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Comparative morphological and anatomical characteristics of the species known as lemongrass (limonotu): *Melissa officinalis* L., *Cymbopogon citratus* (DC) Stapf. and *Aloysia citriodora* Palau.

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Abstract: *Aloysia citriodora* (Verbenaceae), *Melissa officinalis* (Lamiaceae) and *Cymbopogon citratus* (Poaceae) leaves have a gentle lemon-scented essential oil, contains citral or citronellal and are called the Lemongrass in Turkey. This similarity causes the use of plants for the same purposes despite the presence of different families and different morphological and anatomical structure. Instead of Melissa officinalis, which grows naturally in our country, Aloysia citriodora samples are sold in bazaars and herbal markets. Leaves of all species are used and sold. In this study morphological and anatomical features of leaves of *Aloysia citriodora*, *Melissa officinalis* and *Cymbopogon citratus* are investigated to identification of powder and big parts in herbal tea.

Key words: *Melissa*, *Cymbopogon*, *Aloysia*, Lemongrass, Morphology, Anatomy.

Introduction

Aloysia citriodora Palau., *Cymbopogon citratus* (DC) Stapf. and *Melissa officinalis* L. are sold as lemongrass in the herbalist shops in Turkey because of leaves of these species have a gentle lemon-scented essential oil, contains citral or citronellal. This similarity causes the use of plants for the same purposes.

Melissa officinalis is a perennial and a member of the Lamiaceae family. It is known a calming plant. The white flowers and scent attract bees, hence the Turkish name is “Oğulotu” in Turkey. It was used reduce stress and anxiety, promote sleep, improve appetite, and ease pain and

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discomfort from indigestion (including gas and bloating, as well as colic) (Baytop, 1999).

The plant is native to Turkey and grows up to 1 m high. The leaves are cordate shape, 2-10 cm long, have conspicuous venation, very deeply wrinkled and range from dark green to yellowish green in color. Clusters of small, light yellow flowers grow where the leaves exes in the stem. Two subspecies are naturally grown in Turkey: *M. officinalis* L. subsp. *inodora* Bornm. and *M. officinalis* L. subsp. *officinalis* (Dirmenci, 2012; Miller, 1982).

Aloysia citriodora (Syn: *Aloysia triphylla*) and *Cymbopogon citratus* are not wild in Turkey. *Aloysia citriodora* commonly called lemon verbena is native to Argentina and Chile. It is a deciduous shrub growing to 1-3 m high. The leaves are opposite or in whorls of three, 5-10 cm long, lanceolate, pinnate, flowers are small, white, single and inconspicuous. Flowers are purple or white appear in late spring or early summer. The plant has a gentle sedative activity and used for abdominal discomfort. It has a tonic effect on the nervous system and uses in depression (Gattuso et al., 2008).

Cymbopogon citratus is native to Srilanka and South India. The plant is widely cultivated in Tropical Asia and America. The plant is a tall (up to 1,8 m) , rhizomatous, perennial Asian grass. Leaves are strap-like up to 2,5 cm wide, 90 cm long, bright bluish-green and glabrous. Inflorescence is 30-60 cm long and nodding, spikelets are subtended by spathes (Eltahir & Abuereish, 2010).

Cymbopogon citratus is generally used as a fragrance, flavoring agent and treating digestive disorders, such as flatulence, indigestion and acidity. Stalks and leaves are also used as an antispasmodic, hypotensive, anticonvulsant, analgesic, antiemetic, antitussive, antirheumatic, antiseptic and in the nervous and gastrointestinal problems in traditional medicine in the world. (Shah et al., 2011).

There are some anatomical and morphological studies on this species. Şaşkara and friends (2010) researched only morphological and anatomical characteristics of *Melissa officinalis* which sold in herbalists in Turkey.

Material and method

Anatomical research material was dried so firstly they were stayed in distillate water then they were preserved in 70% ethanol. Cross-sections and surface sections of leaves were investigated. Sections were stained using Sartur (Baytop, 1981). Photographs were taken with an Olympus BH– 2 microscope.

Morphological research material was unpowered leaves of species. Leaves shapes, sizes, venations, lamina margins, lamina tips and bases, indumentums and colors have been observed in the samples.

