinagar, Jammu and Kashmir, India. The plant was identified and authenticated by Prof. Akhtar H. Malik, curator Centre for Biodiversity and Taxonomy (CBT), Department of Botany, University of Kashmir under Specimen Voucher No. 2322-KASH. A sample specimen of collected material was deposited in herbarium for future references.

Reagents

All the reagents used were of analytical grade obtained from central drug house (P) LTD. Bombay, India.

Macroscopic and microscopic analysis

Macroscopic and microscopic analysis of stem and root bark of *Ailanthus altissima* were studied according to the method mentioned in Trease and Evans Pharmacognosy.[14,15] The microscopic examination of the stem and root bark of *Ailanthus altissima* are not only essential to identify the adulterants but also indispensable in the correct identification of the plant.

Proximate analysis

Proximate analysis was performed on powdered stem and root bark *Ailanthus altissima* for the determination of various physicochemical parameters like total ash, acid insoluble ash, water soluble ash,[16] extractive values, loss on drying, swelling index,[17] determination of fat content,[18] extractive values (hot, cold and successive)[20] and pH determination.[21] Fluorescence analysis study of powdered drug material was done treating with a few drops of different chemical reagents to detect the color changes under UV at 254 nm and 366 nm and visible light.[18,19] Qualitative phytochemical screening were carried out on the methanolic and aqueous extracts of stem and root bark of *Ailanthus altissima* to determine the presence of various phytoconstituents.[22,23]

RESULTS

Macroscopical evaluation

The macroscopic character has always served as a useful key in faster and early identification of plant material and also serves as an important standardization parameter. The macroscopic features of *Ailanthus altissima* are: It is a large deciduous tree, 18-25 m tall; trunk straight 60 to 80 cm in diameter. The twigs are stout, smooth to lightly pubescent. The buds are finely pubescent, dome shaped and partially hidden behind the petiole. The bark is smooth light grey-brown and rough on large trees, aromatic slightly bitter. Leaves alternate, pinnately compound, large, 30-60 cm or more in length. Flower cluster lobed at leaf base, shorter than leaves, much branched. Fruit with one seeded samara, lanced shaped, flat, pointed, 5 cm long and 1cm wide.

Macroscopy of stem bark of Ailanthus altissima Figure 1(a)

***Colour*:** Grey brown (Externally), pale buff (internally).

***Odour*:** Characteristic

***Taste*:** Slightly bitter

***Size*:** 12-14 cm in length, 1-2 cm in width and is 0.1 cm thick approximately and it varies according to size.

***Shape*:** Curved.

***Texture*:** Fibrous and rough.

***Extra markings*:** Prominent longitudinal striations and ridges.

Macroscopy of root bark of Ailanthus altissima Figure 1(b)

***Colour*:** Buff

***Odour*:** Characteristic

***Taste*:** Bitter

***Size*:** 8-10 cm in length, 3-4 cm in width and is 0.2 cm thick approximately and it varies according to size.

***Shape*:** Double quill.

***Texture*:** Rough and grove surface

***Extra markings*:** Transverse and longitudinal striations and ridges.

Powder microscopy of the stem and root bark of Ailanthus altissima

Diagnostic characters of stem bark

The sclereids occurred as singly and in abundance, showed considerable variation in size and shape (Figure 2). The walls of most of the cells are moderately thickened and often the outer wall is less thickened than others; occasional cells have very thick walls with a small lumen. The fairly abundant fibers, which usually occur in groups or bundles; they are thick-walled and highly lignified, occasional fibers are found associated with sclereids of the pericycle; others occur with parenchyma of phloem. The numerous fragments of cork with conspicuous granular, dark reddish contents. In surface view, the cells are polygonal with slightly thickened walls; in sectional view the cells are arranged in alternating layers of thinner-walled cells with pale, brownish contents and thicker walled lignified cells with dense, reddish brown contents.

