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Nutlet Micromorphological Study on *Salvia* L. (Lamiaceae) from NE Iran

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ABSTRACT

In the present research, micromorphological features of 10 *Salvia* L. nutlets (mericarp) growing in NE Iran were studied by SEM. These species were divided into three and four groups based on the shape and ornamentation of nutlets respectively. The variation in color, size and ornamentation of mericarp helped to identify species.

Keywords: *Salvia*; Iran; Nutlet; Mericarp; Micromorphological Features

1. Introduction

Salvia L. belongs to the family Lamiaceae, comprises about 1000 species distributed in temperate and subtropical regions [1]. This genus has 58 species in Iran in which 17 species are endemic [2-4]. Based on Flora Iranica report, 17 *Salvia* species were distributed in NE Iran [3]. In the present research, micromorphological features of mericarps were assessed for first time in Iran due to high hybridation rate between *Salvia* species [5] and commercial importance of their nutlets. Although *Salvia* is the largest genus of Lamiaceae, its mericarp morphology has been poorly reported. There have been a few reports of external micromorphological study on the mericarp of *Salvia* such as, Nutlet morphology and its taxonomic utility in *Salvia* from Turkey [6], Morphology, anatomy, palynology and nutlets micromorphology of the rediscovered Turkish endemic *Salvia ballsiana* and their taxonomic implications [7], Morphology, anatomy, palynology and nutlets micromorphology of *Salvia macrochlamys* in Turkey [8]. This research tries to present identification key of species based on micromorphology of mericarp.

2. Materials and Methods

Mericarp features of 10 *Salvia* species from NE Iran kept in FUMH including: *S. ceratophylla* L., *S. chorassanica* Bunge, *S. aethiopis* L. *S. atropatana* Bunge, *S. leriifolia* Bent, *S. sclarea* L., *S. macrosiphon* Boiss, *S. chloroleuca* Rech. f. & Aellen, *S. virgata* Jacq., *S. nemorosa* L. were examined. The localities of studied *Salvia* species were presented in **Table 1**. The nutlets were coated with sputter and studied by SEM XL 30. The features such as the size, color, shape, polar axis length/equatorial axis length and ornamentation were evaluated in magnification 25 and 500.

3. Results

3.1. Identification Key of *Salvia* Species Based on Nutlet Features

1a—Reticulate……*S. ceratophylla*
1b—non reticulate……2
2a—stripped……3
2b—stripped with prominence (swollen)……7
3a—simple stripped……4
3b—undulated stripped……6
4a—stripped with deep and coarse grooves.....*S. sclarea*
4b—stripped with fine grooves……5
5a—minute grooves……*S. macrosiphon*
5b—shallow, regular and fine grooves.….*S. chloroleuca*
6a—fine and distant grooves……*S. nemorosa*
6b—coarse-fine and close grooves……*S. virgata*
7a—hexagonal prominence……8
7b—circular prominence……9
8a—regular hexagonal prominence……*S. aethiopis*

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Table 1. The localities of studied *Salvia* species.

Species	Locality
S. atropatana Bunge	West north of Quchan, Galil, 2100 m, Zangouei, 25824, FUMH; west north of Boujnord, Misi nou mount, 1800 m, Joharchi & Zangouei, 20819); west north of Boujnord, Gouinik mount, 1435 m, Joharchi & Zangouie, 40134, (FUMH).
S. chorassanica Bunge	Between Quchan-Drgaz, northern slope of Allahoakbar mount, 1650 m, Joharchi & Zangouie, 16868, (FUMH); North of Masshad, Kalat road, southern mounts of Sandough shekan pass, 1550 m, Jopharchi & Zangouie, 16825, (FUMH).
S. sclarea L.	Boujnord, Badranlou pass, 20 km Boujnord, 1450 m, Jopharchi & Zangouie, 10625, (FUMH); West of Boujnord, base of road, 1485 m, Jopharchi & Zangouie, 40436, (FUMH).
S. *aethiopis* L.	west South of Boujnord, Rein, 1700 m, Jopharchi & Zangouie, 37949, (FUMH); west north of Boujnord, between Koinic and Baghlogh, Jopharchi, 33706, (FUMH); West of Boujnord, after GharehNowDeh, 1485 m, Jopharchi&Zangouie, 40442, (FUMH).
S. ceratophylla L.	10 km Torbat Heidarieh to Khaf, 1000 m, Jopharchi, 13720, (FUMH); Sarakhsroad, Chahak hills, Jopharchi & Zangouie, 14526, (FUMH).
S. leriifolia Bent	West of Sabzevar, mountains of east Sarough, 1650 m, Joharchi & Zangouie, 42420, (FUMH)Gonabad, Ab Sanou mount, Joharchi & Zangouie, 12835, (FUMH).
S. macrosiphon Boiss	Between Srakhs- Mashhad, Bazangan, Joharchi & Zangouie, 16756, (FUMH); West north of Ghaen, Dashte Baiaz, 1900 m, Joharchi, 34480, (FUMH).
S.chloroleuca Rech. f. & Aellen	East of Quchan, Iadak, 1700 m, Joharchi & Zanghouie, 12890, (FUMH); North of Mashhad, Kardeh, 1100 m, Joharchi & Zanghouie, 12929, (FUMH).
S. virgata L.	Kalate naderi, 1100 m, Zangouie, 11198, (FUMH); Torbate Heydarieh, 1340 m, Rafeie & Zangouie, 23176, (FUMH).
S. nemorosa L.	East south f Boujnord, Esfidan, 1561 m, Joharchi & Zanghouie, 40219, (FUMH); Quchan, Oghaz kohneh, 1800 m, Faghihnia & Zangoure, 29451, (FUMH).

