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RESEARCH ARTICLE

A NUMERICAL TAXONOMIC STUDY ON SOME *SALVIA* L. (LAMIACEAE) TAXA FROM TURKEY

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ABSTRACT

In this study, multivariate analysis was carried out in order to elucidate the taxonomic relationships between 14 *Salvia* L. taxa (*S. trichoclada* Benth, *S. suffruticosa* Montbret, *S. euphratica* Montbret var. *euphratica*, *S. euphratica* Montbret var. *leiocalycina*, *S. multicaulis* Vahl., *S. syriaca* L., *S. palaestina* Benth, *S. aethiopsis* L., *S. ceratophylla* L., *S. frigida* Boiss., *S. candidissima* Vahl. subsp. *candidissima*, *S. virgata* Jacq., *S. verticillata* L. subsp. *verticillata*, *S. russelli* Benth) which were distributed naturally in eastern Anatolian region of Turkey. Numerical taxonomic techniques were applied to obtain morphologic and morphometric characters, then interspecific and infraspecific grouping were done according to these characters. Totally 56 morphologic and morphometric characters were obtained from stem, leaf, flower and etc. of samples collected from 53 population belong to these taxa. Eventually, infraspecific variation was found greater than interspecific variation and numerical taxonomic analysis generally showed convenience with the group differentiation Flora of Turkey, furthermore they have given important clues about the rearrangement of F–G group description.

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INTRODUCTION

Salvia, the largest genus of Lamiaceae, is composed of nearly 1000 species distributed extensively in three regions of the world: Central and South America (500 spp.), western Asia (200 spp.) and eastern Asia (100 spp.) (Walker and Sytsma, 2007). Anatolia is a major diversity center for *Salvia* in Asia (Davis, 1982). The first revision of *Salvia* species in Turkey was made by Hedge (1982), who recognized 86 species (Davis et al., 1988). Turkey is one of the centres of diversity for *Salvia* in Old World (Celep et al., 2014). Hedge (1982) recognized 86 species in the Flora of Turkey. Turkey contains about 100 *Salvia* species, 53 (53%) of which are endemic (Celep, 2016). In the Flora of Turkey *Salvia* genus divided 7 groups (A-B-C-D-E-F-G). *Salvia* taxa studied scattered in these groups; *S. suffruticosa* in A, *S. trichoclada*-*S. euphratica* var. *euphratica* and *S. euphratica* var. *leiocalycina* in B, *S. multicaulis* in C, *S. candidissima* subsp. *candidissima* in D, *S. palaestina* in E, *S. syriaca*-*S. aethiopsis*-*S. ceratophylla* and *S. virgata* in G, *S. frigida*-*S. verticillata* subsp. *verticillata* and *S. russelli* in F group (Hedge, 1982). *Salvia* species herbaceous, suffruticose or shrubby perennials, rarely biennial or annual, often strongly aromatic. Stems erect or procumbens, glandular, eglandular or glabrous. Leaves undivided, lyrate or pinnatisect. Inflorescence of variously arranged cymes.

Verticillasters (1)2-10(40) flowered, distant or approximating. Calyx campanulate, infundibular or tubular, bilabiate; upper lip tridentate, obsoletely so or subentire; lower bidentate; fruiting calyx slightly or clearly expanded in fruit and then membranous. Corollas white, yellow, pink, blue or violet, bilabiate (Hedge, 1982). Structure of the vascular bundles in petioles, an important structure in the Lamiaceae family for species identification (Metcalf and Chalk, 1972). Furthermore, the stamen features of the *Salvia* genus, an important characters in systematic (Hedge, 1982). *Salvia* is separated from other members of tribe Mentheae on the basis of its unusual staminal structure. Which Mentheae have four stamens, *Salvia* expresses only two, and two thecae on each stamen are separated by an elongate connective. The staminal structure in *Salvia* is often associated with an unusual pollination syndrome in which the pollinator pushes against the posterior anther theca while accessing a nectar reward at the base of the corolla tube, causing the anterior theca to deposit pollen on the pollinator via a lever-like mechanism (Claben-Bockhoff et al., 2003). The assumption among previous researchers has been that this peculiar pollination mechanism has only evolved once within the Mentheae, and thus, *Salvia* is monophyletic. Volatile oil provides a characteristic special fragrance of many *Salvia* species (Stace, 1991). *Salvia* species are used in traditional medicines all around the world, possessing antioxidant, antidiabetic,

