Quality assessment of blackcurrant, strawberry and cranberry seeds' lipid fraction

Górska A., Piasecka I., Kienc K., Ostrowska-Ligęza E., Wirkowska-Wojdyła M., Bryś J.

Department of Chemistry, Institute of Food Sciences, Warsaw University of Life Sciences (WULS – SGGW), 02-787 Warsaw, Poland

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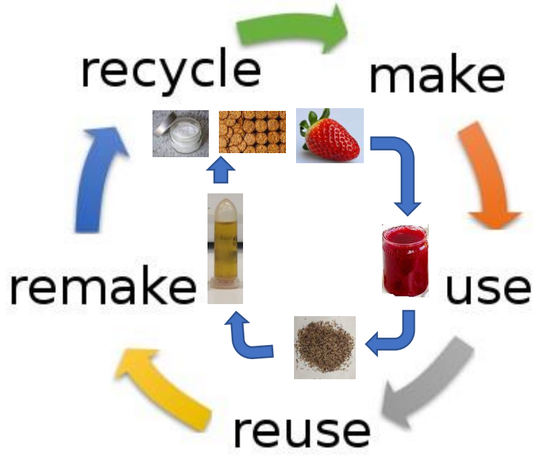
Proper management of waste generated during food production and processing is currently one of major and urgent challenges for the food industry. Berry seeds are believed to be a source of bioactive substances, that could be reused in food and cosmetic production, what is in agreement with the UE politics of circular economy and sustainable development.

The aim of the study was to determine the quality of the oil extracted from blackcurrant, strawberry and cranberry seeds.
The following parameters were considered:

- fatty acids composition by gas chromatography,
- distribution of fatty acids between *sn-2* and *sn-1,3* positions of triacylglycerols by enzymatic hydrolysis,
- oxidative stability of fat by pressure differential scanning calorimetry and
- melting characteristics by differential scanning calorimetry.



Fatty acids composition and positional distribution in blackcurrant, strawberry and cranberry seeds' oils

Table 1. Yield of oil extraction from blackcurrant, strawberry and cranberry seeds

Extracted oil	Yield of extraction [%] (Soxhlet procedure with the use of hexane)
Blackcurant seeds' oil	5.71
Strawberry seeds' oil	11.62
Cranberry seeds' oil	22.74

