MORPHOLOGICAL FEATURES OF GLANDULAR AND NON-GLANDULAR TRICHOMES IN SOME SPECIES OF FAMILY LAMIACEAE

F.M. Ghonam; Z.A. Turki* and M. F. Azazi****

***Botany department, faculty of Science, Menoufiya University, Monoufiya, Egypt**

****Surveying of Natural Resources in Environmental Systems Department Environmental Studies & Research Institute, University of Sadat city**

ABSTRACT

The trichomes on leaves of *Lavandula hybrid*, *Mentha aquatic*, *Mentha citrate, Mentha longifolia, Mentha spicata, Ocimum basillicum, Origanum majorana, Rosmarinus officinalis, Salvia elegans, S. farinaceae, S. splendeus, Thymus capitatus,* and *T. vulgaris* are examined by light microscope. Four types of non-glandular trichomes and four types of glandular trichomes were distinguished. Non glandular trichomes appeared valuable data in taxonomy of Lamiaceae. Four distinct glandular trichomes found: short-stalked capitates, long-stalked capitates, small peltate and large peltate. The peltate trichomes are the most abundant type.

***Keywords**: Trichome, Glandular, Non glandular, Lamiaceae*

INTRODUCTION

Lamiaceae as a flowering family contains large number of medicinal aromatic plants. Many species belonging to the family being highly aromatic due to the presence of external glandular structures that produce volatile oil. Within the micro morphological studies, an important taxonomic significance is attributed to the epidermis, in particular to trichomes. Trichomes are defined as unicellular or multicellular appendages, which originate from epidermal cells only (Cantino, 1992), and can develop on all parts of the plant: vegetative and reproductive. Trichomes on plants, extremely variables in their structure and function, could have taxonomical importance in certain plant groups. The type and distribution of trichomes was one of the features differentiating the various subfamilies (Cantino, 1990 and Harley *et al*., 2004). The micro morphological study of the species belonging to different genera can evidence new similarities or differences among the various taxa (Endress *et al*., 2000).

The present work presents the observations on the trichomes oftherteen taxa belonging to the family Lamiaceae viz. *Lavandula hybrid*, *Mentha aquatic*, *M. citrate, M. longifolia, M. spicata, Ocimum basillicum, Origanum majorana, Rosmarinus officinalis, Salvia elegans, S. farinaceae, S. splendeus, Thymus capitatus,* and *T. vulgaris*.

MATERIALS AND METHODS

Plant material:

The present study was mainly based on fresh materials collected from their natural habitats in Egypt in addition to specimens obtained from spring flower gallery. The aerial parts of the examined plants were collected during the flowering – fruiting period (April–July, 2012).

Anatomical investigations:

Samples for anatomy of stem as well as leaves were chosen from both dry and fresh material. All assessments were made on all plants at similar developmental stages (fruiting stages) and in comparable positions of each plant. Stem samples were taken from 4th internodes from the apex about 2-3 cm. Fresh materials were fixed in F.A.A. (5:5:90), while dried herbarium specimens of stem and leaves were first softened by either normal or warm water, after fixation stem and leaves specimens were transformed in ethyl alcohol series, then embedded in paraffin wax. The specimens were sectioned at 10-15 µm; sections were dehydrated in alcohol-xylol series. Sections were stained in safranin and light green according (Sass, 1961). The transverse sections of stem and leaves were examined by using light microscope. The trichomes types of the investigated taxa, followed the terminology after Payne (1978) and Giuliani & Maleci Bini (2008).

RESULTS AND DISCUSSION

Anatomical characters:

Different types of non-glandular and glandular trichomes were found on all examined leaves of the different taxa (Table1 and Figs 1-10).

Types of non-glandular trichomes:

A - Unicellular (arrect or bent)
B - Multicellular (arrect)
B1- Multicellular (arrect), with smooth surface wall
B2- Multicellular (arrect), with cuticular papillae
C - Multicellular (aduncate)
C1- Multicellular (aduncate), with smooth surface wall
C2- Multicellular (aduncate), with cuticular papillae
D - Dendroid (dendriform) hair

Type A – Unicellular arrect or bent trichomes (Fig.1). These are living trichomes having a vacuolated protoplasm with numerous plastids.

Type B – Multicellular trichomes. They are uniseriate, unbranched, composed of 2-4 cells. Stiffly erect, directed upward from an inclined base. Similar to unicellular trichomes, composed of living cells containing numerous plastids. This type distinguished into two subtypes:

B1-The wall surface is smooth without cuticular papillae (Fig. 2).

B2-The wall surface is covered with cuticular micropapillae (Fig. 3).