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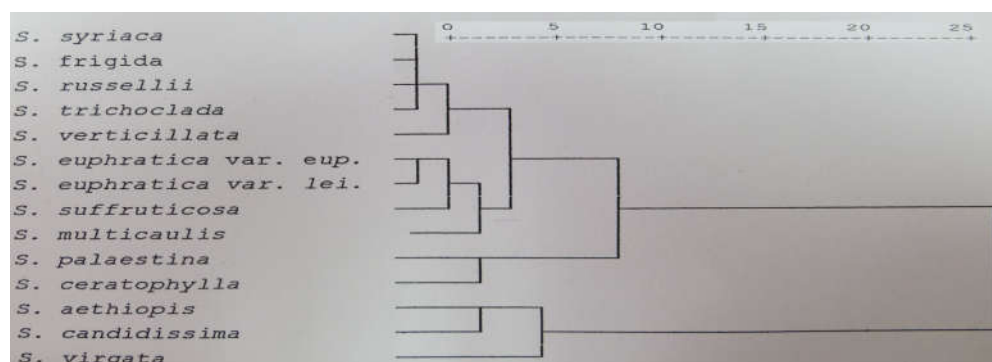


Figure 1. General cluster analyzes of studied *Salvia* taxa

antibacterial, antitumor, antiplasmodial and anti-inflammatory features (Kamatou *et al.*, 2008). Many *Salvia* species are used as herbal tea and in food, cosmetics, perfumery and the pharmaceutical industry (Baylac and Racine, 2003). There are a number of studies on anatomy (Kahraman *et al.*, 2009), trichome morphology and palynology (Aktaş *et al.*, 2009) of the genus *Salvia*. Metcalfe and Chalk (1972) emphasized that *Salvia* is the genus that has the largest number of glandular trichomes of the Lamiaceae family. Furthermore Metcalfe and Chalk (1972) reported that the taxonomic significance structure of the trichomes is well known in the Lamiaceae and related families. However, the anatomical, palynological and trichome structure of most *Salvia* species in Turkey have not yet been investigated. With the present study we aim to clarify the morphological differences and taxonomic relationship between some *Salvia* taxa growing naturally in some parts of Eastern Anatolian Region of Turkey. Morphologic and morphometric characters have been observed and calculated to determine infraspecific relationships between *Salvia* species and their populations.

The study also aims to show the morphologic and morphometric variation between studied taxa. For this purpose, numerical taxonomic methods were applied to obtained characters from *Salvia* taxa. The results and numerical data's have given some clues on the systematic position and intraspecific variation and relationships of the genus patterns. The results were also have been classify and discuss thoroughly taxonomic methods. So borders of interspecific and intraspecific morphologic variation have been determined and these results compared to Flora of Turkey and other studies. Also this study has contributed to a certain extent on *Salvia* taxonomy. New data on the corollaries and different characters of the investigating taxa have been obtained. In addition, basic data have been obtained which will form future systematic, ecological and vegetative research resources about *Salvia* taxa.

MATERIALS AND METHODS

Collecting Samples: 14 *Salvia* taxa were collected from different localities in the vegetation periods of 2004-2006 years. The identification of the specimens were done according to the Flora of Turkey and Herbarium specimens; these specimens were deposited in Firat University Herbarium (FUH). Some locations of plant samples as follows: *S. trichoclada*: Elazığ-Baskil road, 10-15. km right of road, 24.05.2003, HE.-1003. *S. suffruticosa*: Elazığ-Diyarbakir road, 20. km right of road, 01.06.2002, HE.-1010. *S. euphratica* var.

