Original Research Article

Wood anatomical study of *Osyrisquadripartita*Salz.exDecne (African sandalwood) from the Northern Western Ghats, India

Abstract

The family Santalaceae is ~~a~~ medicinally important. *Osyrisquadripartita*Salz.exDecnehas been used for the medicinal use such as~~Antihelmintic~~anthelmintic, ~~leshimaniasis~~ leishmaniasislike leprosy diseases, abnormalities, kidney disease, forage, hygienic/perfuming, eye pain, cold, anaphylactic shock, epilepsy, circumcision wound, toothache, tonsillitis, abdominal pain, urine problem, ~~Breast~~ breast cancer, ~~Mental~~ mental problems and ~~Anti~~anti-coronavirus disease, etc. It has also been reported for its activities such as a~~A~~nti-ulcer activity, ~~Antiviral~~ antiviral activity. *S. album* and *O.quadripartita* belong to the same family ~~Santalaceae~~ santalaceaeand have many similarities in their morphological characteristics. Being both members belong to the same family, that's why anatomical character help to resolve this problem and easy to distinguish most wood anatomical characteristics. Therefore, distinguishing onefrom the other anatomically is very easy.

A study has been carried out to authenticate the identity of this specie based on anatomical characters. The anatomical sections of stem (TS, TLS and RLS) of the species were observed under the bright-field compound binocular microscope, and characters were documented. The aim of the study is to elucidate the means and criteria to identify the anatomical structure of *O. quadripartita*. Though the diagrammatic outline of the stem sections is similar, detailed anatomical characters are significantly different. The characters such as the arrangement of cortical tissues, pericyclicfibres, phloem ~~fibres~~ fibers,andphloem rays are useful in differentiating the stem and petiole of the species. Wood anatomical characteristics of *O.quadripartita* were seriation of rays, type of crystalliferous cells, and abundance of extractives.Ray cells frequently contain rhomboidal crystals. In c~~C~~ortex, and pith region of the stem observed solitary crystals. ~~On the basis of~~Based onthe preliminary study, the species can be differentiated from other species of the same family based only on anatomical characters.

Keywords:*Osyrisquadripartita, Authentication, Anatomy, Vegetative parts*

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Introduction:

The Santalaceae family covered ~~basically~~ three types of habitat like herbs, shrubs, and rare trees. The family Santalaceae is ~~a~~ medicinally important. The family basically widely distributed 44 genera and 930 species(Simpson, 2010). In the *Osyris* genus, ~~Six~~ six or seven species were distributed in Asia, Africa, Europe, and China(Nianhe & Gilbert, 2003). *Osyris* genus is the evergreen root hemiparasites, ethnomedicinal shrub plants. Many tribal peoples this plant leaves uses as making of herbal tea(Herrera, 1984;Subba & Basnet, 2014;Kefalew et al., 2015;Silva et al., 2016). The taxonomical characteristic of *Osyrisquadripartita*Salzmann ex Decaisne, *Ann. Sci. Nat., Bot., sér. 2, 6: 65. 1836.*Plants 2-5 m tall. Branches slender, 3-angled when young.Leaf blade grayish green, 1.2-6 × 0.6-2 cm, leathery, sometimes rugose on both surfaces, with dense glands, base gradually narrowed or obtuse, apex acute to cuspidate or rounded.Male inflorescences 2-4(-13)-flowered; peduncle to 11 mm. Female inflorescences 1-3-flowered; bracts minute, caducous. Male flowers: pedicel 4-8 mm; perianth ca. 4 mm in diam., lobes 3, yellow or green, sometimes flushed brown, ca. 1.5 mm. Stamens 3, filaments very short, disk fleshy; sterile ovary very small, at center of disk. Female flowers usually solitary, sometimes to 4 in subumbel; pedicel to 25 mm, enlarged at apex; bracteoles 2, linear-spatulate, ca. as long as ovary, soon caducous, disk and stamens as in male but stamens sterile. Bisexual flowers similar to female but with fertile stamens; stigmas 3. Drupe orange to red when ripe, drying pale blackish, subglobose or pear-shaped, 4.5-10 mm in diam. Fl. Apr-Jun, fr. Oct. (Zhen, 2022).