Type C - Multicellular trichomes. They are uniseriate, unbranched, composed of 2-4 cells. Trichomes twisted or bent at different levels. Similarly to type B trichomes, they are composed of living cells containing numerous plastids. This type distinguished into two subtypes:

C1-The wall surface is smooth without cuticular papillae (Fig. 4).

C2-The wall surface is covered with cuticular micropapillae (Fig. 5).

Type D- Dendroid hair. Multicellular trichomes, branched to a tree in form; having a stem like part arising immediately from the broadened base and dividing to produce diverging branches which may be repeatedly forked in their turn (Fig. 6). They are composed of living cells containing numerous plastids.

Types of glandular trichomes:

Four types of glandular trichomes are investigated in the studied taxa. These types are represented in the following:

A- Small peltate (cup-shaped)
B - Large peltate (cup-shaped)
C- Short capitate (brevicollate)
D- Long capitate (asciiform)

Type A- Peltate trichomes: They are made up of one basal cell, a short unicellular stalk and up to 10 secretory cells covered with a cuticle, beneath which a large subcuticular space is formed (Fig. 7). The secretorycells contain chloroplasts.

Type B - similar to type A, but with 10-14 secretary cells (Fig. 8)

Type C- Short capitates trichomes: They are made up of one basal cell, the stalk formed ofone or two cells and two secretory cellswithin the head which is covered with a cuticlelayer (Fig.9).

Type D- Long capitates trichomes: They are multicellular (2-3 cells) uniseriate stalk and unicellular glandular head covered with a cuticle (Fig. 10). In this trichome type there are different shapes of the cells composing the head: spherical or significantly elongated, some ofthem narrowed in the lower or middle part.

A characteristic feature of these trichomes was the occurrence of a strongly vacuolated cytoplasm only in the lower, most elongatedcell of the stalk. But the cells lying nearest the head had a dense cytoplasm, with typical secretory cells.

Table (1): Different types of glandular and non-glandular trichomes

No.	Taxa	Glandular trichome	Non- glandular trichome
1	*Lavendula hybrid*	C	D
2	*Mentha aquatica*	A,D	A,C1
3	*Mentha citrata*	A	C1
4	*Mentha longifolia*	B	C1
5	*Mentha spicata*	A,D	C2
6	*Ocimum basillicium*	A,C	B1
7	*Origanum majorana*	B	C1
8	*Rosmarinus officinalis*	D	B1
9	*Salvia elegans*	A	A,B1
10	*Salvia farinaceae*	A,C	B2
11	*Salvia splendeus*	B	C1
12	*Thymus capitatus*	B	B1
13	*Thymus vulgaris*	A	A

Types of non-glandular trichomes: A- Unicellular (arrect or bent),B1- Multicellular (arrect), with smooth surface wall,B2- Multicellular (arrect), with cuticular papillae ,C1- Multicellular (aduncate), with smooth surface wall, C2- Multicellular (aduncate), with cuticular papillae, D - Dendroid (dendriform) hair**.**

Types of glandular trichomes: A- Small peltate (cup-shaped), B - Large peltate (cup-shaped), C- Short capitate (brevicollate), D- Long capitate (asciiform)**.**