euphratica: Malatya-Konak road, Horata promenade, 19.05.2004, HE.-1013. *S. euphratica* var. *leiocalycina*: Malatya University campus, top of observatory, 22.05.2004, HE.-1014. *S. multicaulis*: Elazığ- above Harput center, 24.05.2003, HE.-1017. *S. syriaca*: Elazığ-Baskil road, 10-15.km, 24.05.2003, HE.-1024. *S. palaestina*: Elazığ-Keban road Cip village, 2.km, 08.06.2004, Bağci, 2004. *S. aethiopsis*: Hankendi road 30.km, 11.06.2004, HE.-1035. *S. ceratophylla*: Elazığ-Bingöl road, 04.06.2003, HE.-1037. *S. frigida*: Elazığ-Sivrice road, 21.km, 03.06.2003, HE.-1044. *S. candidissima* subsp. *candidissima*: Sivrice-Kurk village, 03.06.2003, HE.-1047. *S. virgata*: Malatya-Battalgazi village, 22.05.2004, HE.-1048. *S. verticillata* subsp. *verticillata*: Elazığ-between Baskil Keban road, 18.06.2004, HE.-1050. *S. russellii*: Elazığ-Sivrice, Gözeli road 7. km, 19.06.2003, HE.-1052.

Morphologic and Morphometric Analysis: We selected undertaken specimens according to the following criteria: well-preserved specimens; well-developed spikes with open flowers and ripe fruits. The morphometric analysis was carried out by measuring 54 morphological characters (Table 1). Morphological characters selected according to two criteria: (a) their common use for taxonomic identification in *Salvia* groups (A-B-C-D-E-F-G); (b) the variability among different taxa observed in a preliminary review of collected samples. Binocular microscope were used to determined morphologic and morphometric characters of the *Salvia* specimens. Qualitative characters were coded and measured and then these characters calculated with some techniques to obtain morphometric data's. After determination morphologic and morphometric characters, all the plant populations were examined on account of these characters. List of macromorphological characters and their codes for the numerical taxonomic analysis is seen Table 1. Morphologic-morphometric properties of *Salvia* taxa and their characters codes is seen Table 2. A key for determination of the studied species has been constructed from the resulting tree, on the basis of how the taxa were grouped and which characters were useful for the differentiation of those groups and taxa. The cluster analysis results of *Salvia* taxa was showed in Figure 1. SPSS 10.1 packet program was used for this analysis.

RESULTS AND DISCUSSION

The present study showed that morphological characters such as the number of fertile stamen, type of stamen, properties of indumentum type, shape of corolla and calyx, structure of bract have taxonomic value for *Salvia* taxa. Besides, the results of this study have provide useful information on the taxonomic and systematic relationships in some *Salvia* taxa.

Table 1. List of macromorphological characters and their codes for the numerical taxonomic analysis