The only two main species used to produce commercial sandalwood oil are *Santalum album* (Indian sandalwood) and *S. spicatum* (Australian sandalwood). In domestic as well as international market true sandalwood oil is very costly. Wrongly or intentionally some peoples sell adulterated low quality cheaper substitutes, the 'African sandalwood' (*O.quadripartita*).The heartwood of this plant not as strongly fragrant as sandalwood so, this plant is used as adulterating sandalwood in the market (Khare, 2007; Shyaula, 2012). *O. lanceolata* is a timber like true sandalwood and it~~s~~ contains oil components. This oil is used to make a scent (Mabberley, 2018). *O. quadripartita*comingunder least concern IUCN category (Wilson, 2018). In Ethiopia, this plant leaves and root us as medicinal purpose to cure antihelmintic, leishmaniasis like leprosy diseases, abnormalities, kidney disease, forage, hygienic/perfuming, eye pain, cold, anaphylactic shock, epilepsy, circumcision wound, toothache, tonsillitis,

Comment [GYMNO4]: Shorten the introduction. It should contain brief details of the plant, its distribution followed by the main purpose of the study.

Separate the description of the plant under a separate heading.

Separate the ethnobotanical uses/traditional uses as a separate heading.

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abdominal pain and urine problem. The methanol solvent leaves extract of *O. quadripartite* was shows antibacterial and antifungal test (Mouhajir et al., 2001; Gemedo-dalle et al., 2005; Geyid et al., 2005; Giday et al., 2007;Mesfin, 2007;Agize et al., 2013;Getaneh & Girma, 2014;Bayissa, 2015;Birhan et al., 2017;Dires, 2017;Abdela & Sultan, 2018;Worku, 2018;Yohannis et al., 2018).Decocted dried leaves are used for the treatment of breast cancer (Graham et al., 2000). Pyrrolizidine and quinolizidine alkaloid extracted and analyzed from *O. alba*(Woldemichael & Wink, 2002). Anthrax and pasturolosis disease treated with the help of *O. quadripartita*plant root(Advisor, 2017). *O. quadripartita* bark gave to orally for the treatment of jaundice (Maryo et al., 2015). *O. quadripartite* fruits are consumed as wild edible fruit in the Western Ghats, Tamil Nadu regions, and Delanta region of northern Ethiopia (Arinathan et al., 2007; Alemayehu et al., 2015; Meragiaw et al., 2015). During the study of *Osyris* species we observed many of anatomical variation TS of stem (Cork layer, Cortex cell layer, Pericyclic fiber cell number, Phloem cell layer, Phloem medullary layer, Xylem medullary layer, Xylem vessels) of the species were observed under the bright-field light compound microscope and their characters were documented (Metcalfe & Chalk, 1965; Khandelwal & Sethi, 2019). This species produces a annual ring and observed a secondary growth. These plant shows annual rings because of well developed secondary growth. In stem woody anatomy observed a broad range arrangement of vessels and fibers produces a porous wood (Metcalfe & Chalk, 1965). Xylem is a complex tissue system composed of different cell types. The vessel elements adjoining to each other, at their end possess a perforations, whereas tracheids elements lack these perforations. Tracheids elements are elongated, lignified, thick walled and pointed at both end. The perforations several openings which are scalariform perforation plate (Fig.2). Xylem vessels showing a simple pitted in their lateral walls. To observe xylem structure, mature stem are sectioned transversely (transverse section: TS) and longitudinal planes: along the rays (radial longitudinal section: RLS and tangential longitudinal section: TLS). Rays are termed one cell wide tangentially called uniseriateand more than one cell wide called multiseriate observed in both species, viewed in TS and TLS. The vascular cambium produces from secondary xylem and phloem of stem. Prismatic calcium oxalate crystals observed in *O. quadripartita*in the pith region of stem (Evert, 2006; Rudall, 2007; Khandelwal & Sethi, 2019). Starch grains is one of the non-nitrogenous stored form observed in studied plant species. Tapioca starch grain type observed in both plant species (Stevens, 1907; Wallis, 1939).Wood anatomical characteristics of *O.quadripartita* were

