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Evaluation of oil content and fatty acid composition in the seed of grapevine varieties

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ABSTRACT

From the gene collection of the Viticulture Research Station Karlštejn samples of seeds of selected grapevine varieties were obtained during the harvest of 2011 and 2012. Average oil content in analysed grapevine varieties in 2011 was 11.60 ± 0.33 g/100 g seed dry matter. Linoleic acid was the most abundant fatty acid in all analysed grape seed oils, contributing between 68.10 g/100 g oil and 78.18 g/100 g oil. Linolenic acid was present only in small trace quantities ranging from 0.29 g/100 g to 0.77 g/100 g oil. Oleic acid content conformed to MUFA content, which ranged from 8.82 g/100 g–16.92 g/100 g. SFA ranged between 9.04 g/100 g and 12.82 g/100 g of TFA. Statistical analysis revealed close correlation between PUFA and linoleic acid ($R^2 = 0.998$) and MUFA and oleic acid content ($R^2 = 0.994$). Variety of cultivation showed significant impact on the content of fatty acids in oil. Principal component analysis revealed differences or similarity of analysed grapevine varieties related to the content of major FA. The year of cultivation showed different effect on individual FA content.

1. Introduction

Grapes are one of the major fruit crops and about eighty percent of the harvest is used by the winemaking industry, which leads to the generation of large quantities of seed by-product (Yi et al., 2009). Grape seed oil has a large scale of application, being used in various fields from cosmetics to cooking. Grape seed oil is gaining popularity as culinary oil, and has been studied as a possible source of specialty lipids (Bail, Stuebiger, Krist, Unterweger, & Buchbauer, 2008). It is a rich source of linoleic acid (Beveridge, Girard, Kopp, & Drover, 2005), which is associated with promotion of cardiovascular health by down-regulating low-density lipoprotein cholesterol. Grape-seed oils have emerged as a product with potential to be used in food and pharmaceutical applications (Crews et al., 2006). The benefits of grapes are associated with polyunsaturated fatty acids (PUFA) present mostly in seeds. Grape-seed oils may be a good option, as numerous benefits associated with their composition were reported, mainly in terms of essentials fatty acids and vitamin E. Polyunsaturated acids such as linoleic and linolenic acids are essential for the human metabolism due to the lack of enzymes responsible for their biosynthesis (Hanganu, Todaşcă, Chira, Maganu, & Roşca, 2012). PUFA are considered desirable compounds in the human diet because of their effect in reducing the incidence of cardiovascular disease and cancer (Yi et al., 2009). According to Bellido et al. (2006), the ingestion of oleic acid is related to the reduction of the level of low density lipoproteins and consequently, the prevention of arteriosclerosis. Due to dietetic habits, increased consumption of n-3 acids has been

Abbreviations: FA, fatty acids; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; TFA, total fatty acids.

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recommended in the diet (Gebauer, Harris, Kris-Etherton, & Etherton, 2005).

Grape seeds contain about 14–17 g/100 g oil and the main interest in grape seed oil lies in its high content of unsaturated acids, which exceeds those in safflower, sunflower and corn oil (Cao & Ito, 2003). Grape seed oil consists mainly of triglycerides, which are rich in monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), compared to other oil-rich seeds (Baydar & Akkurt, 2001). The oil contents were found to be different for each variety. Saturated fatty acids contents were lower than the values of MUFA and PUFA in all genotypes. Among the identified fatty acids, linoleic acid (C18:2) was the predominant fatty acid and it was followed by oleic acid (C18:1) and palmitic acid (C16:0) in all varieties (Tangolar, Ozoğul, Tangolar, & Torun, 2009).

According to present knowledge, no study has been performed until now that focused on the potential use of seed oils of grape varieties grown in the Czech Republic. As a part of ongoing efforts to develop value-added utilisations of fruit seeds, this study was conducted to determine grape seed oils yield. In this research, the seeds of wine grape and table grape varieties were examined for oil content. Moreover, the FA compositions of oils of these seed samples were determined with the aim of evaluation of the fatty acid profile and the effect of year of harvest on fatty acid content.

2. Material and methods

2.1. Plant material

In total, 23 samples of grape seeds from the gene collection of the Viticulture Research Station Karlštejn, Czech Republic, of selected varieties of grapes were obtained during the harvest of 2011 and 2012 for comparison of the effect of the year (Tables 1 and 2) and additionally 18 other varieties in 2011 (Table 3) for the evaluation of FA content in individual varieties. All seeds were, after pressing, manually separated from the skins in an average of 10 kg samples of grapes and dried to a constant weight. No seeds passed through the wine-making process. Oil concentrations in 2011 are shown in Fig. 1.