Characters	Character positions and codes	
1	Plant length	mm
2	Life form	Perennial : 0, biennial : 1, suffruticose : 2
3	Leaf shape	Simple: 0, Pinnatisect: 1, Pinnatifid: 2, Lyrate: 3
4	Leaf length	mm
5	Leaf width	mm
6	Petiol length	mm
7	Leaf lamina shape	Ovate: 0, oblong: 1, cordate: 2, lanceolate: 3, elliptic: 4, suborbicular: 5, lyrate: 6
8	Leaf blade base	cordate: 0, cuneate: 1, asymmetric: 2, truncate: 3, rounded: 4, attenuate: 5, acute: 6
9	Leaf margin	Entire : 0, serrulate : 1, serrate : 2, crenulate : 3, erose : 4, undulate : 5
10	Leaf apex	Acute: 0, acuminate: 1, obtuse: 2, cuspidate: 3, mucronulate: 4
11	Leaf indumentum	With hair: 0, not hair: 1
12	Leaf hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5, stellate: 6, papillose: 7, pannose: 8
13	Stem shape	Erect : 0, ascending : 1, procumbent : 2
14	Stem branches	not branched: 0, branched: 1, branched at base: 2
15	Stem indumentum	With hair: 0, not hair: 1
16	Stem hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5
17	Inflorescence type	Paniculate: 0, verticillate: 1, candelabriform: 2
18	Inflorescence length	mm
19	Flower cluster number	number
20	Bract length	mm
21	Bract width	mm
22	Bract shape	Ovate: 0, oblong: 1, cordate: 2, lanceolate: 3, elliptic: 4, suborbicular: 5, obovate: 6, orbicular: 7
23	Bract base	cordate: 0, cuneate: 1, asymmetric: 2, truncate: 3, rounded: 4, attenuate: 5, obtuse: 6, connate: 7
24	Bract margin	Entire : 0, crenulate: 1, crenate: 2, crenulate : 3, erose : 4
25	Bract apex	Acute: 0, acuminate: 1, obtuse: 2, cuspidate: 3, mucronulate: 4
26	Bract bottom face indumentum	With hair: 0, not hair: 1
27	Bract bottom face hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5, stellate: 6
28	Bract upper face indumentum	With hair: 0, not hair: 1
29	Bract upper face hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5, stellate: 6
30	Flower number	number
31	Bracteole	Present: 0, Absent: 1
32	Calyx colour	Green: 0, violete: 1, yellow-green: 2, green violet: 3, violet blue: 4
33	Calyx shape	Tubular: 0, infundibular: 1, campanulate: 2
34	Calyx length	mm
35	Calyx lobe length	mm
36	Calyx indumentum	With hair: 0, not hair: 1
37	Calyx hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5, papillose: 6
38	Calyx teeth	With teeth: 0, not teeth: 1
39	Calyx teeth length	mm
40	Corolla bottom lip length	mm
41	Corolla upper lip length	mm
42	Corolla colour	white: 0, yellow: 1, violet: 2, blue: 3, pink: 4, lilac: 5, cream: 6
43	Corolla length	mm
45	Corolla tube	Straight: 0, annulate: 1, ventricose: 2
46	Stylus length	mm
47	Stigma shape	bifurcated: 0
48	Anther length	mm
49	Connective length	mm
50	Filament length	mm
51	Filament indumentum	With hair: 0, not hair: 1
52	Pedicel length	mm
53	Pedicel indumentum	With hair: 0, not hair: 1
54	Pedicel hair type	Tomentose: 0, lanate: 1, pilose: 2, villose: 3, hirsute: 4, pubescent: 5

The most obvious common feature of A and B group is, they have pinnatisect or trisect leaves. The most important feature of A group is; segment apex of leaf is linear-oblong or obovate and petiol with long white eglandular ciliate hairs. The most important feature of B group is; terminal leaf segment is broadly oblong-ovate or obovate and petiol without ciliate hairs. Common features of between C, F and G groups are; have simple, lyrate or pinnatifid leaves. Distinctive features of C group; fruiting calyces membranous-reticulate, infundibular with widely spreading rounded lobes. The common feature of D,E,F and G groups have fruiting thick-textured calyces, tubular to infundubular with erect or spreadind acut lobes. Features of D group is to have more than 20 mm corolla and squamulate, ventricose corolla tube. E group is very similar with D group. The differences between them, in E group, corolla not squamulate. In the F and G groups, corolla less than 20 mm long. In F group flowers are lilac or violet or pinkish.

But in G group flower colours are white, yellow or cream (Table 2). In this study, *S. suffruticosa* which was studied with three populations. Between these populations qalitative characters were similar, but there were observed few differences in qantitative characters (Table 2). These differences arise from leaf and petiol length and number of flower. Our morphological findings generally have been showed similar with Flora of Turkey. *S. tchihatcheffii* also in A group like *S. suffruticosa*. Leaf length and leaf widht of *S. tchihatcheffii* were measured as; 1.4 - 2.50 cm and 0.9-2.0 cm respectively (Aktaş, 2009). On the other hand, we measured average leaf length and leaf widht of *S. suffruticosa* 2.8-1.8 cm (Table 2). *S. tchihatcheffii* were measured as; fertile stem 16-34 cm tall, bract 0.6-2 x 0.5 x 0.8 cm, pedicel 0.30-0.50 cm, and calyx 0.7-1.1 x 0.3-0.5 cm. Unlike that, in here petiole of *S. suffruticosa* 2.5 cm long. Bracts 6x10 mm and ovate, pedicels 4 mm, calyx 10 mm and indumentum with or without villose hairs, corolla yellow and 14 mm (Table 1,2).