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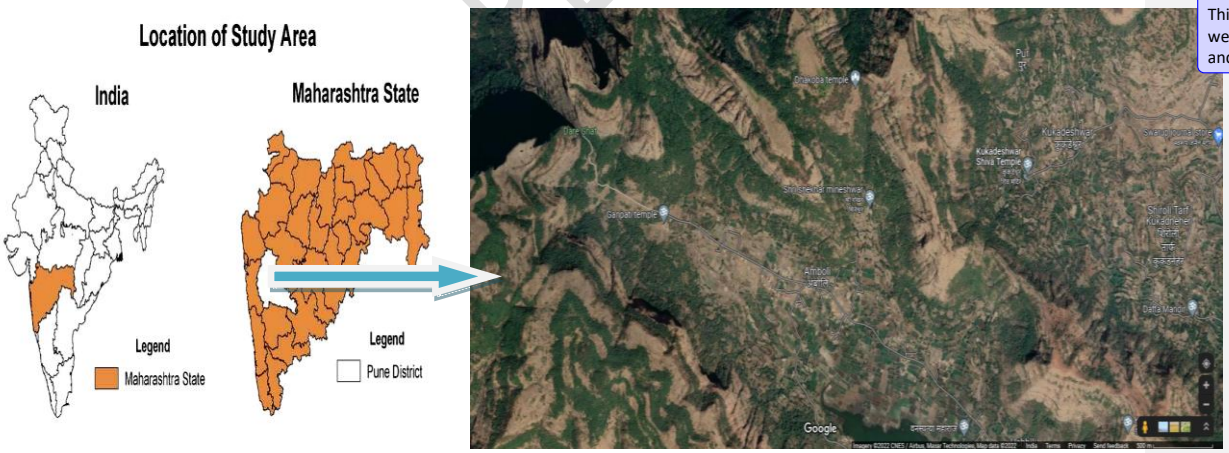
seriation of rays, type of crystalliferous cells and abundance of extractives. Ray cells frequently contain rhomboidal crystals. In Cortex and pith region of stem observed solitary crystals(fig. 2 b, e).(Rao & Das, 1979; Zobel, 1985; Evert, 2006). The sclerenchyma found in the pericyclic region of stem. The stone cells are observed in both species. Stone cells important function is thickening and lignification of the walls of thin-walled parenchyma cells. Stone cell providing a strengthening and toughness of parenchyma cells..Sclerenchyma cells are classified into two categories fibers andsclereids(Rao, 1957; Evert, 2006).

Materialsand methods:

Study area and collection: Leaf and stem of *O. quadripartita*were collected from Pune, district during 2020-2021 of Maharashtra, India. The plant was identified using Flora of Maharashtra & Flora of Chinaand authenticated bymyself.

Anatomical study of stem: Make a thin sliced from fresh mature stem samples for anatomical study (8mm to 10mm) from plant species. Prepare hand sections stained were stain using 0.1% Safraninand mount in glycerin and examined under bright-field compound microscope (Chamberlain, 1920; Khandelwal & Sethi, 2019). Measure a morphometric observations of length, diameter, bredthand number of layers (µm). surface(Salisbury's, 1927; Evert, 2006).



Map 1: STUDY AREAFROM JUNNAR TEHASIL(Table 3)

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Thin sliced section of fresh matured stems were taken for anatomical experiments and so on……

Results and Discussion:

Anatomical study of stem: Transverse Section (T.S.) of stem of *O. quadripartita*(Figs. 2) (Table 4,5and 6)

Corck: Supperficialand strongly thickened corck layer observed in the species. It was 14-16cork layer.

Cortex: The cortex cells arranged in compact form.The total cortex layer is 10-18 (fig.2a).

