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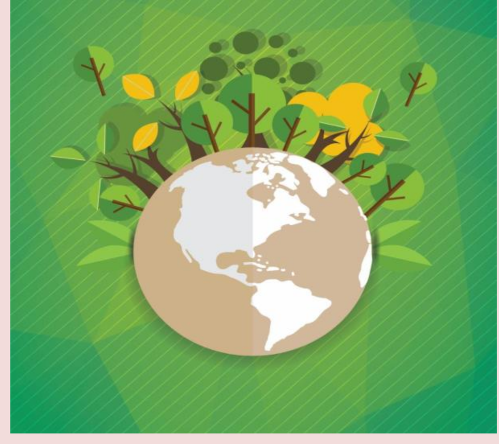

Physico-chemical characterization, fatty acid composition and thermal stability of cold-pressed sunflower oils obtained from 17 newly cultivated hybrids from the region of North Macedonia

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Introduction

Edible vegetative oils are vital constituents of human nutrition, which provide energy, essential fatty acids such as linoleic and linolenic acid but also serve as a carrier of fat soluble vitamins like as A, D, E and K [1, 2]. Edible oils are commonly used for frying, baking, cooking, salad and other industries. Sunflower oil is one of the top five oil crops cultivated worldwide. Cold-pressed and refined sunflower oils rich in linolenic acid, are particularly susceptible to undesirable changes during deep-frying. More saturated oils improve stability, however, if the frying fat is solid at room temperature it will produce a dry dull surface that is undesirable on some fried products. The aim of this study is to cultivate hybrids from which we can produced stable high-oleic sunflower oil which can be used as cooking oil for deep-frying and thermal processing of food.

Table 1. Fatty acid composition of cold pressed sunflower oils from 17 new hybrids (%)

	Experto	Armoni	Fortimi	Adagio	Neoma	Torino	Arisona	Bacardi	Felix
C16:0	4.9±0.3^{d}	5.5±0.1^{c}	6.5±0.4^{b}	5.9±0.2^{b}	5.1±0.1^{c}	7.1±0.3^{a}	5.5±0.1^{c}	6.1±0.4^{b}	5.8±0.1^{b}
C18:0	2.2±0.4^{c}	2.6±0.2^{b}	2.6±0.0^{b}	3.1±0.4^{a}	1.9±0.0^{d}	2.5±0.5^{b}	3.7±0.7^{a}	3.5±0.3^{a}	2.6±0.3^{b}
C18:1	86.2±3.2^{a}	41.8±4.8^{d}	32.0±4.5^{e}	40.8±2.3^{d}	57.7±9.2^{c}	34.0±7.1^{e}	45.8±6.3^{d}	40.4±5.4^{d}	33.7±4.9^{e}
C18:2	4.6±0.2^{f}	49.3±0.3^{b}	57.1±7.1^{a}	48.3±3.0^{b}	32.4±4.1^{d}	53.4±9.8^{a}	42.1±4.1^{c}	48.8±3.9^{b}	55.8±7.7^{a}
C18:3	1.9±0.0^{c}	0.4±0.0^{f}	0.9±0.1^{e}	1.3±0.0^{d}	2.9±0.0^{a}	1.5±0.1^{d}	2.6±0.0^{b}	1.2±0.0^{d}	1.1±0.0^{e}
	Neostar	**Kondi**	**Talento**	**Subaru**	**Edison**	**BG Fila**	**Sumiko**	**Dijamantis**	
C16:0	6.4±0.1^{b}	5.5±0.1^{c}	4.8±0.6^{d}	5.6±0.3^{c}	3.8±0.1^{e}	4.5±0.2^{d}	6.8±0.5^{b}	4.3±0.4^{d}	
C18:0	2.9±0.1^{a}	3.1±0.3^{a}	2.2±0.2^{b}	1.8±0.1^{c}	2.1±0.0^{b}	2.8±0.0^{a}	2.8±0.1^{a}	1.7±0.2^{c}	
C18:1	35.3±4.5^{e}	42.5±2.7^{d}	83.1±5.7^{a}	43.9±5.1^{d}	50.1±7.2^{c}	82.3±9.9^{a}	39.3±5.1^{d}	74.9±6.7^{b}	
C18:2	50.7±4.4^{b}	45.5±2.3^{c}	6.7±0.8^{f}	48.3±4.7^{b}	43.0±6.8^{c}	7.6±1.1^{f}	48.7±6.0^{b}	18.2±3.4^{e}	
C18:3	2.3±0.0^{b}	2.1±0.0^{c}	3.6±0.0^{a}	0.2±0.0^{f}	0.1±0.0^{f}	2.8±0.1^{b}	2.3±0.2^{b}	0.7±0.1^{e}	