Table 2. Morphologic-morphometric properties of *Salvia* taxa and their characters codes

Groups		A	B	B	B	C	D	E	F	F	F	G	G	G	G	
Characters		S. <i>suffruticosa</i>	S. <i>trichoclada</i>	S. <i>euphratica</i> var. <i>euphratica</i>	S. <i>euphratica</i> var. <i>leiocalycina</i>	S. <i>multicaulis</i>	S. <i>candidissima</i> subsp. <i>candidissima</i>	S. <i>palaestina</i>	S. <i>russellii</i>	S. <i>frigida</i>	S. <i>verticillata</i> subsp. <i>verticillata</i>	S. <i>syriaca</i>	S. <i>aethiopsis</i>	S. <i>ceratophylla</i>	S. <i>virgata</i>	
Leaf	Plant length (mm)	355	471.6	375	426	306.9	813	591	510	483	505	470	742.5	490.3	943	
	Life form	0	2	2	2	0	0	0	0	0	0	0	1	1	0	
	lamina shape	1	1	0	0	0	0	3	0	0	0	0	0	0	2	0
	length (mm)	28	25.6	30	27.6	26.9	80.6	87.5	49.4	66.5	55	77	192.5	160	100	
	width (mm)	10.8	13.2	14	12	15.3	73.2	28.3	16.5	20.8	27.5	48	92.5	42.4	45	
	Petiol length	25.0	24.9	10	8.6	33.3	81.5	74.9	36.2	44.2	25.4	33	92.5	-	34	
	Lamina shape	0	1	0	0	0	0	1	1	1	0	0	0	1	0	
	Lamina base	1	1	0	0	0	0	0	1	1	0	0	0	6	0	
	Leaf margin	1	1	3	3	3	4	4	3	4	2	1	4	5	4	
	Leaf apex	0	0	0	0	2	3	2	0	2	0	0	0	2	0	
	Up. face indum.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Up. hair type	2	2	1	1	6	5	0	2	1	3	5	1	1	2	
	Bot. face indum.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bot. face hair type	2	2	1	1	6	8	0	2	1	3	5	1	1	2		
shape	1	0	1	1	0	0	0	0	0	0	0	0	0	0		
Branches	2	2	2	2	0	0	2	2	2	1	2	0	2	0		
indumentum	1	0	0	1	0	0	0	0	0	0	0	0	0	0		
Hair type	-	3	3	-	3	1	4	5	2	3	5	1	3	2		
type	1	0	1	1	1	0	0	1	0	1	0	2	0	0		
Inflo resce	length (mm)	109	246.9	180	216	175.7	480.5	422	268.7	283	172.5	293	452.5	374.4	470	
	Flower heap number	4.6	6.6	6.5	6.3	6.1	13.8	13.3	9.3	9.8	6.7	12.4	11.5	12.6	20.6	
	height (mm)	10.3	29.1	21.5	20.6	12	6.4	16.2	8	10	6.2	7.5	10.5	15.5	8.3	
Bract	width (mm)	6.3	14.8	23	19.6	9	7.9	14.2	3.3	9	4	5.4	13.2	13.6	4.3	
	shape	0	0	0	0	0	0	0	0	7	0	0	6	0	0	
	base	7	0	6	6	7	0	7	3	6	3	0	7	7	7	
	margin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	apex	1	1	0	0	1	1	1	1	1	1	1	3	3	1	
	Up. face indum	0	0	0	1	0	1	0	0	0	1	0	0	0	0	
	Up. face hair type	2	2	3	-	2	-	2	2	2	-	5	2	2	2	
	Bot. face indum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	Bot. face hair shape	3	2	3	-	6	5	3	2	3	2	5	3	3	2	
	Flower number	7	8	6	5	11.6	6	5.9	29.5	5	30	5.4	6	5.5	5	
	Bracteol	0	0	1	1	0	1	1	1	1	1	1	1	1	1	
	Colour	0	3	3	3	1	0	0	1	0	4	0	0	0	1	
	Shape	2	0	2	2	2	2	0	0	1	0	0	0	2	2	
Calyx	length (mm)	10.8	13.7	24	23	15.9	13.6	17.4	5.8	8	6	8	13	14.8	10	
	Lobe height (mm)	5	8.2	20	17	14.3	8.5	11.6	4.8	4.6	5	4.7	9	8.3	6.5	
	indumentum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	Hair type	3	3	5	-	3	2	6	2	3	3	5	1	3	2	
	Teeth status	1	0	1	1	1	0	0	1	0	0	0	0	0	0	
	Teeth length (mm)	-	0.5	-	-	-	1.3	0.9	-	1	0.5	1.2	1	1.6	1	
	Bottom teeth height (mm)	19.3	19.9	28	30.6	12.8	18.5	19.1	8.8	9.2	10	9.6	9.5	14.1	11	
Corolla	upper teeth length (mm)	21.4	22.7	34	35.6	15.7	27.2	24.5	11	12.8	11.5	10.1	11.5	19.1	14	
	colour	1	2	4	4	3	7	5	3	0	3	0	0	6	3	
	Length (mm)	4	10	20	20	6	10	8.2	3.5	4	3	4.5	2	7.8	4	
	Tube shape	1	1	1	1	0	2	0	0	1	0	0	2	2	2	
	Stylus height (mm)	24.8	23.9	34.5	35.3	15.4	45.2	35.8	12.3	14.8	12.3	11	16.7	31	18.6	
	Stigma shape	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stamen	Anther length (mm)	3.7	1.8	2	2	1.6	4	2.7	1	1.6	1.7	1.1	2	3.4	2	
	Connective length (mm)	7.6	4	5	6	2	24.2	13.9	2.6	6.3	2.6	2.2	6.5	15.1	10	
	Filament length	5	4.3	5	6.3	2.4	3.2	3.1	1.3	1.8	1.3	3	3	3	2	
	Filament indumentum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Pedicel	length (mm)	4	3.4	7	5.3	3.2	3.4	3.9	4.3	2.6	4.3	3.7	1.8	3.8	2.4	
	indumentum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	hair type	3	2	3	-	3	2	3	2	2	3	5	1	3	2	