Types of non-glandular trichomes

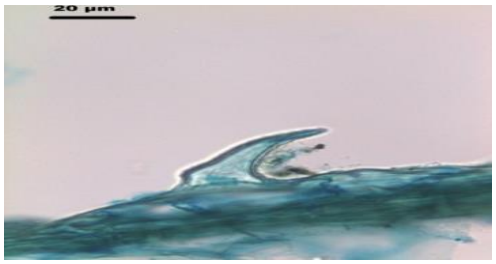

Fig. (1): Unicellular trichome of *Thymus capitatus*

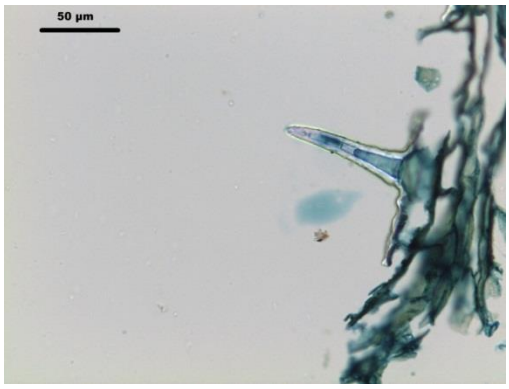

Fig. (2): Arrect non-glandular trichomes of *Salvia elegans*

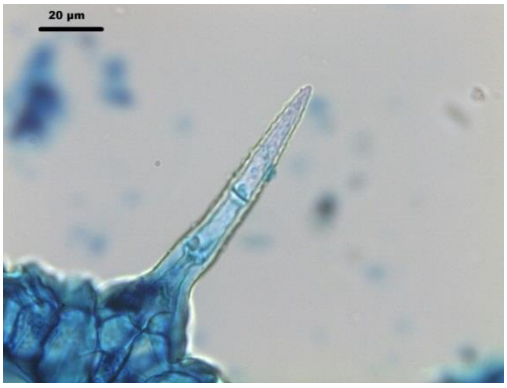

Fig. (3): Arrect rough non-glandular trichomes of *Salvia farinacea*

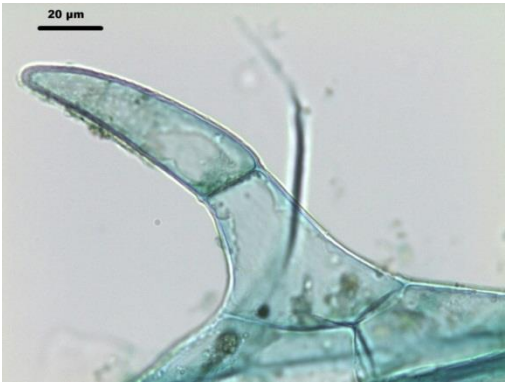

Fig. (4): Bent non-glandular trichomes of *Mentha citratea*

Fig. (5): Bent rough non-glandular trichomes of *Mentha spicata*

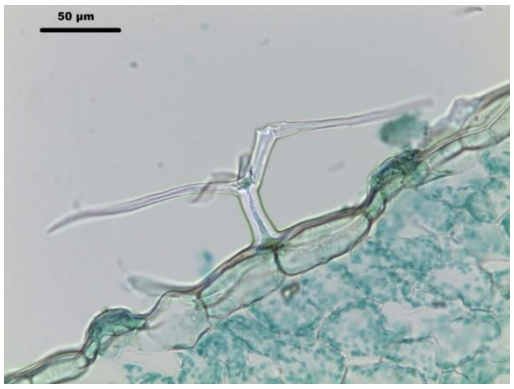

Fig. (6): Dendroid (dendriform) hair of *Lavendula stricta*

Types of glandular trichomes:

