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Evaluation of Biochemical and Dimensional Properties of Naturally Grown *Capparis spinosa* var. *spinosa* and *Capparis ovata* var. *palaestina*

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***Abstract* – The caper plant is native to the Mediterranean Countries. In this study some nutritional, biochemical and dimensional properties of flower buds of *Capparis spinosa* var. *spinosa* and *Capparisovata* var. *palaestina*,naturally grown in Turkey, were investigated. *C. spinosa* var. *spinosa* has predominate values in terms of dry matter, crude ash, crude protein, crude oil, total carotenoid, total phenolic content, antioxidant activity and sugar composition. Statistically differences were found among them. Antioxidant activity of *C. ovata* was found stronger than *C. spinosa* although amount of total phenolics was higher in *C. spinosa.* To the best of our knowledge there are no reports on glucose, fructose and saccharose contents of *C. spinosa var. spinosa* and *C. ovata var. palaestina* and this is the first report on their sugar values. *C. spinosa* var. *spinosa* can be recommended for animal feeding since it has more glucose, saccharose and fructose content than *C. ovata* var. *palaestina*. Findings of present research can be important in order to reveal to using possibility of these two species in human consumption or animal feeding as well as using for cosmetic and medical industries.**

***Keywords* – Biochemical Properties, *Capparis spp*, Dimensional properties, Nutritional-Pomological Properties.**

Abbreviations used: *L* (length), *W* (width), *T* (thickness), *Da* (arithmetic mean diameter), *Dg* (geometric mean diameter), *Ø* (sphericity), DPPH (2,2, diphenyl 1-picrylhydrazyl).

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I. Introduction

Caper plants belong to *Capparidaceae* family which contains about 350 species [1] and according to Lawrence [2], they distributed throughout the tropics in Africa, Asia and America and some subtropical regions in all over the world [3] besides it can be grown in desert regions like as Punjab, Karnataka and Sind [4]. It is supposed that *Capparis spinosa* var. *spinosa* is a hybrid, spontaneously originated from *C. orientalis* and *C. sicula* [5]. *Capparis* spp. is one of the important plants for Mediterranean countries because of its high tolerance to marginal environmental conditions such as poor soil and high temperature [6, 7]. Lands all around the word suffer from severe and very severe erosion and reported that 26% of the world's land has been damage due to improper use [8].

Production of caper plant has been increased due to economic importance during the late 1980s. Nowadays, there are four major producer countries (Spain, Morocco, Turkey and Italy) in the world [9]. *Capparis spinosa* var. *spinosa* and *Capparis ovata* var. *palaestina* are naturally grown in Mediterranean region. The importance of the caper plant has increased on account of it is an alternative crop to marginal environmental conditions, economical value and can be useful soil erosion. Caper can be grown in the regions described as unsuitable for agricultural activities. Consumption of caper gets desirable to person because of its natural growing conditions, without any pesticides and fertilizers. It is also known that unopened flower buds of caper are consumed and used as a food by human and animals as well as for cosmetic and medicine industry. Caper also contains considerable amounts of the anti-oxidant bioflavinoid rutin [10].

It is important determine the biochemical properties of caper species. The present study is, therefore, conducted to reveal the firstly nutritional and biochemical properties of *Capparis spinosa* var. *spinosa* and *Capparis ovata* var. *palaestina* and secondly pomological and dimensional properties determine which are grown naturally in Mediterranean region. It is assumed that finding of the study can be important for human consumption or animal feeding as well as using for cosmetic and medical industries.

II. Materials and Methods

A. Plant Material

Buds of *Capparis spinosa* var. *spinosa* and *Capparis ovata* var. *palaestina* were collected from natural habitat (36º56.589'N- 30º40.423'E) in Mediterranean climate. A total of 1000 buds of every species were gathered. 100 buds were randomly selected for each experiment and analyses were conducted with three replications.

B. Determination of Biochemical and Pomological Properties

Total dry matter, total nitrogen, total oil and total ash of the samples were determined according to a spectrophotometric method [11]. Total carotenoid content of the samples was determined according to reference [12]. The free sugar composition of the samples was performed according to reference [13] chromatograpically with slight modifications while the total phenolic contents of the samples were determined spectrophotometrically [14]. Determination of total antioxidant activity was performed according to the DPPH (2,2-diphenyl-1-picrylhydrazyl) method [15,16,17]. The results were expressed as IC_{50} (mg sample per mg DPPH), amount of the sample that causes 50% scavenging of DPPH radical.

C. Determination of Nutrition Values

Analytical determination of P, K, Fe, Mn, Zn, Ca and Mg was carried out by ICP-OES spectrophotometer and N value was determined by modified Kjeldahl method [18].