S. trichoclada was studied with seven populations. Leaf, flower, corolla, calyx and stamen features of *S. trichoclada* are similar with our study while bracts length have been measured approximately 20 mm (Çobanoğlu *et al.*, 1992), on the other hand in our study bracts length was detected approximately 29.1 mm (Table 2). Our morphological findings on *S. trichoclada* were compared with Flora of Turkey's, and we were observed that corolla length in Flora of Turkey 20-40 mm but in our study we were measured *S. trichoclada*'s corolla length 10 mm (Table 2). In Flora of Turkey leaf length and width are given 12-20 mm and 6-11 mm respectively. Whereas in this study leaf length was 25.6 mm and leaf width 13.2 mm and length and width of bracts measured 29.1 mm and 14.8 mm (Table 2). *S. euphratica* (var. *leiocalycina*; var. *euphratica*) were studied with two different populations and differences of two varieties due to its hair cover; while stem, bracts, calyx and pedicel in *S. euphratica* var. *leiocalycina* without hair; in *S. euphratica* var. *euphratica* has pubescence hair (Table 2). These two varieties except of given characters, there were not showed any morphological differences. *S. trichoclada*, *S. euphratica* var. *leiocalycina* and *S. euphratica* var. *euphratica* in the B group; some important variations (Plant length, bracts height, calyx hair type, corolla colour, pedicel indumentum and pedicel hair type) can be seen among three taxa of B group (Table 2). *S. multicaulis* were studied with seven different populations. Between these populations there weren't any differences about qualitative characters, but there were observed little differences in quantitative characters (Table 2). In Flora of Turkey bracts of *S. multicaulis* broadly ovate and about 15x10 mm, in here bracts measured about 12x9 mm (Table 2). In this study *S. multicaulis* 9-13 flowered, unlike that in Flora of Turkey *S. multicaulis* is 4-10 flowered. In this study, only *S. candidissima* subsp. *candidissima* in D group and was studied with three different populations, these populations were parallel in terms of qualitative characters with Flora of Turkey, but there were some differences in quantitative characters. Morphological characters of *S. candidissima* were observed similar with Flora of Turkey. *S. sclarea* L. and *S. argentea* L. is the same group with *S. candidissima* subsp. *candidissima*. Özdemir and Şenel (1999), reported morphological properties of *S. sclarea* as; the stem is 50-100 cm tall and very clear rectangular in shape. Stem is erect, ascending, and it is branched toward the top.

