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THE FLAVOR PROFILE OF YOUNG SHOOTS, FLOWER BUDS, AND UNRIPE FRUITS OF CAPERS GROWING WILD IN TURKEY

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Capers of the Capparaceae family are perennial plants having medicinal and aromatic properties. Capers growing wild in various regions of the world have been used for different purposes since ancient times. Certain species and varieties of capers have been cultivated especially in the Mediterranean regions and have become an important economic plant in Italy and Spain for the last three decades [1]. Capers ("beriberi, bubu, gabara, geber, gebre otu, gevil, kabbar, kapri, kebere, kapari" in Turkish) are the flower buds of *Capparis* genus [2]. Pickled flower buds, an important seasoning of mediterranean kitchens, are known nearly throughout the world. [3]. Some published data refer to specific aspects of the qualitative composition of flavonoids, the occurrence of elemental sulfur, and physical and chemical properties [4–11]. Glucosinolates are one group of bioactive components occurring in capers [12].

The purpose of this study was to establish the chemical composition of the essential oils obtained from different parts such as young shoot, flower bud, and fruit of *C. spinosa* and *C.ovata* plants growing wild in Turkey.

Young shoots, flower buds, and unripe fruits of caper plants were gathered from *C. spinosa* and *C. ovata* growing wild in Mersin (Mut) and Konya (Selcuklu) in Turkey in August 2003. The essential oils of all samples were hydrodistilled in portions in a circulatory Clevenger's all glass apparatus for 4 hours. For identification of components, we used an analytical Hp 5890 gas chromatograph equipped with an FID (GC) and a DELSI 121 C apparatus fitted with a flame ionization detector and a CP WAX 51 fused silica column (25 m × 0.3 mm; 0.25 μm film thickness). Temperature was programmed from 50°C for 5 min and programmed to reach 220°C at the rate of 3°C per min. An ACP WAX 51 fused silica WCOT column (60 m × 0.3 mm) for GC/MS was used with helium as carrier gas. For GC/MS a CPWAX 52 fused silica CB column (50m × 0.25 mm) was used with helium as carrier gas (flow rate 1 mL/min) and coupled to a HP mass spectrometer: ionization energy 70 eV. Temperature programming was from 50–240°C at the rate of 3°C/min. The samples were injected at injector temperature 240°C.

The constituents of essential oils of young shoots, flower buds, and unripe fruits of *Capparis spinosa* var. *spinosa* and *Capparis ovata* Desf. var. *canescens* growing wild in Turkey were identified by GC-MS. The constituents identified in the essential oils are listed in Table 1.

The yields of the essential oils of fresh young shoots, flower buds, and unripe fruits from *C. spinosa* and *C. ovata* were 0.064% and 0.081%, 0.02 % and 0.071%, and 0.075% and 0.064% (v/w), respectively. The major components in all samples were methyl isothiocyanate, octasulfur, and ethyl linoleate. Where as methyl isothiocyanate, (*E*)-hexan-2-en. (*Z*)-hexan-3-en-1-ol, and 3,4-bis(methylthio)-1,2,5-thiadiazidine are important components of young shoots of *C. spinosa*, methyl isothiocyanate and octasulfure were identified as major constituents of *C. ovata* young shoot oil.

It was previously reported that the extract of *C. spinosa* contained methyl isothiocyanate, acetonitrile, benzaldehyde, dimethyl trisulfide, octan-3-ol, octanoic acid, cyclooctasulfure, and furfural [10]. In addition to sulfides, isothiocyanates, and other flavor molecules, elemental sulfur was identified for the first time in a non-processed food.

Our results were generally similar to the literature findings with regard to the components. The observed differences are probably due to different environmental and climatological factors that can influence the oil composition.

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TABLE 1. Essential Oil Composition of Different Organs of Caper Plants, %

