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Thermal properties of expanded amaranth seed oil

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Introduction

Amaranth was present both in the culture and in the cuisine of the peoples of South America already in pre-Columbian times. This pseudocereal is valued for its high content of vitamins, calcium, iron and squalene. The seeds are also used to produce oil and as a snack in the form of expanded amaranth. Thermal properties of oils are a very important distinguishing feature of their quality and stability. Based on the knowledge of the oxidation time, studied with a differential scanning calorimetry, it is possible to determine the susceptibility of the tested oil to oxidation.

The aim of the study was to analyse the properties of fat extracted from extruded amaranth seeds by thermal and chromatographic methods.

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Materials and Methods

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The analyses of melting characteristic was performed using a TA DSC Q200 differential scanning calorimeter. All measurements were conducted under a nitrogen atmosphere. Before the test, the sample was stored in refrigerated conditions. The oil was weighed in the amount of 3-4 mg and sealed in hermetic aluminium vessels. The samples were cooled to -80°C and then heated to 80°C at a rate of 5°C/min for melting profile analysis.

Oxidation time analysis was performed using a TA PDSC Q20 pressure differential scanning calorimeter. The oil was weighed in the amount of 3-4 mg into an open aluminium vessel. The samples were then heated from room temperature to 120°C, 130°C and 140°C. All measurements were made under an oxygen atmosphere.

Materials and Methods

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The analysis was carried out using a gas chromatograph type YL6100 GC. In order to determine the composition of fatty acids, a BPX-70 capillary column with an internal diameter of 0.22 mm, a film thickness of 0.25 µm and a length of 60 m was used. The chromatograph was equipped with a flame ionization detector FID. The initial temperature was held for 3 minutes at 70°C. The temperature was then raised to 225°C at a rate of 10°C/min and held for 10 minutes.