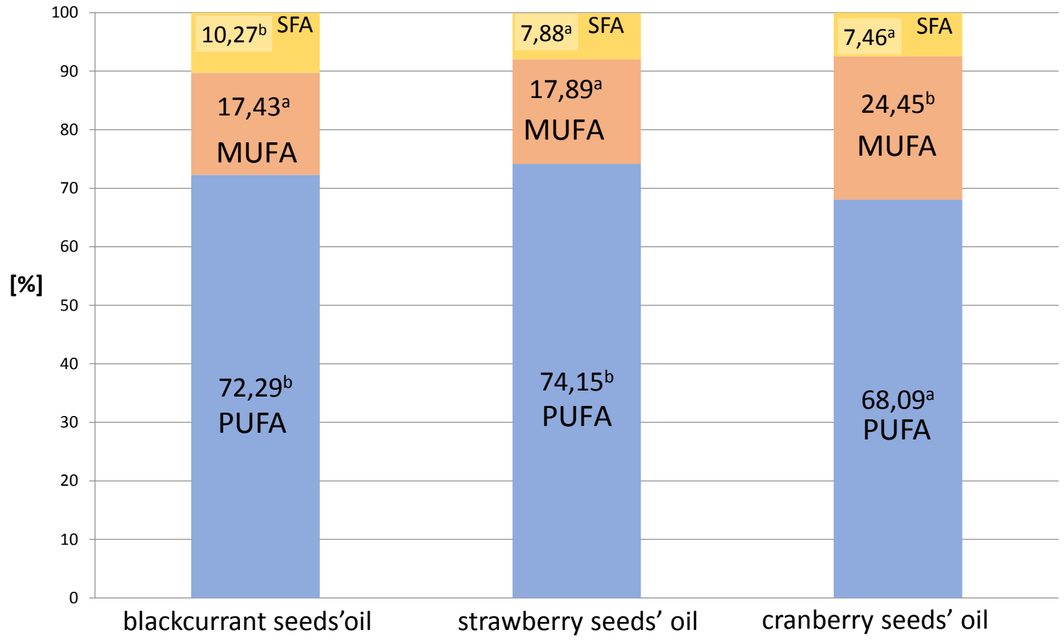


Figure 1. Fatty acid composition of blackcurrant, strawberry and cranberry seeds' oils
PUFA - polyunsaturated fatty acids; MUFA – monounsaturated fatty acids; SFA – saturated fatty acids

Table 2. Composition of selected fatty acids in *sn-2* and *sn-1.3* TAG positions in A -blackcurrant seeds' oil, B- strawberry seeds' oil; C – cranberry seeds' oil and the share of individual acids in the internal (*sn-2*) position (16:0 – palmitic acid; 18:1 n-9 – oleic acid; 18:2 n-6- linoleic acid; 18:3 n-3 – α-linolenic acid; 18:3 n-6 – γ –linolenic acid)

A

Fatty acid	Fatty acids composition in TAGs [%]	Fatty acids composition in sn-2 position [%]	Fatty acids composition in sn-1,3 positions [%]	Share of the fatty acid in sn-2 position [%]
16:0	7.95	4.43	9.71	18.57
18:1 n-9	16.09	21.63	13.32	44.82
18:2 n-6	48.07	49.04	47.59	34.01
18:3 n-6	8.92	9.17	8.80	34.27
18:3 n-3	15.02	13.47	15.80	29.90

B

Fatty acid	Fatty acids composition in TAGs [%]	Fatty acids composition in sn-2 position [%]	Fatty acids composition in sn-1,3 positions [%]	Share of the fatty acid in sn-2 position [%]
16:0	4.71	3.57	5.29	25.25
18:1 n-9	17.26	20.82	15.48	40.21
18:2 n-6	44.01	49.85	41.09	37.76
18:3 n-3	29.76	24.38	32.45	27.31

C

Fatty acid	Fatty acids composition in TAGs [%]	Fatty acids composition in sn-2 position [%]	Fatty acids composition in sn-1,3 positions [%]	Share of the fatty acid in sn-2 position [%]
16:0	5.89	2.19	7.74	12.39
18:1 n-9	23.99	29.53	21.22	41.03
18:2 n-6	36.59	40.85	34.46	37.21
18:3 n-3	31.39	26.78	33.70	28.44

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Induction time of blackcurrant, strawberry and cranberry seeds'oils oxidation