Pericyclic fiber: Pericycle is a part of ground tissue.Ground tissue are primary function is mechanical support. Pericyclicfiber are sclerenchyma in nature. Pericyclicfiber were observed in this species. It was observed in each clump number of cells are 02-06

Vascular tissues:

Phloem: The phloem stratified in to soft and hard portions. In which hard portions is nothing but primary phloem fibers, or protophloem fibers and secondary phloem fibers. Phloem observed in this species 10-15layered. Phloem medullary rays observed in this species there are 2-4layered.Various cluster of crystalline structures deposition were present in pith cells .

Xylem: The arc type vascular bundles observed.Diffuse porous wood observed because of tracharory elements presents (trachidesand vessels). Medullary rays broader and expanded at the distal end. Vessels are arranged in vertical rows. Vessels varying in size 144.31µm. Medullary rays mostly are 1-2.Well developed xylem fibers were arranged in vertical rows and in group. Fiber both end are pointed. Diffuse, aliformand confluent of parenchymatous cell observed in both species.

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Pith: Pith areunlignified, large pitted parenchymatous cell with thin walled. pith region of stem observed solitary crystals.

Table Caption –

Table 1: Classification of *Osyrisquadripartita*

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Kingdom	Plantae
Class	Magnoliopsida
Order	Santalales
Family	Santalaceae
Genus	*Osyris*
Species	*O. quadripartita*Salzmann ex Decaisne
Common names	Pulluruvi, Popali, Dalmia, Paral and wild tea plant

(Singh et al., 2001)

Table 2: Morphology of *Osyrisquadripartita*

Characteristics	
Hight	2-5 m tall
Bark	Brown in colour
Leaves	Simple
Flower	Yellow in colour
Inflorescence	Cymes axillary
Fruit	Drupe orange to redwhen ripe
Occurrence	Bhutan, Cambodia, India, Laos, Myanmar, Nepal, Sri Lanka, Thailand, Vietnam; Africa, S Europe
Altitude from sea level	600-2700 m

(Singh et al., 2000;Zhen, 2022).

Table 3.*Osyrisquadripartita*studied from northern Western Ghats of Maharashtra.

Taxon	**Place of Collection**	**Geographic coordinates**	**Elevation (m)**
Osyrisquadripartita	19°14'22.2"N 73°41'35.4"E	Amboli, Junnar, Maharashtra 410502	1088
	19°13'14.3"N 73°43'37.0"E	Keldare, Junnar, Maharashtra 410502	325
	19°13'56.2"N 73°42'42.7"E	Uchhil, Junnar, Maharashtra 410502	277
	19°30'42.9"N 73°41'42.8"E	Ratangad, Maharashtra 421601	1126

Table 4. Stem anatomical characteristics of *Osyrisquadripartita.*

Characters	***O. quadripartita***
Cork layer	14- 16
Cortex layer	10 - 18
Pericyclic fiber cell number	02-06
Phloem cell layer	10-15
Phloem medullary layer	2-4
Xylem medullary layer	1 - 2
Xylem vessels	simple and perforation
Pith cell	Parenchyma cell- rosette solitary crystals present

Table 5.T.S stem anatomical characteristics of *Osyrisquadripartita*

Characters	*O. quadripartita*
Cork layer lenghth 10 X	53.033±9.95
Pericyclic fiber cell diameter (cell number in each pach 18-25) 10 X	35.32±14.81
Vessele diameter 40 X	114.07±22.19
Medullary rays length 40 X	51.37±16.32
Pith cell diameter 40 X	56.66±16.98

*Each value expressed as mean± S.D of 10 replicate

Table 6.T.L.Sstem anatomical characteristics of *Osyrisquadripartita*

Characters	*O. quadripartita*
Vessele Length 10 X	144.31 ±31.36
Bredth10 X	25.98±3.42
Medullary rays length(Medullary rays cell layer number 2-4) 10 X	406.29±99.56
Bredth10 X	13.40±1.31

*Each value expressed as mean± S.D of 10 replicates

Figure Legends

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Figure 1.~~Morphological appearance~~ *Osyrisquadripartita*from Northern Western Ghats of Maharashtra.