Table 2. Mean values of iodine number, saponification measurement and oxidative stability of different sunflower oils

Hybrids/ Properties	Iodine value (g I_2/100 g)			Saponification value (mg KOH/g)			Oxidative stability (h)		
	2016	**2017**	**Mean**	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mea n**
Experto	85^{jk}	90^{l}	87.5	188^{d}	188^{e}	188.0	1.80^{n}	3.48^{f}	2.64
Armoni	123^{c}	138^{b}	130.5	191^{abc}	189de	190.0	2.86^{j}	2.92^{l}	2.89
Fortimi	129^{a}	140^{a}	134.5	190^{abc}	189de	189.5	2.68^{m}	2.86^{m}	2.77
Adagio	120^{def}	131^{e}	125.5	190^{c}	189de	189.5	2.96^{i}	3.17^{h}	3.07
Neoma	127^{b}	135^{cd}	131.0	190^{c}	189de	189.5	2.81^{k}	2.97^{k}	2.89
Torino	109^{h}	121^{g}	115.0	190^{c}	190^{cd}	190.0	3.66^{d}	3.76^{d}	3.71
Arisona	121^{cde}	125^{f}	123.0	191^{abc}	190^{cd}	190.5	2.73^{l}	3.10^{i}	2.92
Bacardi	120^{ef}	136^{c}	128.0	190^{bc}	190^{bc}	190.0	3.59^{f}	2.99^{k}	3.29
Feliks	122^{cd}	136^{bc}	129.0	190^{abc}	190^{cd}	190.0	2.66^{m}	2.98^{k}	2.82
Neostar	122^{cd}	136^{c}	129.0	191^{abc}	189de	190.0	2.66^{m}	2.93^{l}	2.80
Kondi	121^{cde}	134^{d}	127.5	190^{c}	190^{c}	190.0	2.72^{l}	2.88^{m}	2.80
Talento	87^{j}	90^{l}	88.5	191^{ab}	190^{bc}	190.5	8.68^{b}	10.16^{a}	9.42
Subaru	115^{g}	116^{i}	115.5	191^{abc}	191^{ab}	191.0	3.16^{g}	3.20^{g}	3.18
Edison	111^{h}	111^{j}	111.0	190^{abc}	190^{bc}	190.0	3.64^{e}	3.71^{e}	3.68
BG Fila	83^{k}	85^{m}	84.0	191^{abc}	190^{c}	190.5	9.04^{a}	9.10^{b}	9.07
Sumiko	118^{f}	119^{h}	118.5	192^{a}	192^{a}	192.0	3.04^{h}	3.06^{j}	3.05
Diamantis	95^{i}	94^{k}	94.5	191^{ab}	190^{bc}	190.5	5.24^{c}	5.28^{c}	5.26
Average	**112.2**	**119.8**	**116.0**	**190.4**	**189.8**	**190.1**	**3.76**	**4.03**	**3.90**
$LSD_{0.05}$	2.03	1.80		1.52	1.21		0.02	0.03	
CV (%)	1.09	0.90		0.48	0.38		0.36	0.44	