8b—irregular hexagonal prominence……*S. leriifolia*
9a—distant irregular circular prominence……..……*S. chorassanica*
9b—close circular prominence……..*S. atropatana*

3.2. Description of Studied *Salvia* Nutlets

3.2.1. *S. ceratophylla*

Spherical mericarp, P/E 1.26, dark brown, reticulate with square and irregular reticulations or nets, hairy, the length of reticulations were 25 - 50 µ (**Figures 1(a)** and **2(a)**).

3.2.2. *S. chorassanica*

Trigonous and prolate spheroidal mericarp, P/E 1.63, light brown, with distant irregular circular prominence, the distance between prominences were 50 - 70 µ (**Figures 1(b)** and **2(b)**).

3.2.3. *S. aethiopis*

Trigonous and prolate spheroidal mericarp, P/E 1.57, pale brown with regular hexagonal prominence, the distance between prominences were 20 µ (**Figures 1(c)** and **2(c)**).

3.2.4. *S. atropatana*

Spherical mericarp, P/E 1.39, black, with close, irregular circular prominences, the distance between prominences were 30 µ (**Figures 1(d)** and **2(d)**).

3.2.5. *S. leriifolia*

Spherical mericarp, P/E 1, black, with irregular hexagonal prominences, the distance between prominences were 20 µ (**Figures 1(e)** and **2(e)**).

3.2.6. *S. sclarea*

Ovoid mericarp, P/E 1.37, pale brown, stripped with regular, deep and coarse grooves, the distance between grooves were 2 - 3 µ (**Figures 1(f)** and **2(f)**).

3.2.7. *S. macrosiphon*

Spherical mericarp, P/E 1.15, dark green stripped with minute and irregular grooves, the distance between grooves were 0.5 - 1 µ (**Figures 1(g)** and **2(g)**).

3.2.8. *S. chloroleuca*

Spherical mericarp, P/E 1.36, light brown, yellow, stripped with minute, irregular and shallow grooves, the distance between grooves were 1 - 2 µ (**Figures 1(h)** and **2(h)**).