Diagnostic characters of root bark

Powder of root bark when examined under microscope shows numerous fragments of cork with conspicuous granular, dark reddish contents (Figure 3). In surface view, the cells are polygonal with highly thickened walls; in sectional view the cells are arranged in alternating layers of thinner-walled cells with pale, brownish contents and thicker walled lignified cells with dense, reddish brown contents. The fibers were highly lignified, usually occur in bundles and were in abundance and shows presence of starch grains.

Pharmacognostic analysis and Phytochemical Screening

The proximate analysis was used for the pharmacognostical analysis of powdered stem and root bark of *Ailanthus altissima* (Table 1). The fluorescence characteristics of powdered drug were studied under U.V and visible light after treating with different chemical reagents is reported (Table 2). Also, the preliminary phytochemical investigation of methanolic and aqueous extracts revealed various phytoconstituents (Table 3).

Figure 1: (a) Dried stem bark of *Ailanthus altissima*. (b) Dried root bark of *Ailanthus altissima*.

Table 1: Physicochemical analysis and extractive values of stem and root bark of *Ailanthus altissima*

Physico-chemical Parameters	Result					
	Stem bark			Root Bark		
Total ash value (% w/w)	6.48			7.22		
Acid insoluble ash value (% w/w)	0.42			0.74		
Water soluble ash value (% w/w)	4.6			5.98		
Swelling index (% w/v)	3			2		
Fat content (% w/w)	4.9			2.89		
Foreign matter (% w/w)	0.029			0.019		
Loss on drying (% w/w)	6.62			10.46		
Foaming index	Less than 100			Less than 100		
pH 1% solution	7.78			7.3		
pH 10% solution	6.8			6.6		
Extractive Values						
Extracts	**Cold extractive value (%w/w)**		**Successive extractive value (%w/w)**		**Hot extractive value (%w/w)**	
	***A. altissima* Stem Bark**	***A. altissima* Root Bark**	***A. altissima* Stem Bark**	***A. altissima* Root Bark**	***A. altissima* Stem Bark**	***A. altissima* Root Bark**
Petroleum ether (40-60°C)	1.38	1.38	4.276	2.178	-	-
Chloroform	2.84	1.92	2.6	3.268	-	-
Ethyl acetate	3.56	1.98	1.326	1.028	-	-
Methanol	7.54	4.6	7.812	4.68	32.693	20.844
Aqueous	6.46	6.8	1.968	8.058	21.684	22.688

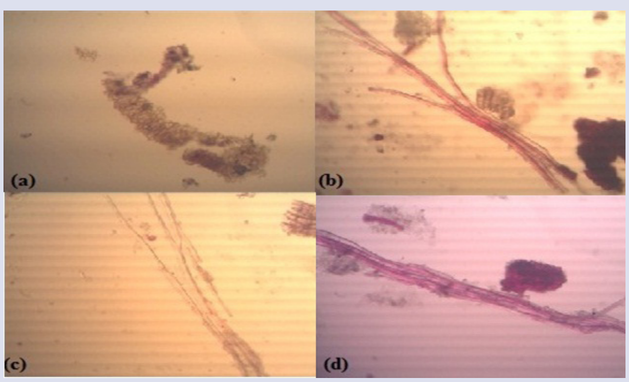

Figure 2: Microscopic structures of stem bark of *Ailanthus altissima* (a).Cork cells, (b).Vascular Bundles, (c).Group of Fibers (non lignified) and (d). Xylem Vessels (Lignified).

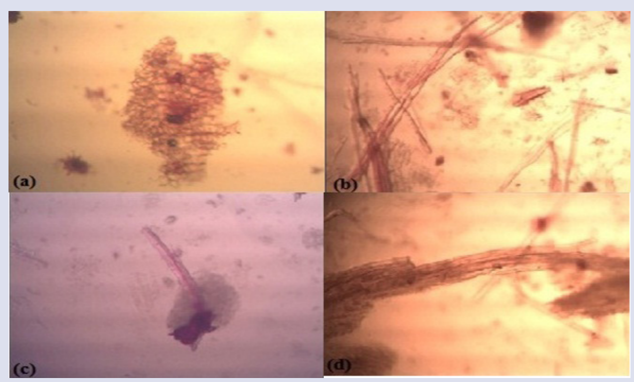

Figure 3: Microscopic structures of root bark of *Ailanthus altissima* (a). Cork cells, (b).Vascular Bundles, (c). Fibers (lignified) and (d). Xylem Vessels (non lignified).

