



Microsculpture of Nutlets Surface of some Libyan *Salvia* L. species (Lamiaceae)

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Abstract

A comprehensive morphological and micro-morphological study of the nutlets of five Libyan *Salvia* species (Lamiaceae) was conducted to evaluate nutlets characteristics by using scanning electron microscopy (SEM). Differences in surface ornamentation, size, shape and color were observed between the species. The studied species were categorized in three basic types based on surface ornamentation: irregular prominences, regular prominences and smooth nutlets. The shape of nutlets were described as oblong, ovoid-oblong to globose-subglobose and their size range is 2–3.5 mm in length and 1.5–2.5 mm in width. Nutlet micromorphological characteristics such as surface ornamentation can be useful for classification and identification of *Salvia* species in Libya.

Keywords: *Salvia*, Microsculpture, Nutlets, Lamiaceae, Libya

Introduction

The genus *Salvia* L. (Lamiaceae) is one of the largest genera in this family (Cvetkovikj et al. 2015). The plant name *Salvia* (sage) comes from the Latin word salvare, which means healer (TOPÇU et al. 2013). The genus *Salvia* L. belongs to the Mentheae tribe within the Nepetoideae subfamily (Kharazian 2014) includes around 1000 species that have almost cosmopolitan distribution (Saravia et al. 2018); In Libya, it is represented by 10 species; out of which 3 are cultivated (Jafri, 1985). Numerous species of the *Salvia* genus are economically important since they are used as spices and flavouring agents in the field of perfumery and cosmetics (Felice Senatore et al., 2004 and 2006); and some species of *Salvia* have been cultivated worldwide for use in folk medicines (Tohamy et al. 2012). Nutlet ornamentation, shape, size and colour particularly proved to be good taxonomic characters for the Egyptian Lamiaceae taxa(Kamel, 2014).

Salvia L. has been shown that gross morphology of nutlets and their sculpturing pattern are variable and taxonomically useful at a species

level (Oran 1996). Studies on nutlet micromorphology within Lamiaceae showed that nutlets features e.g., shape and surface sculpturing, were potentially useful at different taxonomic levels (Moon et al., 2009; Khosroshahi & Salmaki, 2018). Among different nutlet characters, type of sculpturing has been considered to be taxonomically most important (Kahraman et al., 2011), however, color, size and shape of nutlets were considered unimportant, either because they did not vary or the variation was random or too great (Oran, 1996). Ozkan et al., reported the nutlets are placed in three groups based on the shape and ornamentation. Ozkan explained *S. aethiopis* and *S. virgata* nutlets ornamentation are foveate and reticulate, While Mousavi, S. et al (2013) preferred to name, surface with hexagonal prominences and undulated stripped respectively.

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Recent studies of the mericarp morphology of Lamiaceae taxa have contributed useful information at different taxonomic levels. The importance of mericarp morphology in the modern taxonomy of Lamiaceae has been emphasized by many researchers (Kaya & Dirmenci 2012, Dinç et al. 2009 and Kaya et al. 2014).

Kahraman & Dogan (2010) reported that the pollen size, shape and exine ornamentation, and nutlet micromorphology in the genus *Salvia* were important in distinguishing between the species.

Material and Methods

Specimens from five *Salvia* species were collected from several localities in Libya, collected from different localities of Libya between January 2019 and October 2020. Identification of species was performed using Flora of Libya (JAFRI et al 1985), Flora Of Europa (Tutin et al 1992). Nutlets (Mericarps) were first observed with a stereomicroscope to ensure that they were of normal size and maturity. For nutlets length and width, five samples of each taxon were taken and measured. For Scanning Electron Microscope (SEM) observation, dried mature nutlets of five individuals for each species were examined using a SEM microscope model (Joel, JFC 1100). Nutlets were directly mounted on aluminum stubs using double-sided adhesive and were sputter coated with a thin layer of gold. Coated nutlets were examined and SEM micrographs were

captured at 200 \times and 500 \times . The terms used for describing the cypsela surface patterns have been adopted according to Stearn (1992). All photographs were taken at Central Laboratory of Alexandria University, Alexandria, Egypt. (Figure 1).

Results and Discussion

In this study, macromorphological and micromorphological characters of Nutlets were observed via SEM. Nutlets shape, size and other features of Nutlets were given in table (1). In addition, illustrating SEM photomicrographs are presented in Figure. (1). The shape was variable among the studied species; it is globose-subglobose, ovoid and oblong. The colour of nutlet was Pale green with netted lines brown, dark brown and black. The mean length of mature nutlets of the studied species ranged from 2 mm to 3.5 mm. The smallest nutlet recorded in *S. verbenaca* whereas nutlet of *S. fruticosa* and *S. viridis* where the longest ones. The observations in the studied species, surface patterns were divided in three types: **Type I:** Regular: regular hexagonal prominences as in *S. fruticosa* and regular prominence in chain form as in *S. viridis*. **Type II:** Irregular prominence with fine and rough folds as in *S. lanigera* and Irregular prominence with deep and shallow channels as in *S. verbenaca*. **Type III:** No microphological features observed (smooth) as in *S. spinosa*.