Result and discussion

Morphological Characteristics

Identification problems are occurred in small parted herbal teas. Therefore some characteristics can be used easily for identification. The leaves margins of *M. officinalis* are crenate, but the leaves of *A. citriodora* and *C. citratus* are entire. Also the leaves venation of *M. officinalis* is pinnate but venetion between lateral vein is distinct reticulate. The leaf venation of C. citratus is parallel so small parts can be seen as small stick and leaves are glabrous (Fig. 1). The leaves venation of *A. citriodora* are pennate but there are 90° angle between lateral vein and main vein and venation between lateral veins are not reticulate. Detailed characters are summarized in table 1.

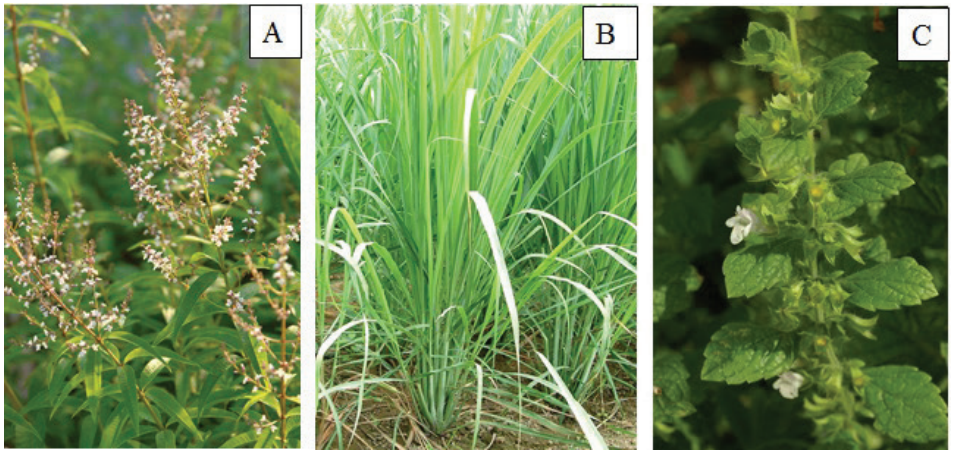

Figure 1. The species of *Aloysia citriodora* (A), *Cymbopogon citratus* (B) and *Melissa officinalis* (C)

Table 1. Comparatively Morphological Characteristics of Lemongrass Species

Characteristics	***Aloysia citriodora***	***Cymbopogon citratus***	***Melissa officinalis***
Leaf shape	lanceolate	linear	broadly ovate
Leaf size	5-10 cm	5-7 cm	2-10 cm
Venation	pinnate	parallel	pinnate
Lamina margin	entire	entire	crenate
Lamina tip and base	acute and acute	acuminate and sheath and ligule	acute or obtuse, cuneate to cordate
Indumentum	Upper surface pubescent and both surface secretion hair	glabrous	both surface adpressed-villous to sparingly pubescent and secration hair
Dried color	Pale green	Pale green	Dark green
Photos of drogs			

Anatomical Characteristics

Anatomy of these species is very useful for identification of big parted samples for separating this species.

Differences in the main vascular bundle and surface of leaves occur according to family and genus characteristics. *A. citriodora* (Verbenaceae) and *M. officinalis* (Lamiaceae) belong related families and anatomical characteristics are more related than Poaceae species *C. citratus.*

Leaves are bifacial anomocytic stomata and capitate glandular trichomes in *A. citriodora* and *M. officinalis*; unifacial, paracytic stomata and secretion cells non trichomes in *C. citratus*. The main distinguish feature is peltate glandular trichomes (Labiatae type glandular trichome) between two species (Table 2, Fig. 2-4).

Table 2. Detailed anatomical characteristics of Lemongrass Species.