The upper part of stem is covered by glandular hair which has essential oil. The lower part of stem is pubescent to hirsute. This hair gives gray-white colour to stem. Leaves of *S. sclarea* are simple and broad. They are ovate to ovate-oblong. The petiole is 3-9 cm length. Glandular and eglandular hair is present on the surface of petiole. Inflorescence is paniculate, flowers are zygomorphic symmetric. The flowers are arranged verticillately on plant and 2-6 flowers are present at verticillares. Flowers are at the base of bracts. Pedicel is 2-3 mm length. The shape of the calyx is ovate-campanulate. Calyx has numerous glandular and hard eglandular hair. Corolla is 20-30 mm length. Upper lip is lilac, lower lip is cream. The filament is 10-15 mm length and anther is 2-4 mm length. The stigma is bifurcate and 15-35 mm length. Bracts are 15-35 x 10-25 mm. Unlike that, in here stems of *S. candidissima* subsp. *candidissima* up to 81 cm tall, erect, not branched as mentioned above. The stem indumentum lanate. Petiole 8 cm length. Pedicels up to 3.4 mm length. Calyx 13.6 mm length, up to 20 mm in fruit and campanulate. Calyx has glandular-pilose hair (Table 1-2). Furthermore, some

morphological variations can be seen between *S. sclarea* and *S. candidissima* subsp. *candidissima* (Table 1-2). Morphological measurements plant organs of *S. argentea* (Baran *et al.*, 2008) and *S. candidissima* subsp. *candidissima* (Table 2) generally are overlapping, except of some little measurements. *S. palaestina* were studied with seven different population. No more differences were found in these populations, but we observed some qualitative differences. In Flora of Turkey bracts of *S. palaestina* were reported as 15x18 mm long but we determined 16x20 mm (Table 2). Furthermore, corolla colour of *S. palaestina* is lilac or whitish-lilac in Flora of Turkey, unlike that in this study we found it lilac (Table 1-2). Also in Flora of Turkey (Hedge, 1982) pedicel length 2-5 mm, but in our study we measured pedicel 3.9 mm (Table 2). Stems of *S. glutinosa* L. (in the same group with *S. palaestina*) up to 1 m tall, erect, branched above, stem indumentum sparsely eglandular and glandular pilose to villous, petiole 4-11 cm, pedicel up to 5 mm long, calyx 10-14 mm long, up to 20 mm in fruit, tubular to campanulate, calyx indumentum densely glandular-villous (Kahraman *et al.*, 2009). It is noteworthy that, in this study stem length of *S. palaestina* was 59.1 cm unlike of *S. glutinosa* (1 m) (Kahraman *et al.*, 2009). The stem of *S. hypargeia* Fich. and Mey. is 25-60 cm long, leaves are simple and mostly basal, inflorescence is raceme (Kandemir, 2003); on the other hand, *S. verticillata* subsp. *verticillata* is c. 50 cm long and erect; leaves are simple, inflorescence is verticillaster (Table 2). *S. russellii*, *S. frigida* and *S. verticillata* subsp. *verticillata* are in the F group. Between these taxa some differences can be seen in the petiole length, lamina shape, lamina base, leaf apex, bract shape and flower number (Table 2). *S. ceratophylla*, *S. virgata*, *S. syriaca* and *S. aethiopsis* are in the same group (G) in the Flora of Turkey. In Flora of Turkey *S. ceratophylla* 2-5 flowered, whereas in here 5-6 flowered (Table 2).