Table 1: Macro- and micromorphological features of the studied species

Species	Shape	Colour	Length (mm)	Width (mm)	Ornamentation
<i>S. fruticosa</i>	Globose-subglobose	Dark brown to black	3 - 3.5	2.5	Regular reticulate, hexagonal, with narrow depressed anticinal wall and wide raised pericinal wall
<i>S. lanigera</i>	Ovoid, oblong	Dark brown to black	2.25-2.5	1.25-1.5	Irregular prominence with fine and rough folds
<i>S. spinosa</i>	Ovoid	Pale green with netted lines	3	2	No microphological features observed (smooth)
<i>S. verbenaca</i>	Ovoid	Dark brown	2	1.5	Irregular prominence with deep and shallow channels
<i>S. viridis</i>	Oblong	Brown	3-3.5	2	Regular prominences in chain form with tangled strands on the surface

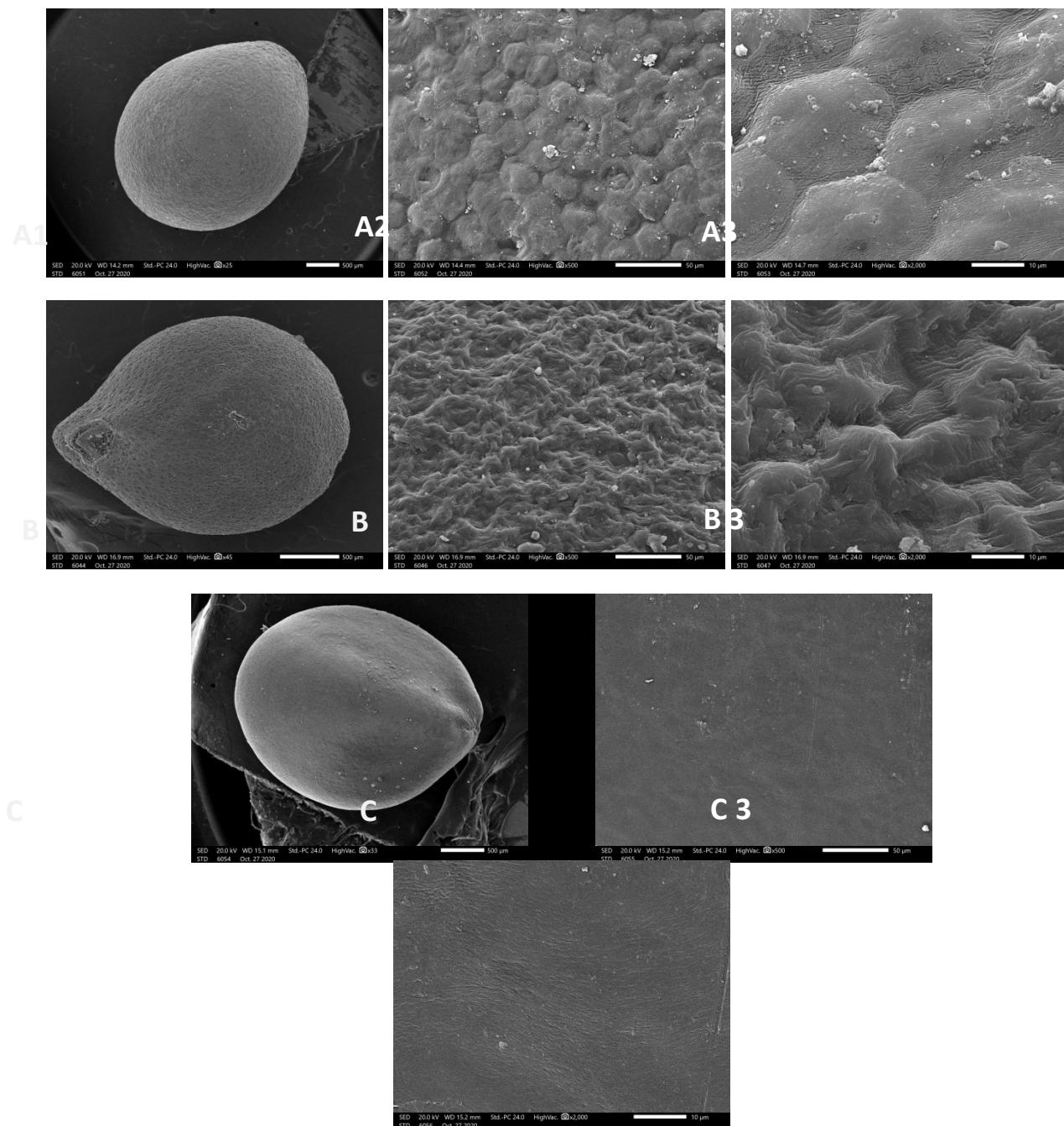


Fig.(1): Scanning electron micrographs of Nutlets in *Salvia* species consist of 1-shape (x25) ; 2 surface ornamentation (x500): a- *S. fruticosa*; b- *S. lanigera* ; c- *S. spinosa*

Ozkan et al. (2009) reported that the nutlets were placed in three groups based on the shape and ornamentation (spherical, trigonous and prolate spheroidal) and (foveate, reticulate and verrucate) respectively. Between 12 studied *Salvia* nutlets in their study, *S. ceratophylla*, *S. aethiopis* and *S. virgata* were common with the present research.

