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Comparative chemical analysis of essential oils from different organs of three *Pastinaca* taxa

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Introduction

Pastinaca sativa* subsp. *sativa L., Apiaceae (parsnip) is cultivated mainly in the temperate regions of the world because of its edible root. The roots of the best quality are obtained from the plants from the first year, in which this biennial plant usually forms only leaf rosette. In the second year, flowering stems emerge (the plant is cultivated for two years in order to obtain fruits for reproduction). Wild-growing ***P. sativa* subsp. *urens*** (Req. ex Godr.) Čelak. is widely distributed in Europe and ***P. hirsuta*** Pančić is endemic in the central part of the Balkan Peninsula (east Serbia, North Macedonia and south and west Bulgaria).

Objective

To investigate and compare the composition of the essential oils obtained from **roots**, **leaves**, **stems**, **flowers** and **fruits** of cultivated ***P. sativa* subsp. *sativa*** (from the first and/or the second year) and wild-growing ***P. sativa* subsp. *urens*** and ***P. hirsuta*** from Serbia.

Methods

Essential oils were isolated from dried and comminuted plant material by hydrodistillation using Clevenger-type apparatus for 2.5 h. The composition of essential oils was determined by GC-FID and GC-MS and analyzed using multivariate statistical methods: principal component analysis (PCA), non-metric multidimensional scaling (nMDS) and unweighted pair-group arithmetic averages clustering (UPGMA).

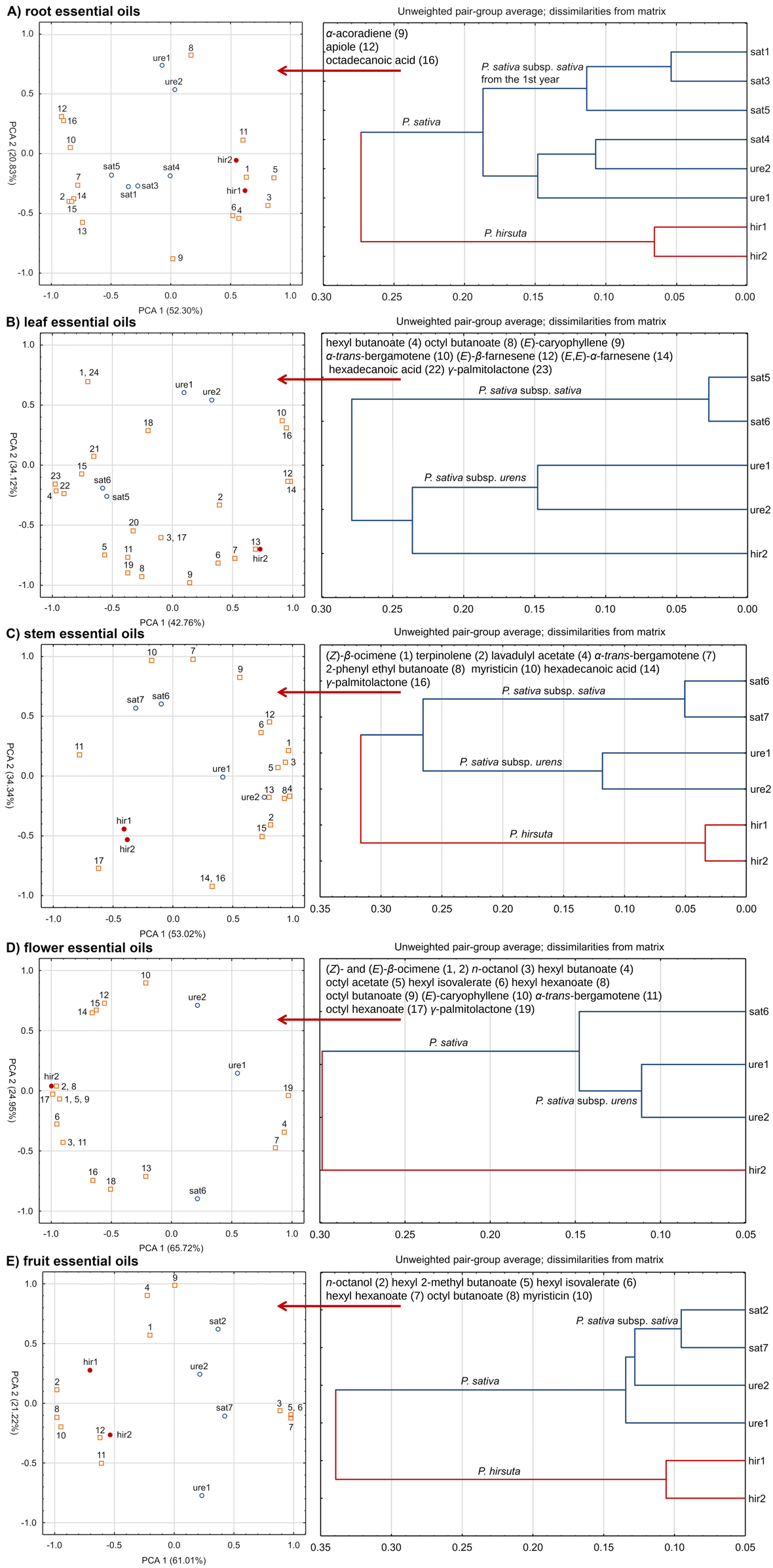
Wild-growing Pastinaca taxa:
P. sativa subsp. urens (left) P. hirsuta (right)

Cultivated P. sativa subsp. sativa roots

Results

Twenty-nine parsnip essential oils were investigated: 11 *P. sativa* subsp. *sativa* (**sat**) oils (from four localities; the oils of roots and leaves from both the first and the second year, and of the other organs from the second year), 10 *P. sativa* subsp. *urens* (**ure**) oils (from two localities) and eight *P. hirsuta* (**hir**) oils (from one locality, collected in two different years). Among other, **Table** includes acronyms (**Acr**), № of identified compounds (**Cd №**) and % of identified compounds (**% id**). Different organs are highlighted with different color. **Figure** includes **PCA (left)** and **UPGMA (right)** analyses (results of nMDS analysis are not shown, because no new relations compared to PCA and UPGMA analyses were observed). In **PCA**, only names of compounds that contributed the most to 1st and 2nd PC are given.