Table 3. Mean values of free fatty acid, peroxide value and density of different sunflower oils

Hybrids/ Properties	Free fatty acid (%)			Peroxide value (O_2/kg)			Density (mg/cm^3)		
	2016	**2017**	**Mean**	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mean**
Experto	0.42^{c}	0.15^{bcd}	0.29	0.69^{m}	0.78^{i}	0.74	0.912^{h}	0.913^{f}	0.913
Armoni	0.47^{b}	0.16^{b}	0.32	1.21^{de}	0.89^{h}	1.05	0.919^{bcd}	0.919^{a}	0.919
Fortimi	0.22^{j}	0.12^{ef}	0.17	1.14^{f}	1.03^{f}	1.09	0.917^{abc}	0.918^{b}	0.918
Adagio	0.60^{a}	0.12^{ef}	0.36	1.28^{b}	1.14^{d}	1.21	0.915^{ef}	0.918^{b}	0.917
Neoma	0.29^{h}	0.14^{bcde}	0.22	1.07^{h}	0.98^{g}	1.03	0.918^{abc}	0.919^{a}	0.919
Torino	0.25^{i}	0.13^{cde}	0.19	1.14^{f}	0.56^{l}	0.85	0.916^{def}	0.915^{d}	0.916
Arisona	0.36^{de}	0.15^{b}c	0.26	0.99^{j}	0.72^{j}	0.86	0.916^{def}	0.919^{a}	0.918
Bacardi	0.32^{g}	0.14^{bcde}	0.23	0.84^{l}	0.78^{i}	0.81	0.918^{ab}	0.919^{a}	0.919
Feliks	0.33f^{g}	0.12^{ef}	0.23	0.63^{n}	0.65^{k}	0.64	0.916^{def}	0.919^{a}	0.918
Neostar	0.37^{d}	0.14^{bcde}	0.26	1.35^{a}	0.78^{i}	1.07	0.919^{a}	0.919^{a}	0.919
Kondi	0.46^{b}	0.16^{b}	0.31	1.19^{e}	0.77^{i}	0.98	0.916^{def}	0.918^{b}	0.917
Talento	0.30^{h}	0.15^{bcd}	0.23	0.86^{k}	0.78^{i}	0.82	0.913^{gh}	0.914^{e}	0.914
Subaru	0.14^{k}	0.13^{cde}	0.14	1.21^{d}	1.30^{b}	1.26	0.916^{def}	0.916^{c}	0.916
Edison	0.13^{kl}	0.13^{cde}	0.13	1.10^{g}	1.13^{d}	1.12	0.916^{cde}	0.916^{c}	0.916
BG Fila	0.35^{ef}	0.33^{a}	0.34	1.36^{a}	1.34^{a}	1.35	0.912^{h}	0.912^{f}	0.912
Sumiko	0.14^{k}	0.13^{de}	0.14	1.25^{c}	1.23^{c}	1.24	0.918^{ab}	0.918^{b}	0.918
Diamantis	0.11^{l}	0.10^{f}	0.11	1.05^{i}	1.09^{e}	1.07	0.914^{fg}	0.914^{de}	0.914
Average	**0.31**	**0.15**	**0.23**	**1.08**	**0.94**	**1.01**	**0.916**	**0.917**	**0.916**
$LSD_{0.05}$	0.02	0.02		0.02	0.02		0.001	0.001	
CV (%)	3.82	9.90		0.93	1.37		0.12	0.06	

Materials and Methods

Fields Trials

Field trials were carried out at the experimental research area in Ovče Pole valley, near Sveti Nikole municipality, in the east-central part of the Republic of North Macedonia. Ovče Pole is a plain situated around the fow of Sveti Nikole’s river, which is a tributary to the Bregalnica River, within the following geographic coordinates N: 41°49′21.9″ and E: 21°59′03.9″. The climate in Ovče Pole valley is characterized by hot and dry summers and temperately cold winters, with occasional sharp lows. The experimental area belongs to the continental sub-Mediterranean area. The field experiments were set up during two consecutive growing seasons (2016 and 2017). The investigated area on which the research was conducted is owed by the Faculty of Agriculture, “Goce Delchev” University - Štip, the Republic of North Macedonia.