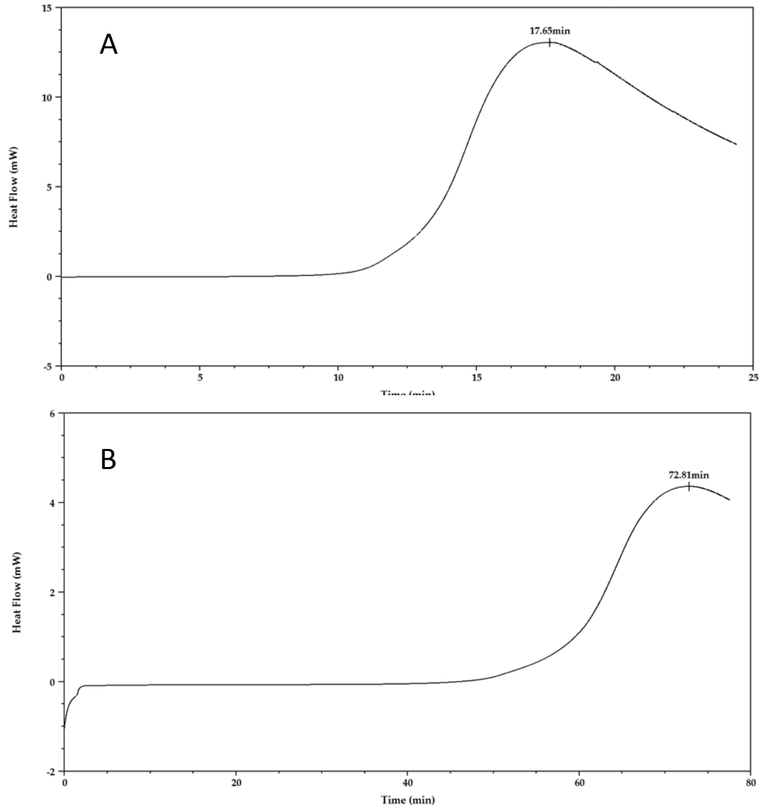

Figure 2. PDSC curve of blackcurrant seeds' oil in 120°C (A) and 100°C (B)

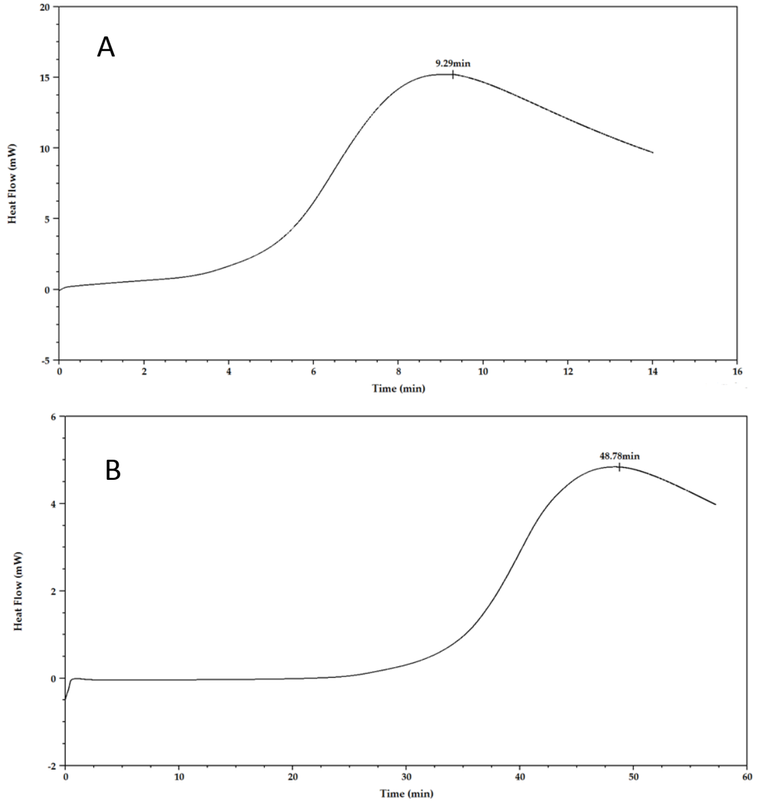

Figure 3. PDSC curve of strawberry seeds' oil in 120°C (A) and 100°C (B)