Ozkan explained *S. aethiopis* and *S. virgata* nutlets ornamentation are foveate and reticulate while in present research, it was preferred to name, surface with hexagonal prominences and undulated striped respectively. Also, Kahraman et al.(2009) pointed the size, shape and ornamentation of *S. balliana*, *S. macrochlamys*

and *S. hedgeana* are diagnostic. Our findings agree with those of previous studies in Lamiaceae confirming the usefulness of Nutlet

characteristics. Nutlet morphology provides valuable data for delimitation of closely related species

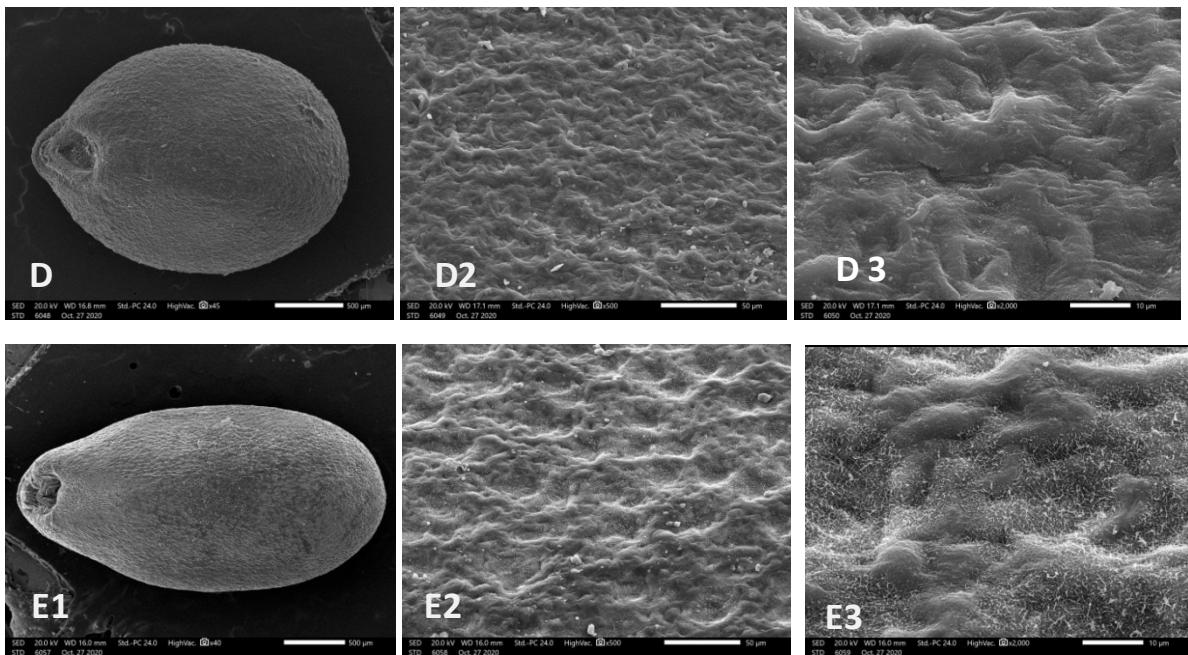


Fig. (1): Scanning electron micrographs of Nutlets in *Salvia* species consist of 1-shape (x25); 2 surface ornamentation (x500): D- *S. verbenaca*; E- *S. vrbenaca*

Conclusion

In conclusion, the shape, color and ornamentation of *Salvia* nutlets varied among the species and those are taxonomical characters help to identify species.

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