DISCUSSION

Standardization is an essential analytical aspect for the study of identity, purity and quality of crude drug sample of plant origin**.** There are various physicochemical parameters used for the quality evaluation of the herbal drugs. According to the World Health Organization, the macroscopic and microscopic description of a plant is the first step to establish the identity and the degree of purity of such materials and should be carried out before any tests are undertaken[24]. The present macroscopic and microscopic observations of stem and root bark of *Ailanthus altissima* thus provide useful information for quality control parameters for the crude drug. Quantitative and fluorescence standards of the powdered drug provide valuable information to substantiate and authenticate the phytomedicine. The extractive values were used to find out the amount of active principles. The successive and cold extraction yield calculated for petroleum ether, chloroform, ethyl acetate, methanol and water extracts of stem bark of *A. altissima* showed that methanolic extract registered higher percentage of yield 7.812 and 7.54% respectively as compared with other solvents. While in case of root bark of *A. altissima*, aqueous extract registered higher percentage of yield (8.058 and 6.8% respectively for successive and cold extraction) as compared with other solvents.

Table 2: Fluorescence analysis of stem and root bark of *Ailanthus altissima*

Materials/Treatment	Observations Under UV Cabinet					
	Visible/Day light		Short Wavelength (254 nm)		Long wavelength (365 nm)	
	Stem bark	Root bark	Stem bark	Root bark	Stem bark	Root bark
Powder drug as such	Off white	Off white	Light green	Off white	Off white	Off white
Powder drug treated with dist. H_2O	Off white	Buff	Green	Light yellow	White buff	Off white
Powder drug treated with 10 % Aq. NaOH	Yellow	Light yellow	Fluorescent green	Light Fluorescent green	Light green	Light green
Powder drug treated with NH_3	Yellow	Buff	Fluorescent green	Light green	Light brown	White
Powder drug treated with conc. H_2SO_4	Dark brown	Brown	Black	Black	Black	Dark brown
Powder drug treated with H_2SO_4 + Water	Dark brown	Brown	Dark brown	Black	Black	Brown
Powder drug treated with Conc. HCl	Dark green	Yellowish green	Fluorescent green	Green	Brown	Brown
Powder drug treated with Conc.HCl + dist. Water	Light brown	Light brown	Fluorescent green	Yellowish green	Dark brown	Light brown
Powder drug treated with Conc.HNO_3	Reddish brown	Reddish brown	Fluorescent green	Dark green	Brown	Black brown
Powder drug treated with Conc.HNO_3 + dist. Water	Golden brown	Reddish brown	Fluorescent green	Dark green	Dark brown	Black
Powder drug treated with Iodine sol.	Reddish brown	Black brown	Dark green	Black	Black	Black
Powder drug treated with 5% Ferric chloride sol.	Light yellow	White yellow	Fluorescent green	Light green	Dark brown	Black
Powder drug treated with 10% Picric acid	Yellow	Yellow	Intense Fluorescent green	Fluorescent green	Brown	Dark green
Powder drug treated with GAA	Buff	Buff	Fluorescent green	Light green	Buff	Off white
Powder drug treated with Pet. Ether	Buff	Buff	Light yellow	Light green	Buff white	Off white
Powder drug treated with Chloroform	Light brown	Light brown	Fluorescent green	Green	Green	Off white
Powder drug treated with Ethyl acetate	Buff	Buff	Light green	Light green	Buff	Off white
Powder drug treated with Methanol	Buff	Buff	Light green	Off white	Milky white	Off white
Powder drug treated with 5% Pot. dichromate	Orange	Orange	Intense Fluorescent green	Fluorescent green	Dark brown	Black
Powder drug treated with Alcoholic KOH	Off white	Off white	Fluorescent green	Buff	Buff	Buff
Powder drug treated with 10% Picric acid + dist. Water	Light Yellow	Yellow	Fluorescent green	Fluorescent green	Dark green	Dark green