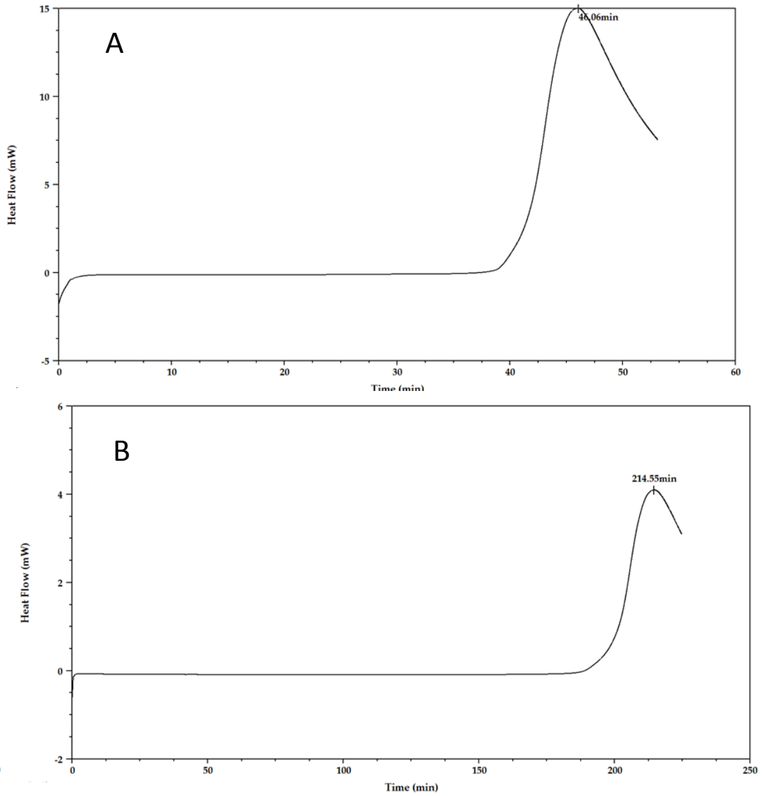

Figure 4. PDSC curve of cranberry seeds'oil in 120°C (A) and 100°C (B)

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Melting profile of blackcurrant, strawberry and cranberry seeds'oils