Components	*C. spinosa*		*C. ovata*	RT	Component	*C. spinosa*		*C. ovata*	RT
	shoot	fruit	bud			shoot	fruit	bud	
Methyl isothiocyanate	26.5	1.1	49.6	3.56	Linalyl acetate	-	0.1	-	18.99
Pentan-2-en-1-ol	0.2	-	-	3.86	Dihydroedulane I	0.4	-	0.3	20.09
2,4,6-Trimethyl-1,3,5-trioxane	0.1	-	-	4.07	Thymol	0.2	0.2	-	20.25
2-Methylbutan-2-en-1-ol	-*	-	0.1	4.31	Theaspirane B	-	-	0.1	20.38
Ethyl isothiocyanate	-	-	0.6	4.69	Carvacrol	-	0.1	0.1	20.47
Propyl isothiocyanate	1.4	-	-	5.31	2-Hydroxy-5-methylbenzoic acid	0.1	-	-	20.77
trans-Hexan-2-enal	2.08	-	0.1	6.01	Theaspirane A	-	-	0.1	20.83
(*Z*)-Hexan-3-en-1-ol	2.1	-	0.2	6.07	Phenylmethyl thiocyanate	0.5	-	0.1	22.15
(*E*)-Hexan-2-en-1-ol	0.4	-	-	6.42	Methyleugenol	0.3	-	-	23.15
Hexyl formate	0.9	-	0.1	6.55	*N,N′*-Dimethylthiourea	1.7	-	1	23.83
Hexanol	-	-	0.8	6.57	Geranylacetone	0.2	-	-	24.33
2,5-Diethyltetrahydrofuran	-	-	0.2	7.47	beta-Ionone	0.9	-	Tr.	25.15
Butane-2-isothiocyanate	0.7	-	1.3	8.51	Ethyl -4-ethoxybenzoate	-	0.6	-	26.23
Isobutyl isothiocyanate	0.2	-	2.9	9.31	Lauric acid	-	1.8	-	27.37
Benzaldehyde	0.3	-	Tr.	9.71	Hexyl benzoate	0.2	-	-	27.58
Dimethyltrisulfide	0.2	-	Tr.	9.91	Caryophyllene oxide	0.1	0.6	-	27.66
Octan-3-ol	-	-	0.5	11.01	Ethyl laurate	-	0.3	-	27.85
Heptadecane-2,4-dienal	-	-	0.1	11.50	3,4-*bis*(methylthio)-1,2,5-thiadiazidine	2.9	-	-	27.91
Methylcarbamothioic	0.5	-	-	11.61	Carotol	-	1.2	-	28.10
acid *O*-methyl ester					Toluene-2-sulfonamide	-	-	0.2	28.72
p-Cymene	0.1	-	0.1	11.88	Cumyl 2-methylbutyrate	-	0.5	-	28.90
Limonene	-	Tr.	Tr.	12.04	Daucol	-	0.5	-	29.04
2-Ethylhexanol	-	-	0.1	12.10	Cumyl isovalerate	-	0.2	-	29.13
1,8-Cineol	-	0.1	Tr.	12.12	Methyltetradecanoate	-	0.1	-	30.79
Benzyl alcohol	-	-	0.3	12.32	6,10,14-Tetramethylpentadecan-2-one	-	0.3	-	33.25
2-Methylbutyl isothiocyanate	0.2	-	-	12.94	Methylhexadecan-9-enoate	-	0.3	-	34.51
gamma-Terpinene	-	-	Tr.	13.06	Methylhexadecanoate	-	0.3	-	34.95
n-Octanol	0.2	-	Tr.	13.51	Ethylhexadecan-9-enoate	-	1.2	-	35.85
o-Ethylmethylcarbamothioic acid	0.7	1.65	-	14.24	Ethylhexadecanoate	-	1.6	0.3	36.28
Linalool	-	0.3	0.1	14.41	Octasulfure	-	1.1	6	37.68
Nonanal	0.1	-	-	14.58	Octadecane-9,12-dienoic acid	-	0.4	Tr.	38.13
Phenylethyl alcohol	0.4	-	0.1	14.86	Methyloctadecan-9-enoate	-	0.4	-	38.26
Camphor	-	0.1	-	15.88	Hexadecanoic acid	-	0.2	-	38.93
N-Heptylidene-methanamide	0.9	-	-	16.40	Ethyl linoleate	-	1.1	0.1	39.35
Benzyl acetate	-	-	0.1	16.42	Ethyloctadecan-9-enoate	-	1.6	0.3	39.50
Methyl salicylate	0.4	-	-	17.32	Hexadecanal *O*-methyloxime	-	-	0.8	40.37
Estragol	-	-	0.4	17.50	Octadecamethylcyclononasiloxane	-	4.5	-	40.55
1,4-Dimethyltetrasulfide	0.4	-	0.1	18.03	$C_{23}H_{48}$	-	0.2	0.1	41.79
beta-Cyclocitral	0.2	-	-	18.10	Tetracosamethylcyclododecasiloxane	-	4.4	-	42.87
Cuminaldehyde	-	0.1	-	18.8	3,6-Dioxa-2,4,5,7-tetrasilaoctane	-	0.2	-	50.87

Tr.:<0.1; *unidentified.

Additionally isolated: *C. spinosa* (bud): methylisothiocyanate - 65.97, *p*-cymene - 0.1, estragol - 0.1, thymol - 0.1, *N,N′*-dimethylthiourea - 5.8, octasulfure - 12, ethyl linoleate - 0.4, $C_{23}H_{48}$ - 0.3; *C.ovata* (shoot): methyl isothiocyanate - 96, ethyl isothiocyanate - Tr., hexanol - 0.1, *N,N′*-dimethylthiourea - 0.1, 3,4-*bis*(methylthio)-1,2,5-thiadiazidine - 0.4, octasulfure - 1.1; *C. ovata* (fruit): methyl isothiocyanate - 64.9, ethyl isothiocyanate - Tr., *o*-ethylmethylcarbamothioic acid - 0.9, octasulfure - 0.6.

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