Acr	Phenophase	Date	Locality	Organ	Yield (%)	Cd №	Two the most abundant compounds (%)	% id
sat1	Vegetative (1st year)	Aug '10	Crepaja	**Root**	0.52	24	Myristicin (76.8), terpinolene (14.8)	98.2
sat2	Fruiting (2nd year)	Aug '10	Leskovac	**Fruit**	1.40	23	Octyl butanoate (79.0), octyl hexanoate (8.1)	97.3
sat3	Vegetative (1st year)	Aug '18	V. Plana	**Root**	0.77	28	Myristicin (75.7), terpinolene (16.6)	98.4
sat4	Fruiting (2nd year)	Aug '18	V. Plana	**Root**	0.02	45	Myristicin (82.5), γ-palmitolactone (4.5)	97.5
sat5	Vegetative (1st year)	Aug '18	Kovačica	**Root**	0.51	22	Myristicin (59.3), terpinolene (28.7)	98.6
	Vegetative (1st year)	Aug '18	Kovačica	**Leaf**	0.16	40	Myristicin (42.8), (*E*)-β-farnesene (22.3)	96.7
sat6	Flowering (2nd year)	June '18	Kovačica	**Leaf**	0.16	34	Myristicin (41.4), (*E*)-β-farnesene (22.4)	93.6
	Flowering (2nd year)	June '18	Kovačica	**Stem**	0.13	34	Myristicin (64.9), (*E*)-β-farnesene (14.4)	97.6
	Flowering (2nd year)	June '18	Kovačica	**Flower**	0.73	45	Octyl butanoate (31.4), myristicin (21.5)	92.1
sat7	Fruiting (2nd year)	Aug '18	Kovačica	**Stem**	0.08	36	Myristicin (63.3), γ-palmitolactone (18.4)	95.1
	Fruiting (2nd year)	Aug '18	Kovačica	**Fruit**	1.71	43	Octyl butanoate (70.9), *n*-octanol (9.1)	98.1
ure1	Dominantly fruiting	July '16	Perućac	**Root**	0.14	31	Myristicin (39.7), terpinolene (23.4)	92.7
	Dominantly fruiting	July '16	Perućac	**Leaf**	0.09	47	γ-Palmitolactone (22.6), (*E*)-β-farnesene (13.8)	90.7
	Dominantly fruiting	July '16	Perućac	**Stem**	0.03	47	γ-Palmitolactone (50.6), (*E*)-β-farnesene (6.5)	89.4
	Dominantly fruiting	July '16	Perućac	**Flower**	0.43	43	Octyl butanoate (29.7), γ-palmitolactone (13.9)	90.3
	Dominantly fruiting	July '16	Perućac	**Fruit**	2.44	24	Octyl butanoate (53.6), octyl acetate (28.9)	97.3
ure2	Dominantly fruiting	Aug '17	Povlen	**Root**	0.10	38	Myristicin (62.1), γ-palmitolactone (15.6)	97.3
	Dominantly fruiting	Aug '17	Povlen	**Leaf**	0.10	50	γ-Palmitolactone (29.5), caryophyllene oxide (10.6)	90.5
	Dominantly fruiting	Aug '17	Povlen	**Stem**	0.05	53	γ-Palmitolactone (53.4), (*E*)-β-farnesene (4.9)	91.0
	Dominantly fruiting	Aug '17	Povlen	**Flower**	0.56	42	Octyl butanoate (26.1), γ-palmitolactone (24.0)	95.6
	Dominantly fruiting	Aug '17	Povlen	**Fruit**	1.96	25	Octyl butanoate (65.1), octyl hexanoate (15.4)	98.2
hir1	Dominantly fruiting	July '07	Vlasina	**Root**	0.10	33	Apiole (30.9), (Z)-falcarinol (25.9)	90.8
	Dominantly fruiting	July '07	Vlasina	**Stem**	0.04	34	γ-Palmitolactone (53.3), octadecadienoic acid (34.0)	95.5
	Dominantly fruiting	July '07	Vlasina	**Fruit**	2.71	13	Hexyl hexanoate (59.8), hexyl butanoate (22.0),	95.6
hir2	Dominantly fruiting	July '19	Vlasina	**Root**	0.11	31	Apiole (25.8), myristicin (20.3)	90.3
	Dominantly fruiting	July '19	Vlasina	**Leaf**	0.07	40	γ-Palmitolactone (47.5), octadecadienoic acid (24.3)	90.0
	Dominantly fruiting	July '19	Vlasina	**Stem**	0.05	27	γ-Palmitolactone (60.4), octadecadienoic acid (25.5)	92.3
	Dominantly fruiting	July '19	Vlasina	**Flower**	0.93	30	Hexyl butanoate (61.9), hexyl hexanoate (17.0)	92.5
	Dominantly fruiting	July '19	Vlasina	**Fruit**	3.90	14	Hexyl butanoate (58.4), hexyl hexanoate (29.1)	96.9



Conclusions

Wild-growing parsnips are equally interesting sources of essential oils as cultivated parsnip. Locality and year of collection did not significantly influence relations among taxa observed in multivariate statistical analysis.

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