D. Determination of Dimensional Properties

To determine the size dimensions of the caper buds, 100 buds were randomly selected. Measurements of length (*L*), width (*W*) and thickness (*T*) were made with micrometer to an accuracy of 0.001 mm at natural moisture content. The arithmetic mean diameter (*Da*), geometric mean diameter (*Dg*) and sphericity (*Ø*) of the buds were calculated by using following formula [19].

E. Statistical Analysis

The experiment was designed according to completely randomized with three replications and data analysis was carried out using the analysis of variance and SAS statistical computer package ($p \leq 0.05$) [20]. Nutrition values were analyzed using SPSS 23.0 version. Correlations were obtained by Pearson correlation coefficient in bivariate correlations.

III. Results and Conclusions

Table 1. Some biochemical properties of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina*

Subspecies	Total phenolic (mg/kg)	Total carotenoid (mg/kg)	Antioxidant activity IC_{50} (mg/mg DPPH)	Glucose (mg/kg)	Fructose (mg/kg)	Sacharose (mg/kg)
C. spinosa var. *spinosa*	2465.56 a	21.24 a	32.88 a	8113.42 a	14546.0 a	3653.07 a
C. ovata var. *palaestina*	2183.44 b	19.76 b	31.04 b	6378.19 b	10751.6 b	2712.59 b
$LSD_{\%5}$						

Table 2. Some pomological properties of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina*

Subspecies	Dry matter (%)	Crude ash (%)	Crude protein (%)	Crude oil (%)
C. spinosa var. *spinosa*	23.05 a	1.91 a	9.45 a	7.35 a
C. ovata var. *palaestina*	21.21b	1.63 b	7.58 b	6.63 b
$LSD_{\%5}$	1.1834	0.2755	0.6085	0.2755

Biochemical and pomological properties of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina* were presented in Table 1 and Table 2, respectively. Crude oil, total carotenoid, dry matter, Zn and especially Fe contents of buds of both species use in this study were higher than the findings of reference [21] and reference [22]. Phenolic compounds which are believed to prevent many diseases and helpful to human health are excessive desire for consumption in food industry [23]. Plants contain the polyphenolic compounds may exhibit anticarcinogenic or cardioprotective effect as antioxidants [24]. The amount of total phenolics differed significantly between varieties. Total phenolic content of *C. spinosa* and *C. ovata* were found as 2465.56 mg/kg FW and 2138.44 mg/kg FW, respectively. Reference [25] found that the total phenolic content of methanolic extracts of Caper berries from different locations in the main island of the Kingdom of Bahrain ranged from 90 to 210 mg GAE/ 100 g FW. Similarly, reference [26] were determined lower total phenolic content in *C. spinosa* L. samples (37.01 mg GAE/100 g DW) obtained from Turkish herb markets. [27] reported extremely high amount of total phenolic compounds in *C. ovata* L. as 185.54 mg GAE/g DW. Also, according to the results of reference [28] total phenolic content ranged from 1151.6 to 2243.96 mg/100 g FW. In another study [29] amount of total phenolics varied from 64 to 120 mg/g in the extracts of *Capparis sicula* subsp. *sicula* and *Capparis orientalis* that were collected in Italy. The results in different studies may show discrepancy because of using different extraction methods for determination of total phenolics.

Antioxidant activities of the methanolic extracts were found to be 32.88 and 31.04 mg DW/mg DPPH for *C. spinosa* and *C. ovate*, respectively. According to the results of different researchers, *Capparis ovata* L. [27] and *Capparis spinosa* L. [30] were declared as a good antioxidant source with IC_{50} values of 4.082 mg/ml and 177.451µg/ml, respectively. In another study DPPH radical scavenging activity of *Capparis spinosa* L. was determined as 0.32 mg/ml [26]. Reference [25] reported that the amount needed to achieve 50% DPPH inhibition (IC_{50}) from *Capparis spinosa* samples ranged between 2.1 to 5.8 mg. Due to the differences in expression units, comparison of results obtained in this study with those reported in the literature is difficult. As stated by reference [27] and reference [26], the genetic structure of plants and environmental-geographical factors or/and using different analysis methods may lead to different results.

Table 3. Correlations between total phenolic contents, antioksidant activity and total carotenoid

	Total phenolic (mg/kg)	Antioxidant activity IC_{50} (mg/mg DPPH)	Total carotenoid (mg/kg)
Total phenolic (mg/kg)	1	.857	.966*
Antioxidant activity IC_{50} (mg/mg DPPH)	.857	1	.934
Total carotenoid (mg/kg)	.966*	.934	1

* Correlation is significant at the 0.05 level.