	Aloysia citriodora	*Cymbopogon citratus*	*Melissa officinalis*
Cross-Section of Main Vascular Bundle			
Structure	Bifacial and hypostomatic	Unifacial and hypostomatic	Bifacial and hypostomatic
Upper epidermis	Single-cell layer, unequal shape and size cell	Single-cell layer, large cells	Single-cell layer, unequal shape and size cell
Trichomes	Puberulous, glandular trichomes	Glabrous	Mainly simple, rarely multi-cellular non-glandular and peltate (Labiatae type) or long-stalked capitates glandular trichomes
Palisade parenchyma	1-2 layered	Mesophyll don't contain palisade and spongy parenchyma, cells are smaller than parenchymatic cells around the main vein	1 layered
Spongy parenchyma	3-4 layered		4-5 layered
Vascular Bundle	Distinct	Distinct	Distinct
Sclerenchyma	3-4 layered, around vascular bundle	3-4 layered, around vascular bundle	1-2 layered, around vascular bundle
Lower epidermis	Single-cell layer, unequal size, tannin is not present	Single-cell layer, small cells, large amount of tannin	Single-cell layer, similar to upper epidermis, tannin is not present
Surface-Section of Leaves			
Upper epidermis	Unequal polygonal cells, walls are often wavy, trichomes are capitates glandular and simple hooked non-glandular.	1 layered, rectangular shape, length/ weight 2-4(-5)	Unequal polygonal cells, walls are often wavy and in different shape and size, margin undulated or protruding, *trichome bases* are regularly found.
Lower epidermis	Stomata anomocytic, Unequal polygonal cells, walls are often wavy, capitate glandular trichomes are seen.	Stomata paracytic, length/weight 1/3, Secretion cell are present.	Stomata anomocytic, length/weight 1-3, secretion cell are present.