It may be due to high polarity of methanolic solvent which can draw high variety of plant constituents than the other solvents.[25] The ash values were used to detect the presence of any foreign matters e.g. sand and soil, water soluble salts adhering to the surface of the drugs. There is always a considerable difference in the ash values of different drugs but mostly the difference varies within narrow limits in case of the same drug. The acid insoluble ash consists mainly of silica and high acid insoluble ash thereby indicating the contamination with earthy materials. The water-soluble ash was used for the measurement of inorganic elements. The total ash values of a plant drugs are not always trustworthy due to the possibility of presence of non-physiological substances. So, the authentication of acid insoluble ash was also done which showed lowest content of acid insoluble ash 0.42 % in stem bark and 0.72 % in root bark of *Ailanthus altissima*. Loss on Drying (LOD) determines the amount of moisture as well as volatile components present in a drug. Higher moisture content in the drug sample may causes hydrolysis of active ingredients of the drug and decreases its quality and efficacy. The final dryness of the drug and rate of moisture removal are equally important and it was observed that the moisture content in stem and root bark of *Ailanthus altissima* was found to be 6.62% and 10.46 % respectively. The pH of the stem (1% and 10% solutions) was found to be 7.78 and 6.80. For root bark, it was found out to be 7.30 and 6.60 respectively (Table 1). The pH of the

Table 3: Preliminary phytochemical screening of various extracts of stem and root bark of *Ailanthus altissima*

Test	Methanolic extract		Aqueous extract	
	Stem bark	Root bark	Stem bark	Root bark
Carbohydrate				
Molish test	+	+	+	+
Fehlings test	-	-	-	-
Selwinoffs test	-	-	-	-
Benedict' s test	-	-	-	-
Alkaloids				
Wagners test	-	+	-	-
Dragendroff's test	-	+	+	+
Saponins				
Foam test	+	+	-	+
Steroids				
Salkowski test	-	-	-	-
Fats and Oils				
Filter paper test	+	+	-	-
Proteins				
Biuret test	-	-	-	-
Amino acids				
Ninhydrin test	-	+	-	-
Glycosides				
Legal's test	-	-	-	-
Keller Killani test	+	+	+	+
Starch				
Iodine test	-	-	-	-
Tannins and Phenolics				
Ferric Chloride test	-	-	-	-
Pot. Dichromate test	-	+	-	+
Bromine water test	+	+	+	+
Resins				
Ferric Chloride test	-	-	-	-
Flavonoids				
Shinoda test	+	+	-	+
Lead acetate test	+	+	+	+
Terpenes and Terpenoids				
	+	+	+	+

"+" Positive, "-" Negative

extracts reveals the concentration of acidic and basic compounds. Fluorescence is an important phenomenon exhibited by various chemical constituents present in plant material (Table 2). If the substances themselves are not fluorescent, they may often be converted into fluorescent derivatives by applying different reagents hence some crude drugs are often assessed qualitatively in this way and it is an important parameter of pharmacognostical evaluation.[26] The plants are considered as biosynthetic laboratory for a multitude of compounds. The compounds that are responsible for therapeutic effect are usually the secondary metabolites. The results of preliminary phytochemical screening of stem and root bark of *Ailanthus altissima* showed the presence of carbohydrates, phenolic compounds, flavonoids, alkaloids, proteins, saponins, sterols and tannins, in the methanolic and aqueous extracts (Table 3). This preliminary phytochemical screening may be useful in the detection and further quantitative analysis of such compounds. The phenolic and flavonoid compounds act as antioxidants. These compounds are also reported to have anticancer, antimicrobial, anti-inflammatory and anti-allergic activities etc.[27] Phenolic compounds are most widely occurring groups of phytochemicals and derivatives of the pentose phosphate, shikimate, and phenylpropanoid pathways in plants. These compounds are secondary metabolites which have vital role in reproduction and growth, give protection against harmful predators and pathogens.[28] Therefore, quantitative analysis of these compounds is very important to check the quality of drug.