Results and discussion

Results from fatty acid methyl esters presented in table I and values for oxidative stability presented in tables 2 and 3 indicated strong relationship between percentage of oleic acid, iodine number, free fatty acid, peroxide number and thermal stability of cold-pressed sunflower oils produced from 17 newly cultivated hybrids. As we can see from the table I, the percentage of oleic acid in cold-pressed edible oils from Experto hybrid was 86.2% and the value for iodine number was 87.5 g I_2/100 g which was expected due to the high level of monosaturated fatty acid. The same tendency was observed for cold-pressed edible oils produced from BG Fila and Dijamantis hybrids. The free fatty acid value of the tested oils varied between 0.10 and 0.60% oleic. Negative correlation confirmed inverse relationship between the amounts of oleic acid and values of iodine number (r=-0.896). Opposite, positive correlation between iodine number and amount of linoleic acid (r=0.892) means that sunflower oils with higher value of iodine number will be thermally unstable and not suitable for deep-frying. Furthermore, the highest value for oxidative stability was measured for cold-pressed sunflower oils obtained from Talento, BG Fila and Dijamantis hybrids (over 9 and 5 h, respectively). This can be explained by the fact that the oils from those three hybrids had the highest level of oleic acid (83.1, 82.3 and 79.4% respectively) (Table 1).

Monounsaturated fatty acids are more stable then polyunsaturated which makes sunflower oil suitable for deep-frying. Positive linear correlation between the amount of oleic acid and oxidation stability (r=0.687) confirmed our statement that higher amount of monounsaturated fatty acids (as oleic acid) can improve thermal stability and makes the sunflower oils from Fila BG and Dijamantis hybrids suitable for cooking and deep-frying. The oxidative stability of other examined hybrid around 3 h can be explained by dominance of polyunsaturated linoleic acid with levels between 43% and 57.1% (Table 1). Statistical analysis confirmed our findings due to the negative linear correlation between oxidative stability and amount of polyunsaturated linoleic acid (r=-0.698). Due to its fatty acid profile, we expected higher value for oxidative stability (over 6 h) for cold-pressed sunflower oil from Experto hybrid. More precisely, the level of oleic acid for this oil was 86.2% and only 4.6% of polyunsaturated linoleic acid. Surprisingly, the oxidative stability of the oils was only 2.64% which can be explained as oxidation of the oil during production (Table 2).

Conclusion

Due to the fatty acid profile, we recommend the cold-pressed sunflower oils from three hybrids Experto, BG Fila and Dijamnatis as cooking oils suitable for thermally processing of food. Furthermore, we recommended the gap of oleic/linoleic acid as the most important for determination of thermal stability of sunflower oils. Finally, physicochemical parameters iodine number and oxidation stability can be significant parameters for prediction of the dominance of fatty acids in sunflower oil.

Reference

1. I. Donev, N. Markova Ruzdik, S. Kostadinović Veličkovska, Lj. Mihajlov, E. Arsov, S. Mirev. Growing season weather impacts on the physicochemical properties and quality of sunflower oils cold-pressed from hybrids grown in the Republic of North Macedonia. Riv. Ital. Sostanze Grasse. *97*, 27-35, (2020).
2. S. Kostadinović Veličkovska, N. Markova Ruzdik, Lj. Mihajlov, E. Arsov, S. Mirev, I Donev. Impact of the hybrid on the fatty acid composition and thermal stability of cold-pressed sunflower oils produced from 17 newly cultivated hybrids from the region of North Macedonia. Riv. Ital. Sostanze Grasse. Article in press.