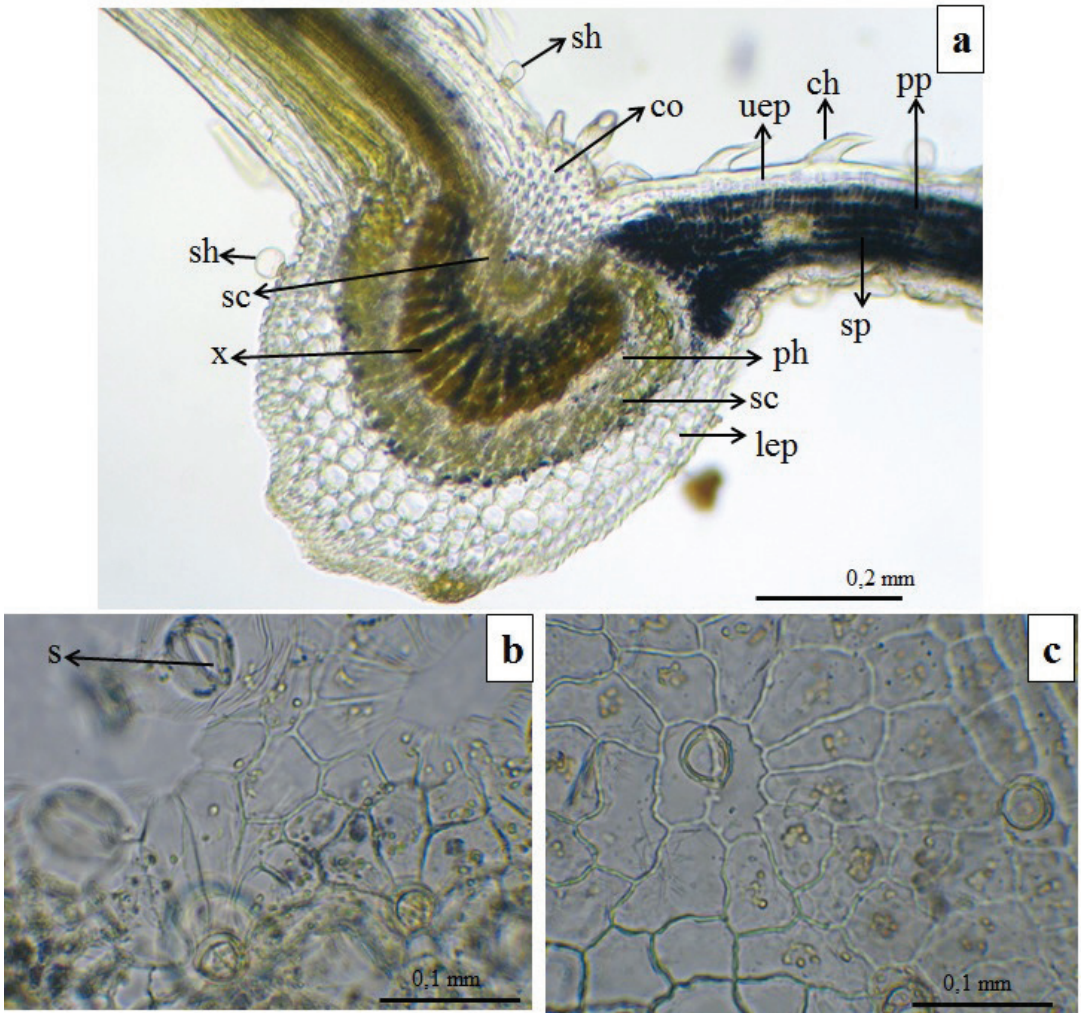

Figure 2. Cross-sections and surface sections of leaves of *Aloysia citriodora*, a cross section of midrib vein, b surface section of lower epidermis, c surface section of upper epidermis; ch cover hair, co collenchyma, lep lower epidermis, ph phloem, pp palisade parenchyma, s stomata, sc sclerenchyma, sh secretion hair, sp spongy parenchyma, uep upper epidermis, x xylem.

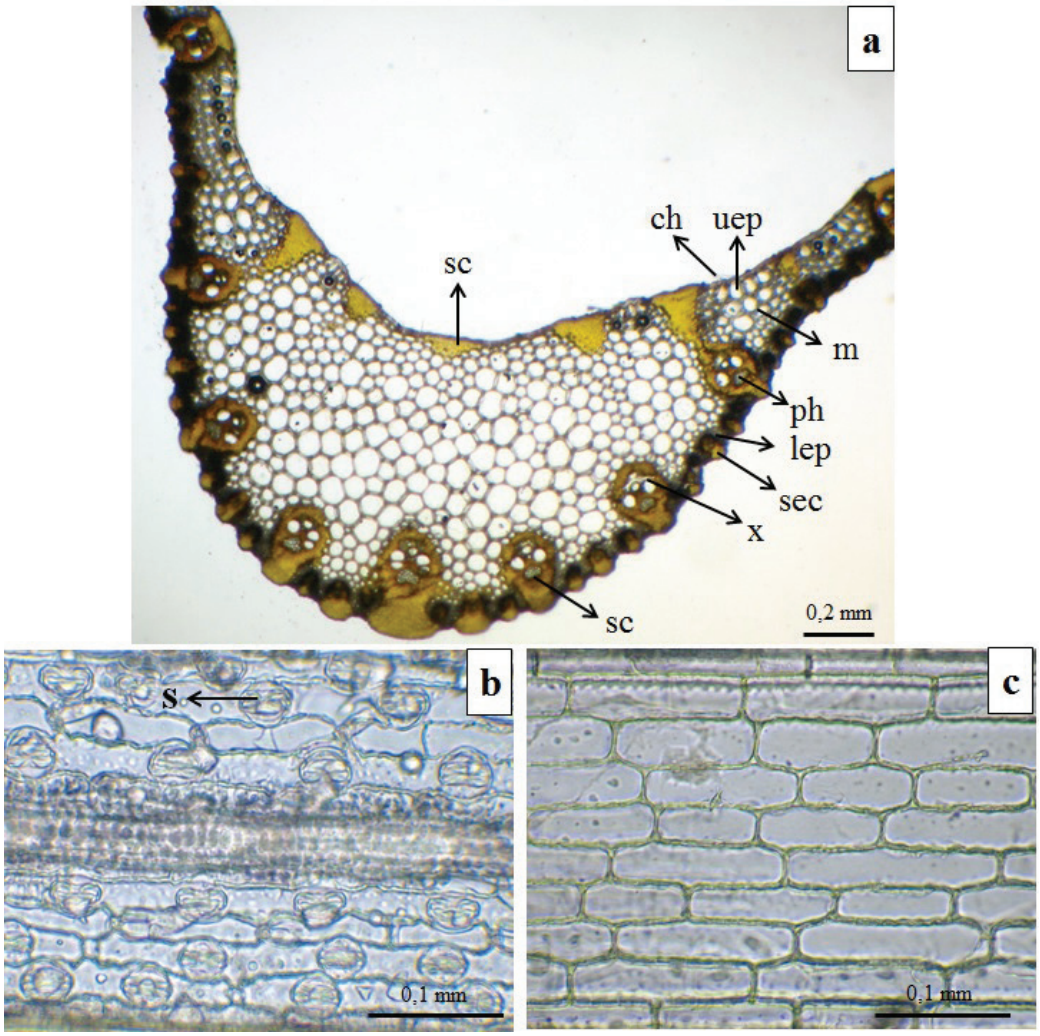

Figure 3. Cross-sections and surface sections of leaves of *Cymbopogon citratus*, a cross section of midrib vein, b surface section of lower epidermis, c surface section of upper epidermis; ch cover hair, lep lower epidermis, m mesophyll, ph phloem, s stomata, sc sclerenchyma, uep upper epidermis, x xylem.