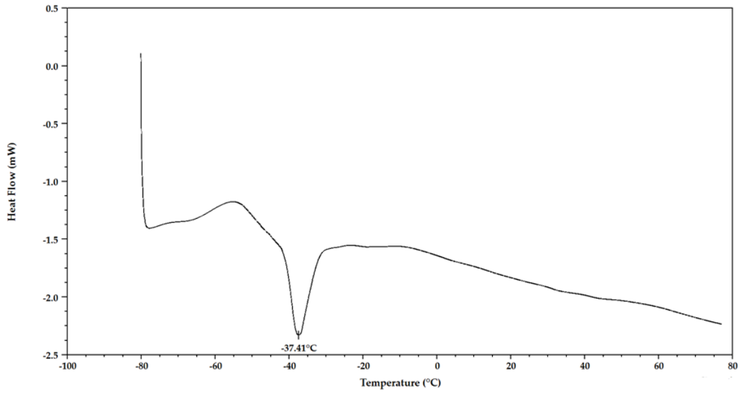

Figure 5. Melting curve of blackcurrant seeds' oil

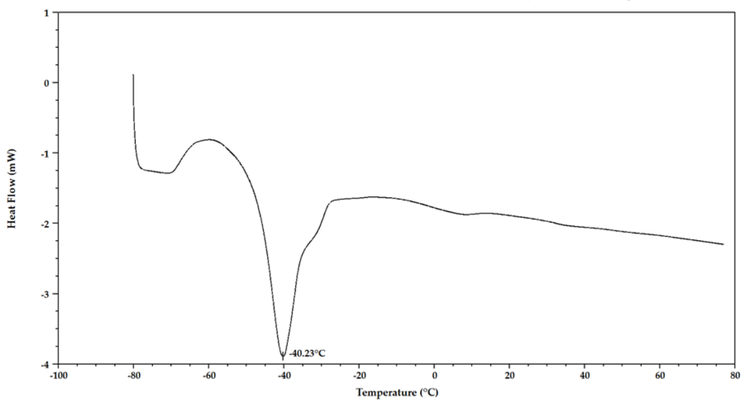

Figure 6. Melting curve of strawberry seeds' oil

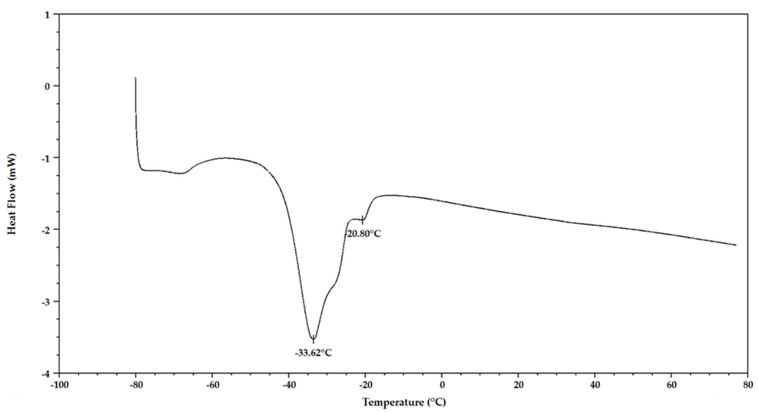

Figure 7. Melting curve of cranberry seeds' oil

Table 3. Temperature of endothermic transitions of blackcurrant, strawberry and cranberry seeds' oil

Oil	endotherm 1 [°C]	endotherm 2 [°C]
Blackcurrant seeds' oil	-37.41	-
Strawberry seeds' oil	-40.25	-
Cranberry seeds' oil	-33.63	-20.80

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Conclusions:

- ✓ Blackcurrant, strawberry and cranberry seeds' oils are a rich source of polyunsaturated fatty acids, especially linoleic acid and alpha-linolenic acid
- ✓ Blackcurrant and strawberry seeds' oils were characterized by the highest content of polyunsaturated fatty acids
- ✓ Blackcurrant, strawberry and cranberry seeds' oils are a source of monounsaturated fatty acids, eg oleic acid. Cranberry seeds' oil was characterized by the highest content of monounsaturated fatty acids
- ✓ Triacylglycerol molecules were characterized by the highest share of unsaturated fatty acids (oleic acid and linoleic acid) in the internal (*sn-2*) position. It is characteristic for vegetable oils and beneficial from the nutritional point of view as it ensures good digestibility of the aforementioned acid. Saturated fatty acids usually occupied the outer positions of triacylglycerols
- ✓ Blackcurrant and strawberry seeds' oils were characterized by short oxidation induction time, which proves their low oxidative stability. This fact should be combined with the high content of polyunsaturated fatty acids
- ✓ Cranberry seed oil was characterized by longer time of oxidation reaction induction. This is due to the fact that it contained higher content of monounsaturated fatty acids, which oxidize more slowly

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Conclusions:

- ✓ The melting curves for blackcurrant and strawberry seeds' oils were characterized by one endothermic transition, which indicates the presence of low-melting fractions of triacylglycerols containing polyunsaturated fatty acids
- ✓ The shape of the melting curve for cranberry seeds' oil differed from the shape of the melting curves for blackcurrant and strawberry seeds' oils and indicated two endothermic transformations, connected with the presence of low-melting fractions of triacylglycerols containing polyunsaturated fatty acids and medium-melting fractions rich in monounsaturated fatty acids. The shape of the curves corresponds to the analysis of the fatty acid composition

On the basis of the analyzes, it can be concluded that cranberry seeds' oil is characterized by the highest quality parameters among the analyzed oils: it can be a source of both polyunsaturated and monounsaturated fatty acids; the positional distribution of fatty acids is nutritionally favorable.

The oil is also characterized by the highest resistance to oxidative processes.

Research equipment used in the study - GCxGC TOF MS chromatograph for a complete two-dimensional gas chromatography with a time-of-flight mass spectrometer and an automatic station sample preparation and administration autosampler - was purchased as part of the "Food and Nutrition Centre - modernisation of the WULS campus to create a Food and Nutrition Research and Development Centre (CŻiŻ)" co-financed by the European Union from the European Regional Development Fund under the Regional Operational Programme of the Mazowieckie Voivodeship for 2014-2020 (Project No. RPMA.01.01.00-14-8276/17).

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