2.2. Chemicals

Methanol p.a. (Lach-Ner Ltd., Neratovice, Czech Republic); methanolic base 0.5 mol/L (Supelco, Sigma–Aldrich CZ, Prague, Czech Republic); GC grade hexane (Lach-Ner Ltd., Neratovice, Czech Republic); sodium chloride p.a. (Lach-Ner Ltd, Neratovice, Czech Republic); distilled water.

2.3. Determination of oil content by Soxhlet method

A Soxhlet apparatus was used for the extraction of oil from the dried powdered seeds. Finely powdered grape seeds in an HR 2185 Philips electric mill (Philips, Ltd., Amsterdam, the Netherlands) (ca 0.5 g) were extracted with hexane (p.a., Lach-Ner Ltd, Neratovice, Czech Republic) at 70 °C, then hexane was removed on a Büchi rotovapor R-215 (Büchi Labortechnik GmbH, Essen, Germany) at 65 °C and grape oil was then further dried to a constant weight in an oven at 60 °C and weighed. Oil contents were expressed per dry weight of the seeds (w/w).

2.4. Determination of fatty acids in grape oils with GC-FID

2.4.1. Preparation of methyl esters

40 μL of the oil sample was pipetted to a thick-walled tube (10 × 1.5 cm), suitable for use in a centrifuge, with an automatic pipette. 0.5 mL of methanol and 0.5 mL of methanolic base (sodium methanolate) was added to this tube. The tube was carefully sealed and the content at the bottom of the tube was gently shaken. After shaking, the tube was placed in a water bath at 75–80 °C and the mixture was allowed to react for 1 min. After this time, the tube was taken out and the content shaken gently again for better dispersion

Table 1
Composition of major and essential fatty acids in grape seeds of vine varieties in 2011 and 2012 (g/100 g oil).