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Table 4. Correlations between glucose, fructose and Sacharose

	Glucose (mg/kg)	Fructose (mg/kg)	Sacharose (mg/kg)
Glucose (mg/kg)	1	1,000**	-1,000**
Fructose (mg/kg)	1,000**	1	-1,000**
Sacharose (mg/kg)	-1,000**	-1,000**	1

** Correlation is significant at the 0.01 level.

Correlations between total phenolic contents, antioksidant activity and total carotenoid were presented in Table 3. As the results, total phenolic and total carotenoid were positively correlated (R^2 = .966, p<0.05).

According to the findings in this study, antioxidant activity of *C. ovata* was found stronger than *C. spinosa* although amount of total phenolics was higher in *C. spinosa*. This result can be attributed to differences in phenolic composition of two varieties. As can be seen from Table 1, *C. spinosa* var. *spinosa* has more glucose, saccaharose and fructose content than *C. ovata* var. *palaestina*. Considering the correlations results (Table 4), glucose and fructose were positively correlated (R^2 = 1.000, p<0.01,). On the other hand, saccaharose and glucose, saccaharose and fructose were negatively correlated. To our knowledge there are no reports on glucose, fructose and saccharose contents of *C. spinosa var. spinosa* and *C. ovata var. palaestina* and this is the first report on their sugar values.

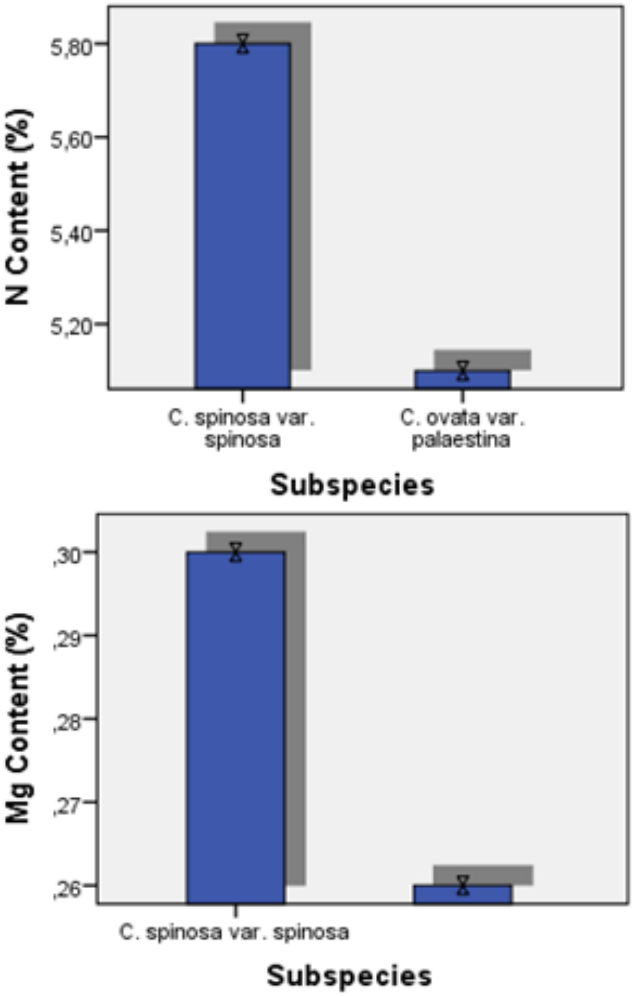
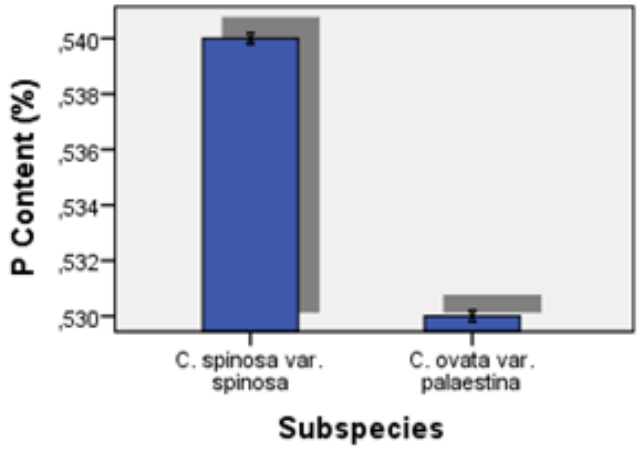
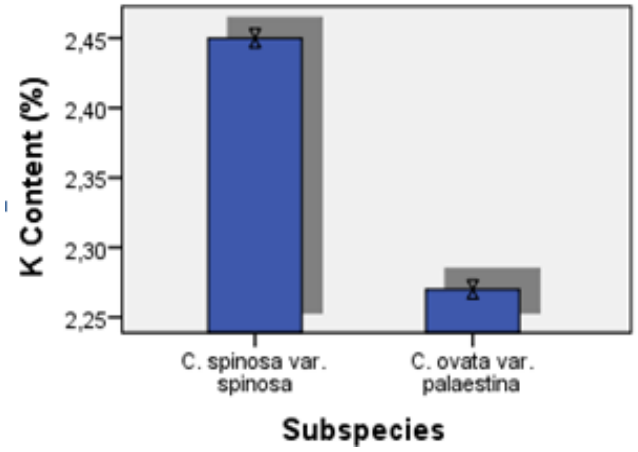
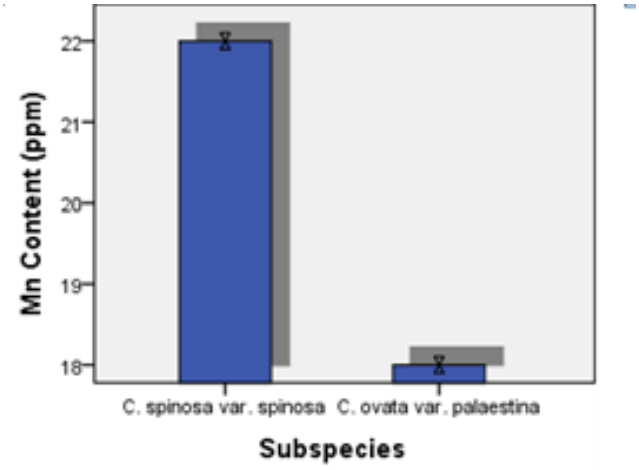