CONCLUSION

Nowadays medicinal plants and herbal formulations are predominantly used due to their less side effects and the presence of enormous level of active ingredients. No detailed standardized work has been reported in literature for this plant. Stem and root bark powder subjected for microscopic, pharmacognostical and preliminary phytochemical analysis provides relevant information which may be helpful in authentication of the crude drug and check adulteration for quality control of raw material. The pharmacognostic parameters observed in present study, being reported for the first time adds to the existing knowledge of *Ailanthus altissima* can be quite useful for identification, standardization, development and preparation of crude drug's formulation and inclusion in various pharmacopoeias for treating various ailments. The current observation will also be helpful in differentiating the stem and root bark of this species from closely related species of same genus and family.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATION USED

LOD: Loss on drying; ***A. altissima:*** *Ailanthus altissima*.

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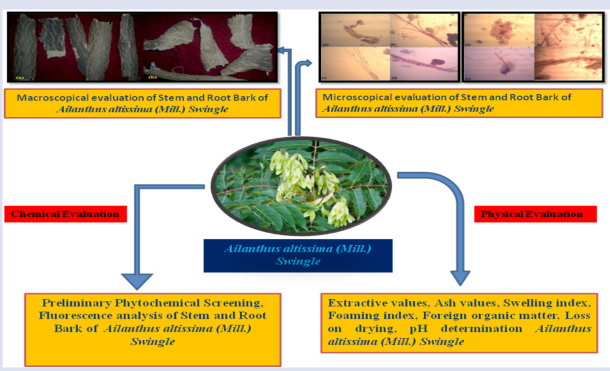
GRAPHICAL ABSTRACT

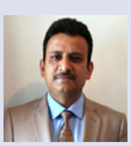


HIGHLIGHTS OF PAPER

- The *Ailanthus altissima* (Mill.) Swingle is known to have an anti malarial activity due to presence of active chemical constituents that include ailanthone - an allelopathic chemical.
- The root bark of *Ailanthus altissima* (Mill.) Swingle has been used in treating cardiac palpitation, asthma and epilepsy. It has potent anti-anaphylactic and anti-inflammatory properties.
- The results of preliminary phytochemical screening of stem and root bark of *Ailanthus altissima* (Mill.) Swingle showed the presence of carbohydrates, phenolic compounds, flavonoids, alkaloids, proteins, saponins, sterols and tannins.
- Presence of important plant secondary metabolites such as flavonoids, phenolic substances and steroids in *Ailanthus altissima* (Mill.) Swingle could make the plant useful for treating different ailments.
- This is the first report of its kind on the stem and root bark of *Ailanthus altissima* (Mill.) Swingle, which will serve as valuable source of information towards establishing pharmacognostic standards for its identification, purity, quality and classification.

AUTHOR PROFILE

Weekar Younus Raja: Is a doctoral fellow in Pharmacognosy & Phytochemistry at Department of Pharmaceutical Sciences, University of Kashmir, Srinagar. His research is focused on the development of quality standards of medicinal plants belonging to Himalayan region and screening them for biological activities.



Prof. Zulfiqar Ali Bhat: Is presently heading Department of Pharmaceutical Sciences, University of Kashmir. His area of specialization is Pharmacognosy & Phytochemistry. He has more than 20 years of teaching & research experience. His area of research is mainly focused on medicinal plants of Kashmir Valley and Ladakh region. He has worked on plants having CNS, anti-diabetic, anti-inflammatory, anti-ulcer, anti-hyperlipid¬emic & hepatoprotective activity. He is also member of many scientific journals. Prof. Bhat has number of national and international publications to his credit and has guided a number of PhD scholars.

Mr. Ishtiyaq Ahmad Chashoo: Is Lecturer at Department of Pharmaceutical Sciences, University of Kashmir, Srinagar. His area of interest is natural product chemistry and clinical biochemistry. He has worked on plants having anti-diabetic, anti-inflammatory, antioxidant and anti-hyperlipid¬emic activity.

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