Variety	Palmitic acid			Stearic acid			Oleic acid			Linoleic acid			α-Linolenic acid		
	2011	2012	mean ± SD	2011	2012	mean ± SD	2011	2012	mean ± SD	2011	2012	mean ± SD	2011	2012	mean ± SD
André (B)	7.14	7.20	7.17 ± 0.04	3.18	3.40	3.29 ± 0.16	12.98	15.01	14.00 ± 1.44	74.24	72.03	73.14 ± 1.56	0.33	0.28	0.31 ± 0.04
Bacchus (W)	7.08	7.58	7.33 ± 0.35	3.39	3.11	3.25 ± 0.20	13.36	11.63	12.50 ± 1.22	73.43	75.44	74.44 ± 1.42	0.31	0.42	0.37 ± 0.08
Pinot N. Précoce (B)	6.91	6.60	6.76 ± 0.22	4.57	4.44	4.51 ± 0.09	12.76	12.91	12.84 ± 0.11	71.90	73.55	72.73 ± 1.17	0.54	0.46	0.50 ± 0.06
Děvín (W)	5.94	5.98	5.96 ± 0.03	5.24	4.83	5.04 ± 0.29	15.11	14.59	14.85 ± 0.37	71.25	72.60	71.93 ± 0.96	0.49	0.38	0.44 ± 0.08
Chardonnay (W)	6.44	6.50	6.47 ± 0.04	5.65	3.81	4.73 ± 1.30	16.78	16.52	16.65 ± 0.18	69.25	71.12	70.19 ± 1.32	0.36	0.32	0.34 ± 0.03
Kerner (W)	6.40	6.62	6.51 ± 0.16	3.85	3.71	3.78 ± 0.10	12.95	14.45	13.70 ± 1.06	74.61	72.75	73.68 ± 1.32	0.42	0.37	0.40 ± 0.04
Madeleine Ang. (W)	6.56	6.82	6.69 ± 0.18	4.96	4.51	4.74 ± 0.32	13.10	13.30	13.20 ± 0.14	72.60	72.81	72.71 ± 0.15	0.47	0.33	0.40 ± 0.10
Pinot Meunier (B)	6.72	7.07	6.90 ± 0.25	3.71	3.45	3.58 ± 0.18	13.56	14.69	14.13 ± 0.80	73.67	72.54	73.11 ± 0.80	0.39	0.39	0.39 ± 0.00
Muscat Dessert. (W)	6.81	7.02	6.92 ± 0.15	4.05	4.01	4.03 ± 0.03	12.86	14.54	13.70 ± 1.19	73.73	72.43	73.08 ± 0.92	0.37	0.37	0.37 ± 0.00
Pálava (R)	6.43	6.62	6.53 ± 0.13	3.66	4.14	3.90 ± 0.34	10.42	13.95	12.19 ± 2.50	77.23	73.37	75.30 ± 2.73	0.44	0.40	0.42 ± 0.03
Veltliner Green (W)	6.76	6.89	6.83 ± 0.09	3.68	3.42	3.55 ± 0.18	9.97	10.49	10.23 ± 0.37	77.19	77.08	77.14 ± 0.08	0.62	0.48	0.55 ± 0.10
Zenit (W)	7.83	7.28	7.56 ± 0.39	4.24	3.74	3.99 ± 0.35	12.58	14.70	13.64 ± 1.50	71.64	71.78	71.71 ± 0.10	0.77	0.45	0.61 ± 0.23
Pinot N. Swiss (B)	6.78	7.39	7.09 ± 0.43	3.63	4.06	3.85 ± 0.30	12.93	16.06	14.50 ± 2.21	74.37	69.85	72.11 ± 3.20	0.43	0.37	0.40 ± 0.04
Pinot Noir (B)	6.84	6.89	6.87 ± 0.04	4.05	3.96	4.01 ± 0.06	13.43	15.79	14.61 ± 1.67	73.55	71.37	72.46 ± 1.54	0.38	0.32	0.35 ± 0.04
Pinot Blanc (W)	6.33	6.12	6.23 ± 0.15	3.58	3.45	3.52 ± 0.09	15.88	18.00	16.94 ± 1.50	71.80	70.31	71.06 ± 1.05	0.37	0.32	0.35 ± 0.04
Arom. Riesling (W)	7.14	6.35	6.75 ± 0.56	3.18	3.22	3.20 ± 0.03	12.98	15.92	14.45 ± 2.08	74.24	72.50	73.37 ± 1.23	0.33	0.34	0.34 ± 0.01
Riesling Red (R)	6.68	6.90	6.79 ± 0.16	3.21	3.28	3.25 ± 0.05	13.62	13.57	13.60 ± 0.04	73.95	74.17	74.06 ± 0.16	0.50	0.43	0.47 ± 0.05
Rheinriesling (W)	6.42	6.96	6.69 ± 0.38	3.29	3.67	3.48 ± 0.27	14.13	14.54	14.34 ± 0.29	74.02	72.85	73.44 ± 0.83	0.46	0.39	0.43 ± 0.05
Riesling Italian (W)	6.34	5.98	6.16 ± 0.25	5.25	4.58	4.92 ± 0.47	16.26	15.91	16.09 ± 0.25	69.95	71.28	70.62 ± 0.94	0.41	0.39	0.40 ± 0.01
Sauvignon (W)	6.39	6.63	6.51 ± 0.17	5.51	6.20	5.86 ± 0.49	11.08	12.28	11.68 ± 0.85	75.02	73.07	74.05 ± 1.38	0.40	0.38	0.39 ± 0.01
Siegerrebe (B/R)	6.21	6.08	6.15 ± 0.09	4.61	5.00	4.81 ± 0.28	10.59	12.21	11.40 ± 1.14	74.97	74.37	74.67 ± 0.42	0.63	0.44	0.54 ± 0.13
Silvaner Green (W)	8.02	8.34	8.18 ± 0.23	3.85	4.30	4.08 ± 0.32	13.12	13.02	13.07 ± 0.07	72.79	72.16	72.48 ± 0.45	0.49	0.43	0.46 ± 0.04
Záhoranka (W)	6.13	6.21	6.17 ± 0.06	3.66	3.77	3.72 ± 0.08	11.24	11.49	11.37 ± 0.18	76.90	76.54	76.72 ± 0.26	0.41	0.37	0.39 ± 0.03
Average	**6.76**[a]	**6.85**[b]	**6.81 ± 0.59**	**4.10**[a]	**3.97**[a]	**4.04 ± 0.74**	**13.14**[a]	**14.12**[b]	**13.63 ± 1.73**	**73.43**[a]	**72.87**[b]	**73.15 ± 1.94**	**0.45**[a]	**0.38**[b]	**0.42 ± 0.08**

Pinot N. Précoce = Pinot Noir Précoce; Madeleine Ang. = Madeleine Angevine; Muscat Dessert. = Muscat Dessertnyi; Pinot N. Swiss = Pinot Noir Swiss selection; Arom. Riesling = Aromatic Riesling; B = blue; W = white; R = rose; values marked with different letters in columns are significantly different at $P \leq 0.05$. All analyses were carried out in three replicates.