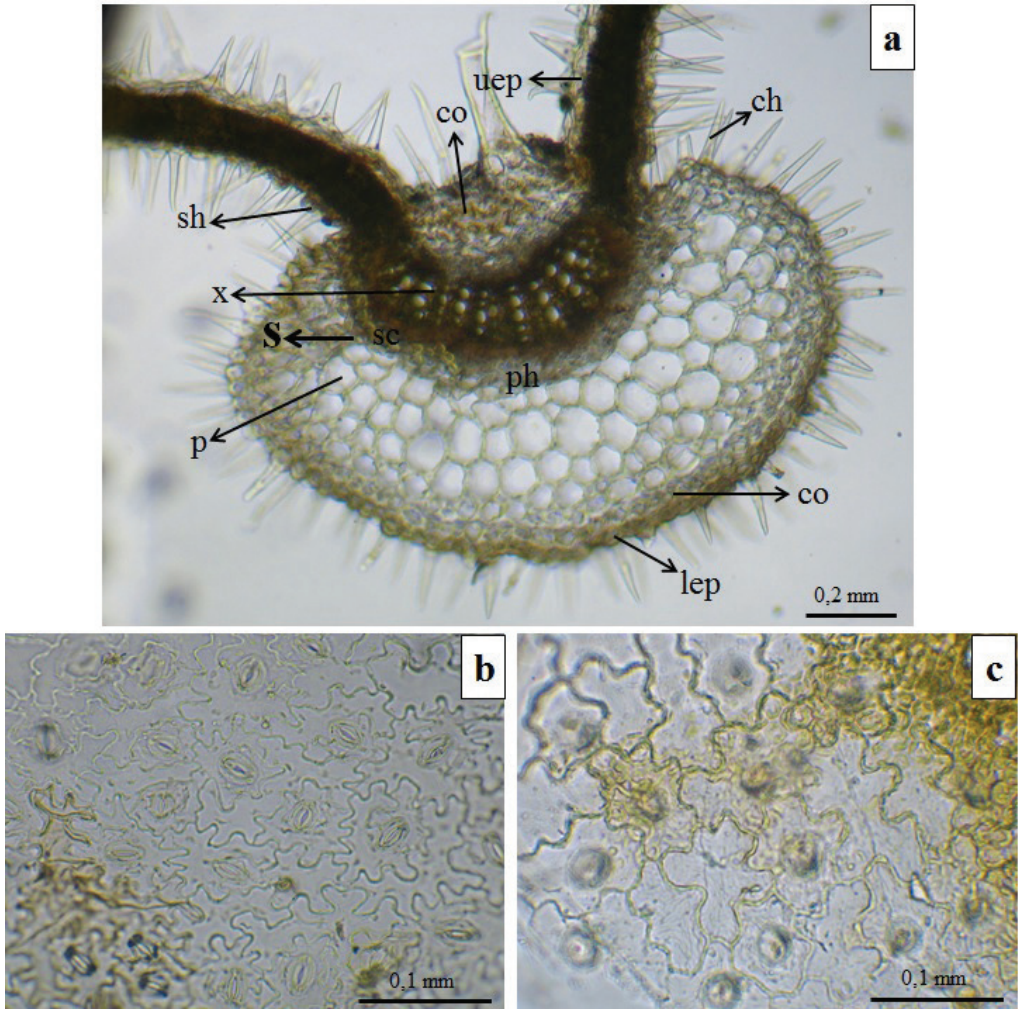

Figure 4. Cross-sections and surface sections of leaves of *Melissa officinalis*, a cross section of midrib vein, b surface section of lower epidermis, c surface section of upper pidermis; ch cover hair, co collenchyma, lep lower epidermis, p parenchyma, s stomata, sh secretion hair, uep upper epidermis, x xylem.

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