3.2.9. *S. virgata*

Ovoid mericarp, P/E 1.28, dark brown, undulated-

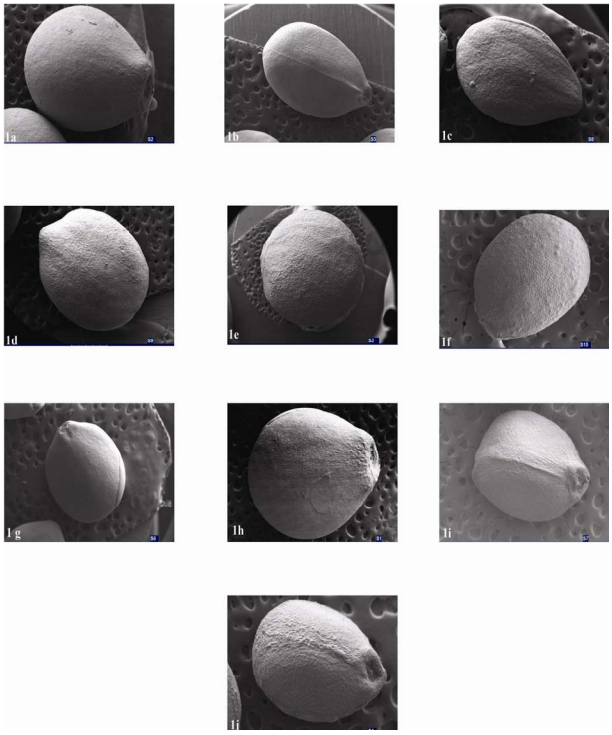

Figure 1. Electromicrographs of mericarps: (a) *S. ceratophylla*, (b) *S. chorassanica*, (c) *S. aethiopis*, (d) *S. atropatana*, (e) *S. lerrifolia*, f) *S. sclarea*, (g) *S. macrosiphon*, (h) *S. chloroleuca*, (I) *S. virgata*, (J) *S. nemorosa.*

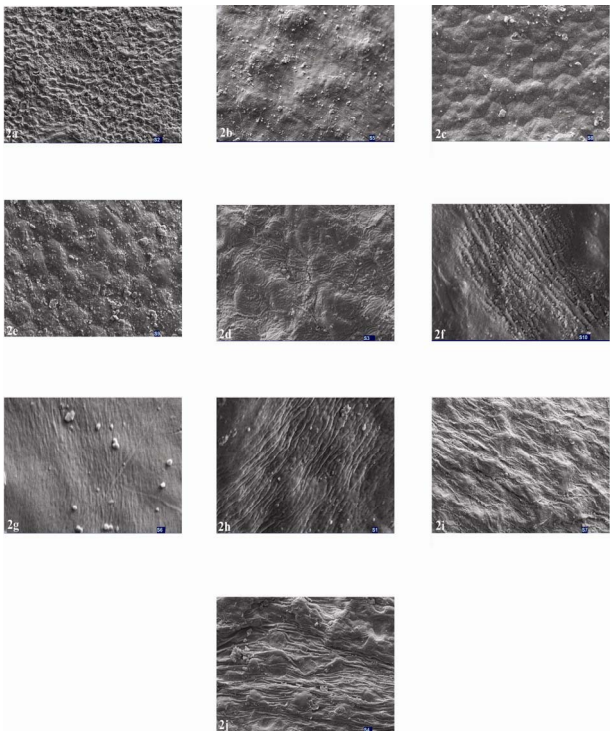

Figure 2. Electromicrographs of mericap: (a) *S. ceratophylla*, (b) *S. chorassanica*, (c) *S. aethiopis*, (d) *S. atropatana*, (e) *S. leriifolia*, f) *S. sclarea*, (g) *S. macrosiphon*, (h) *S. chloroleuca*, (i) *S. virgata*, (j) *S. nemorosa.*

stripped, with coarse-fine grooves and close prominences, the distance between prominences were 15 - 20 µ (**Figures 1(i)** and **2(i)**).

3.2.10. *S. nemorosa*

Ovoid mericarp, P/E 1.38, black, undulated-stripped, with distant coarse-fine grooves and distant circular prominences, the distance between prominences were 40 - 50 µ (**Figures 1(f)** and **2(f)**).

4. Discussions

The results showed *S. chorassanica* and *S. leriifolia* had the maximum and minimum nutlet size respectively. The nutlets were divided into three groups based on their shape:

1) Trigonous and prolate spheroidal like *S. chorassanica*, and *S. aethiopis*;

2) Spherical such as *S. chloroleuca*, *S. atropatana*, *S. leriifolia*, *S. macrosiphon* and *S. ceratophylla*;

3) Ovoid like *S. sclarea*, *S. nemorosa* and *S. virgata*. Also four groups were recognized based on mericarp ornamentation:

a) Reticulate with shallow, fine and irregular reticulations in *S. ceratophylla*;

b) With regular or irregular hexagonal and circular prominences like *S. chorassanica*, *S. aethiopis*, *S. atropatana* and *S. leriifolia;*

c) Stripped with regular and irregular, deep or shallow grooves such as *S. sclarea*, *S. microsiphon* and *S. chloroleuca*;

d) Prominent stripped in *S. virgata* and *S. nemorosa*.

Ozkan *et al*., reported the nulets are placed in three groups based on the shape and ornamentation (spherical, trigonous and prolate spheroidal) and (foveate, reticulate and verrucate) respectively [1]. 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 stripped respectively. Also, Kahraman *et al*. pointed the size, shape and ornamentation of *S. ballsiana*, *S. macrochlamys* and *S. hedgeana* are diagnostic [7,8]. In conclusion, the shape, color and ornamentation of Salvia mericarps varied among the species and those are taxonomical characters help to identify species.

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