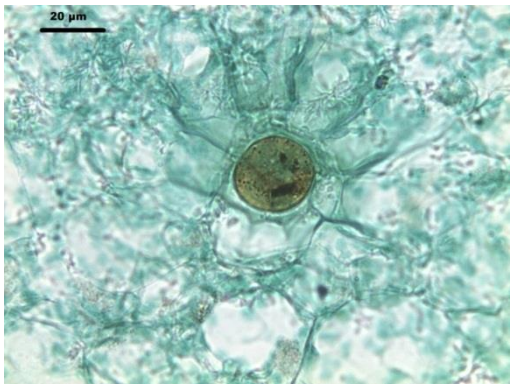

Fig. (7): Small peltate trichomes of *Mentha citrata*

Fig. (8): large peltate trichomes of *Salvia splendens*

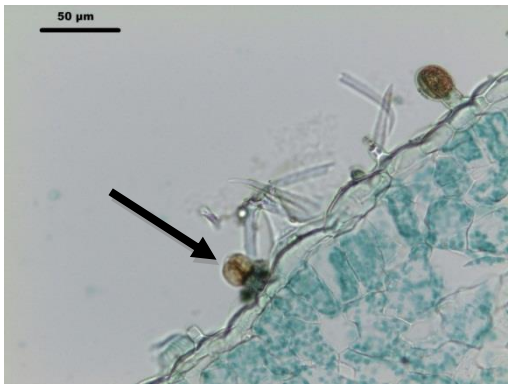

Fig. (9): Short capitates trichomes of *Lavendula hybrid*

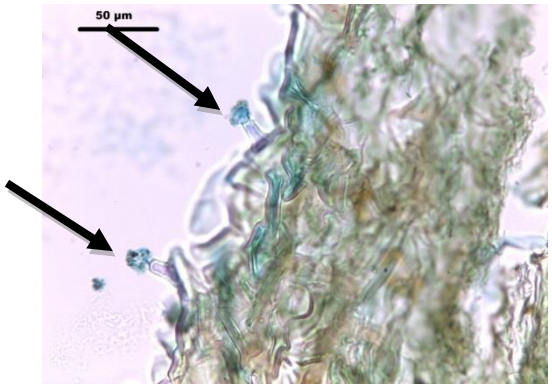

Fig. (10): Long capitates trichomes of *Rosmarinus officinalis*

The aerial surfaces of almost all of the aromatic plants belonging to the family Lamiaceae examined are covered with trichomes, including non-glandular trichomes and glandular or secretory trichomes (Werker*et al*., 1985; Werker, 1993). In the present study, four types of non-glandular trichomes (A, B, C and D) are distinguished. Type Arepresented in three of the studied species viz: *Mentha aquatica*, *Salvia elegans* and *Thymus capitatus*.Type B1 represented in four species: *Ocimum basillicum, Rosmarinus officinalis, Salvia elegans* and *Thymus capitatus*. Type B2 observed only in *Salvia farinaceae*. Type C1 represented in five species *Mentha aquatic, M. citrate, M. longifolia, Origanum majorana* and *Salvia splendens*. Both Type C2 and Type D are represented in only one species from studied taxa: *Mentha spicata* and *Lavendula hybrid* respectively.

Every species of the three studied *Salvia* species have different type of non-glandular trichomes as *Salvia elegans* have type A and B1, *Salvia farinaceae* have type B2 and *Salvia splendens* have type C1. *Mentha citrate, M. longifolia* and *M. spicata* have the same type of trichomes C1 and only the species *M. spicata* have the type C2 .The two studied species *Thymus capitatus* and *T. vulgaris* have two different types of non-glandular trichomes, viz. *T. capitatus* has type B1 and *T. vulgaris* has type A.

Within the family Lamiaceae, different species can have different types, distribution, morphology, and density of glandular trichomes, which could be of important taxonomic value (El-Gazzar and Watson, 1970), such as having both peltate and capitates trichomes, or with only either peltate or capitates trichomes, or, more rarely, having neither (Huang *et al*., 2008).The present study showed that trichomes have great taxonomic value in the studied taxa at the level of species, but this is not detectable with the four studied species of *Mentha* species, where two species of *Mentha* have the same

type of glandular trichomes small peltate (A) and long capitates (D) .*Mentha citrate* has only type (A) small peltate and *Mentha longifolia* has the type (B) long peltate.

Every species of the three studied species of *Salvia* have type of glandular trichomes differ from the others as *Salvia elegans* have small peltate trichomes (A), *S. farinaceae* have small peltate trichomes (A) and short capitate (C) and *S. splendens* have large peltate type (B). *Thymus capitatus* have large peltate trichomes (B) while *T. vulgaris* have small peltate trichomes (A).

The glandular trichomes are known to be the primary sites of secondary metabolite biosynthesis, secretion and storage, and generally consist of either simple subcutaneous glands or of trichomes (Weiss, 1997). In present study, four distinct glandular trichomes, i.e. short-stalked capitates, long-stalked capitates, small peltate and large peltate glandular trichomes were found.

Two types of capitates trichomes are found based on their morphological features, namely short capitate (C) and long capitates trichomes (D). The differences between these trichomes are in the stalk length, the neck cell and the shape of the glandular head. The result is consistent with the findings of Werker*et al*. (1985) who noted that capitates trichomes are very variable in stalk length, glandular head shape and secretions, and can be classified into various types. The short-stalked capitates trichomes (C) are represented in three of the studied taxa: *Lavendula hybrid, Ocimum basillicum* and *Salvia farinaceae*. The short-capitate trichomes are the commonest type of capitates trichome found in Lamiaceae and these types have globoid to obovoid uni- or bicellular glandular heads (Ascensao *et al*., 1999). The long-stalked capitates trichomes (D) found in three of the studied species *Mentha aquatic, M. spicata* and *Rosmarinus officinalis*. According to Ascensao *et al*. (1999), capitates trichomes may differ in terms of their morphological characteristics, reflecting the different secretory processes, and would probably have distinctive functions.

Peltate trichomes are very frequently found in the studied taxa, as small peltate (A) found in seven species *Mentha aquatica, M. citrate, M. spicata, Ocimum basillicum, Salvia elegans, S. farinaceae* and *Thymus vulgaris*. Large peltate trichomes (B) found in four species *M. longifolia, Origanum majorana, Salvia splendens* and *Thymus capitatus*. In many of the species of the Lamiaceae, the broad head of the peltate trichomes usually consisted of four to twelve cells (Werker*et al*., 1993; Serrato-valenti *et al*., 1997; Bisio *et al*., 1999; Corsi and Bottega, 1999; Turner *et al*., 2000; Huang *et al*., 2008; Bagherpour *et al.,* 2010; Kahraman *et al*., 2010). Previous studies on Lamiaceae did not report peltate broad head with more than 12 cells. In the present study large peltate trichomes head consisted of 10-14 cells. The peltate trichomes produce most of the essential oils, i.e. terpenes (Clark *et al*., 1997)

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