Qualitative characters of *S. virgata* which detected by Eroz (2001), similar with our study, but in terms of quantitative characters there were some differences from our study. While in the study of Eroz (2001) bracte 3.5-7 mm, calyx 5-9 mm and corolla 9-22 mm; in this study bracte 8.3 mm, calyx 10 mm and corolla 11-14 mm (Table 2). In Flora of Turkey leaves of *S. syriaca* simple, ovate, cordate, c. 6-13 x 4-8 cm; bracts ovate, c. 5x5 mm; pedicel 3-4 mm; calyx tubular 5-7 mm, densely eglandular or glandular-pubescent; corolla white c. 10 mm. In this studied leaves of *S. syriaca* c. 2.7 x 1.5 cm; bracts broadly ovate, c. 9x12 mm; pedicel 3.2 mm; calyx campanulate with villose hair; corolla blue 6 mm long (Table 2). In Flora of Turkey *S. aethiopsis* 25-60 cm, calyx c. 12 mm and petiole is 4-9 cm length, but in our research plant 74.2 cm, calyx c. 13 mm and petiole 9.3 cm long (Table 2). In addition, in this study morphological features of *S. aethiopsis* similar with Eroz (2001) research. Petiole of *S. staminea* (which is in the G group) Montbret and Aucher *ex* Benth. is 0.5-9.0 cm, bracts 2-15 x 4-10 mm broadly ovate; pedicel 2-3 mm, calyx 6-8 mm up to 12 mm, in fruit tubular campanulate, upper lip tridentate, equal to or shorter than lower. Calyx indumentum densely glandular or eglandular pilose with or without long flattened glandular hairs; corolla white to pale yellow, 12-16 mm, tube almost 5 mm, ventricose, squamulate, upper lip nearly straight and narrow (Kahraman *et al.*, 2009); whereas petiole, leaf length, lamina shape, lamina base, bract, calyx shape and pedicel hair types of *S. ceratophylla*, *S. virgata*, *S. syriaca* and *S. aethiopsis* have conspicuous differences (Table 2). Macromorphological properties of *Salvia* taxa are useful at both infrageneric and species level. The infrageneric

delimitation of *Salvia* is performed using multivariate analysis. The morphometric analysis was carried out by measuring 54 morphological characters (Table 1). Cluster analyses of *Salvia* taxa and populations are seen in Figure 1-2. In Figure 1, morphological characters of *S. syriaca*, *S. frigida*, *S. russellii* and *S. trichoclada* species were found to be near and located in the same cluster very similar; *S. verticillata* was detected nearest from these species and was located in the cluster. Except *S. trichoclada* (in the B group), other *Salvia* species have general properties of F and G groups; so these two groups can be combined in the one group with further researches. *S. euphratica* subspecies which were in the first big cluster because they have very similar characters and were found to be expected cluster; except *S. suffruticosa* (A group), *S. multicaulis* and *S. euphratica* subspecies were in the same group; different from others. *S. palaestina* (E group) and *S. ceratophylla* (F group) were in the same small cluster and combined with the big cluster on a level of much similarities. Last triple cluster *S. aethiopsis*, *S. candidissima* and *S. virgata* combined with other cluster (includes 11 taxa) with very similarities. If we accept *S. virgata* and *S. aethiopsis* in the F group, in this triple cluster *S. candidissima* (D group) was seen different. This research is sustainable to investigate relationships within this important group of plants, and we believe it is premature to present any taxonomic rearrangements diversity of *Salvia* and related genera. Consequently in this study, some quantitative differences have been shown between interpopulation and intrapopulations. We can say these differences arise from ecological conditions and distance of locations from each other. Also we can say that, this study like a small revision; *Salvia* species which naturally spreaded Elazığ and Malatya vicinity have been shown some variations in interspecific - intraspecific and interpopulation-intrapopulations level. This feature is an important aspect of our study. Furthermore this study provides important clues about phenetic resemblances of the species. Generally in the dendrogram (Figure 1), all of the examined *Salvia* taxa have been shown convenience with the group differentiation in Flora of Turkey. Obtained dendrogram has given meaning results in respect to infrageneric and interspecific relationships. Other dendrogram (Figure 2) which includes 53 populations of studied 14 *Salvia* taxa is very important in terms of having not showed very big variations.

Conclusion

In conclusion, this research includes macromorphological, morphometric and numerical analysis. With this research macromorphological characters that were considered to have taxonomically diagnostic value are studied and their possible variations are evaluated. Life form, stem, leaf, bract, inflorescence, calyx, pistil, corolla, pedicel and stamen properties of the genus are compared at both infrageneric and species level. The results showed that some characters such as leaf shape, number of flowers in each verticillasters, plant-leaf-calyx-corolla length and shape, colour of calyces and corollas, calyx structure and stamen type are of taxonomic value. In this research grouping generally overlaps with the Flora of Turkey; but due to different blind F and G group in the dendrogram, they may be combined if reviewed again. Obtained results are very important due to systematic of genus and aromatic properties of studied and in the next researches with *Salvia* taxa.

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