Fig. 1. Macro nutrient content of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina* ($LSD_{\%5}$).







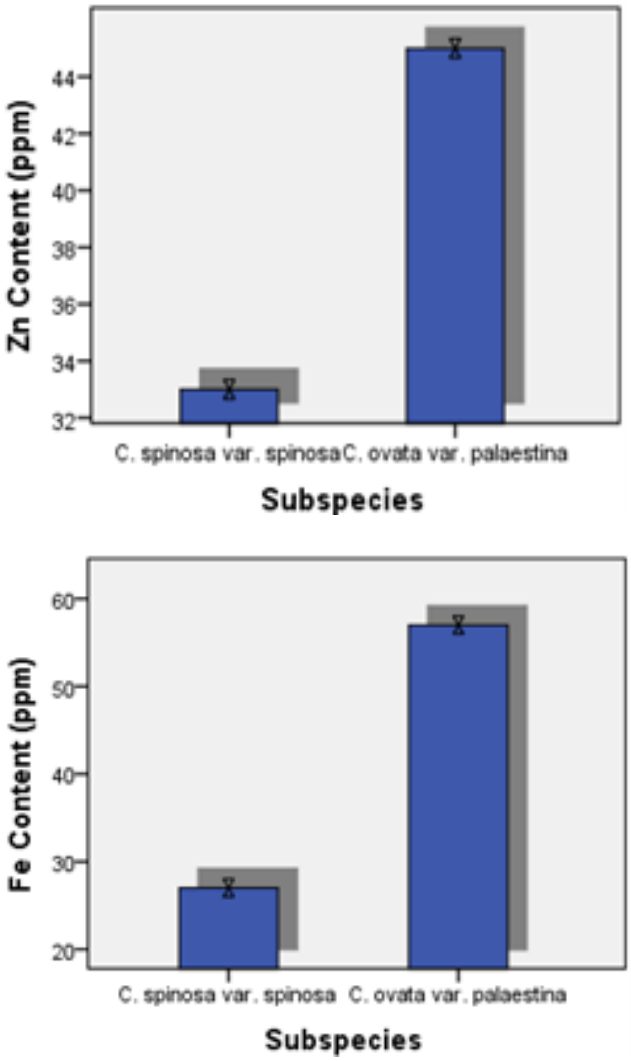


Fig. 2. Micro nutrient content of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina* (Both species containing trace amount of Cu, $LSD_{\%5}$).