Figure 2.(a-i) Stem anatomy of *O.quadripartita*

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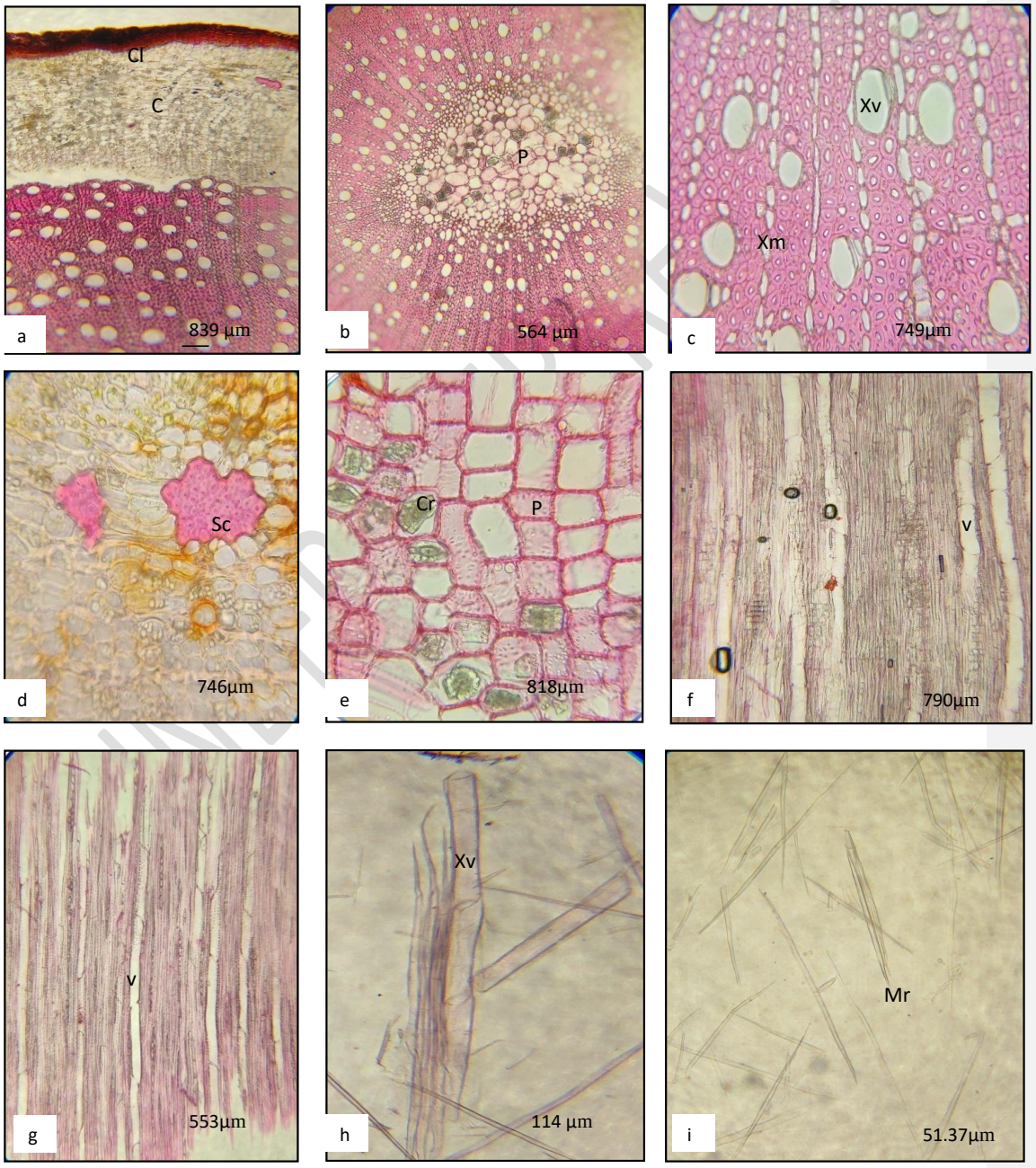
Cl= Cork layer,C=Cortex layer, E = epidermis,P = pith, Ph = phloem, X = xylem,Xylem vessels (40x), Mr= Medullary rays length (40 X), Xm= Xylem medullary layer, Pm= Phloem medullary layer, V= vessels, Sc= Sclerides, Cr= Crystalliferous cells



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