The macro-micro nutrient content of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina* were given in Figure 1 and Figure 2. The results showed that the *C. ovata* var. *palaestina* buds were significantly rich in Fe amount. The *C. ovata* var. *palaestina* buds contained 2.1 times more Fe than those of *C. spinosa* var. *spinosa* buds. Next to that, Mn and Zn contents of *C. spinosa* var. *spinosa* buds were higher than those of *C. spinosa* var. *spinosa* buds. Results obtained on N, P, K and Cu contents of both species buds were found to be similar to each other. Reference [22], worked on some physical and chemical characters of *C. spinosa* var. *spinosa* and *C. ovata* Desf. var. *canescens* (Coss.) Heywood and reported that June was the most suitable harvest month due to high mineral contents (K, P, Ca, Cu, Fe and Mn), crude protein, crude fiber, ascorbic acid and total carotenoids values of flower buds. Similarly, reference [31] informed that June was more suitable month than other month in terms of analysis on physical and chemical properties of caper. As the caper buds were small but contained more water, crude oil, crude fiber, crude ash, reducing sugar, crude energy, ascorbic acid, total carotenoids and starch values than bigger size buds. Reference [32] examined to mineral contents of different part of *Capparis ovata* Desf. They found that Ca, K, Mg and P contents were very high in caper buds. Mn, Fe and Zn contents were obtained 16.0 ppm in small buds, 10.3 ppm in middle buds and 10.2 ppm in large buds; 55.3 ppm in small buds, 40.4 ppm in middle buds and 39.0 ppm in large buds; 38.6 ppm in small buds, 38.7 ppm in middle buds and 32.5 ppm in large buds. Findings of these present study Mn (18 ppm), Fe (57 ppm) and Zn (45 ppm) were higher than the findings of reference [32].

Table 5. Dimensional properties of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina*

Subspecies	L (mm)	W (mm)	T (mm)	Average Weight (g)	Da (mm)	Dg (mm)	Ø (%)
C. spinosa var. *spinosa*	9.19a	7.51a	9.78a	0.29a	8.81a	8.74a	90.07a
C. ovata var. *palaestina*	8.91a	7.45a	9.60a	0.26a	8.68a	8.62a	89.73a
$LSD_{\%5}$							

The average values of length, width, thickness, average weight, geometric mean diameter, arithmetic mean diameter and sphericity were calculated in both subspecies of caper and statistical results were given in Table 5. According to the results, buds of *C. ovata* var. *palaestina* are smaller than of *C. spinosa* var. *spinosa* but there is no statistically significant difference between them. These findings were in agreement with reference [33] for caper buds. According to reference [33], length, width, thickness, geometric mean diameter and sphericity of buds were increased linearly with the increase in moisture. Although the results of present study on physical properties of the species were slightly higher than reference [33], generally most of the results were similar were in agreement with their findings, on highest moisture content (82.93%). Similar findings were also reported by reference [34] with 82.99% moister content for *C. ovata* Desf. var. canescens (Coss.) Heywood. In the study conducted by reference [22], wide/length of buds and weight of one bud values increased due to late harvest process and they obtained the highest values from buds they harvested in first week of August. However, harvest was done in the first week of July, in this study. It is seen that bud weights are higher compared to reference [22]'s data of July. The study from reference [34] was conducted on *C. ovata* Desf. var. *canescens*, which is a sub-cultivar of *C. ovata*. Buds, collected in July, had lower values in dry matter (17.01%), crude oil (1.35%) and total carotenoid (13.61 mg/kg) contents, although they have a little higher values in dimensional characteristics. Furthermore, there is not any significant difference between these two sub-cultivars in terms of crude protein content (8.72% for *C. ovata* Desf. var. *canescens*; 7.58% for *C. ovata* var. *palaestina*). In another study, *C. spinosa*

buds, collected from Salina Island, were categorized in small, middle and big dimensions and it is determined that, the more bud volume increases, the more dry matter (39.35 %) increases yet protein (4.60%) and crude oil (1.25%) decreases [35]. Recently discussed studies and this study obviously reveal that, optimum harvesting time and dimensions of buds are quite significant due to buds' area of usage (cosmetics, animal feeding and brine etc.), late harvest process expands the bud volume, yet, decreases the biochemical and nutritional contents.

In this study some chemical and physical properties of *C. spinosa* var. *spinosa* and *C. ovata* var. *palaestina* naturally grown in Mediterranean climate were investigated. Although there was no statistically significant difference between two species in terms of dimensional properties, statistically differences were found on some biochemical properties (dry matter, crude ash, crude protein, crude oil, total carotenoid, total phenolic content, antioxidant activity and sugar composition). In addition, *C. ovata* var. *palaestina* buds were significantly rich in Fe amount. *C. spinosa* var. *spinosa* can be recommended for animal feeding since it has more glucose, saccharose and fructose content than *C. ovata* var. *palaestina*. Findings of these present study, in general, can be a good source of guide for those deciding on choosing the right species according to their need.

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