Results

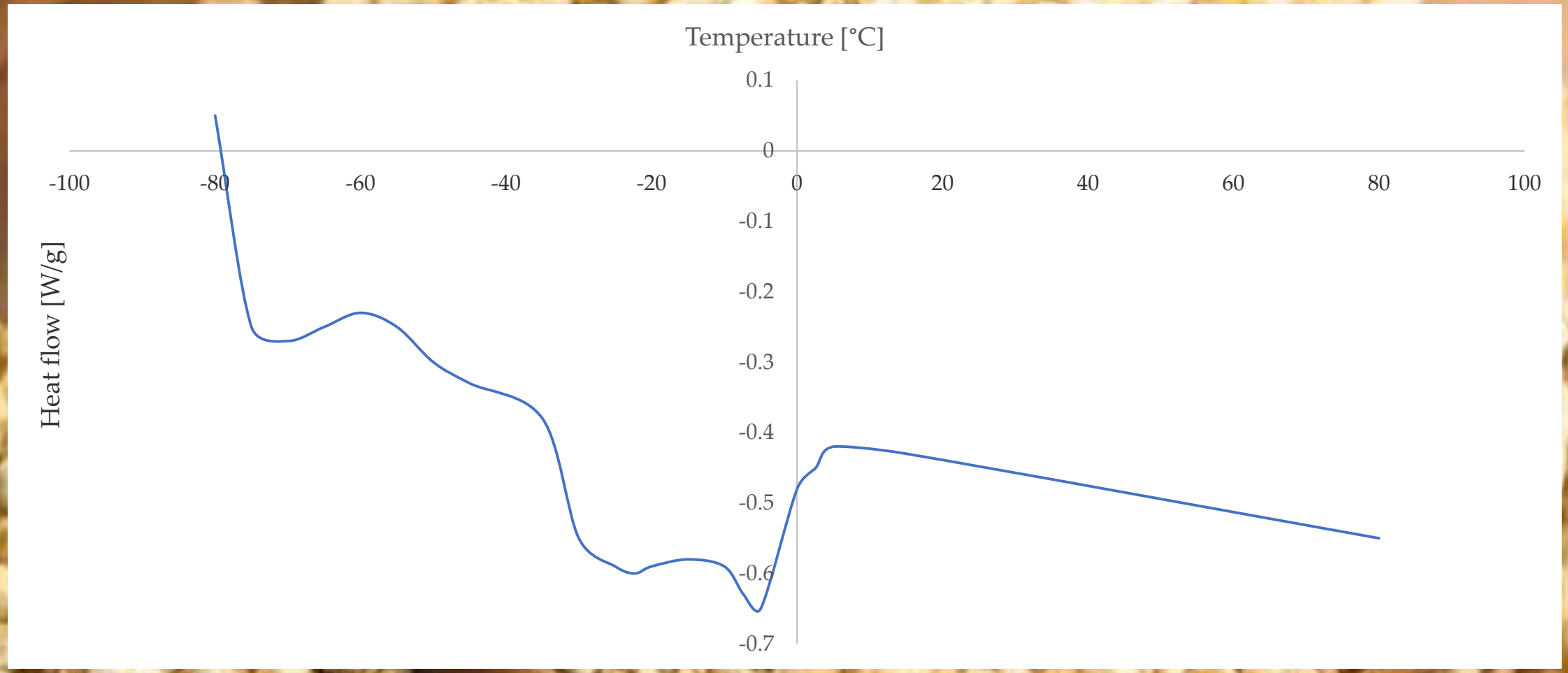

Figure 1. Melting characteristic of amaranth oil.

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Results

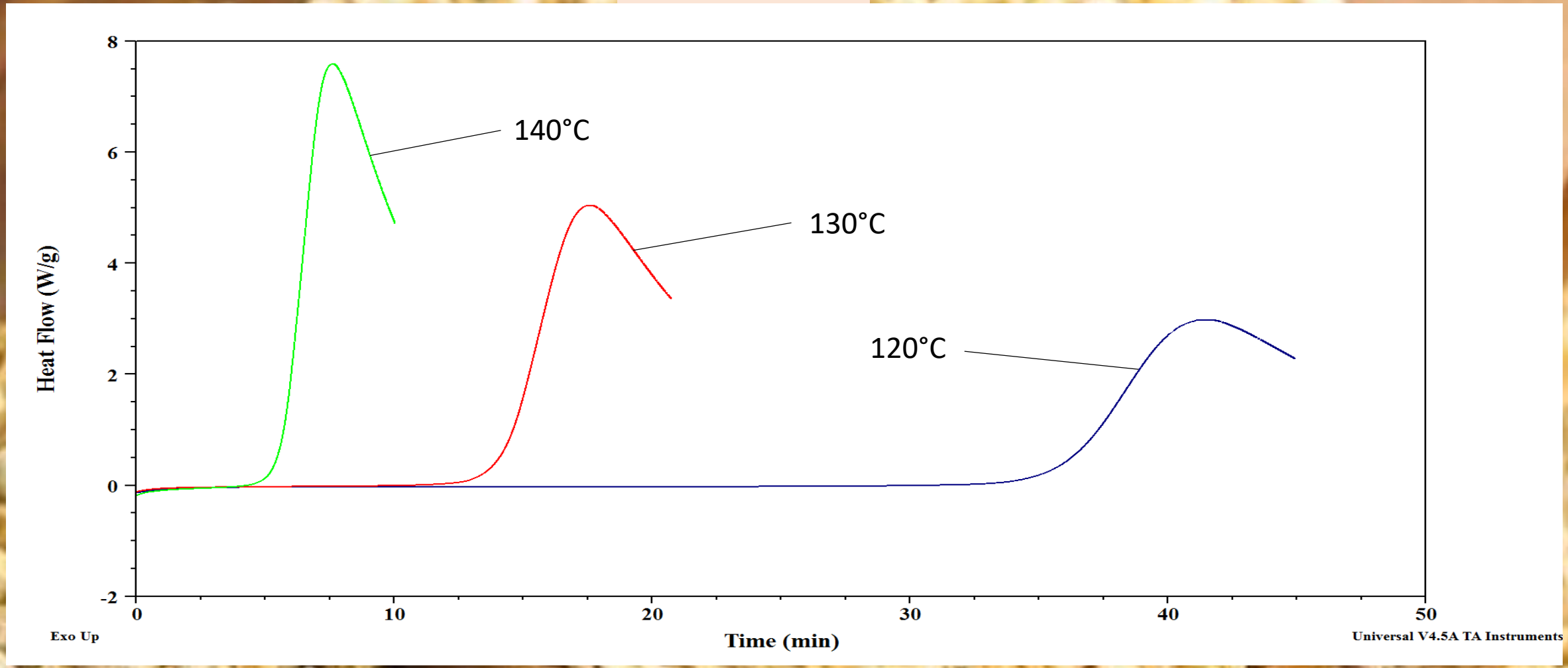

Figure 2. The curve of amaranth oil oxidation at temperature 120; 130 and 140°C.

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Results

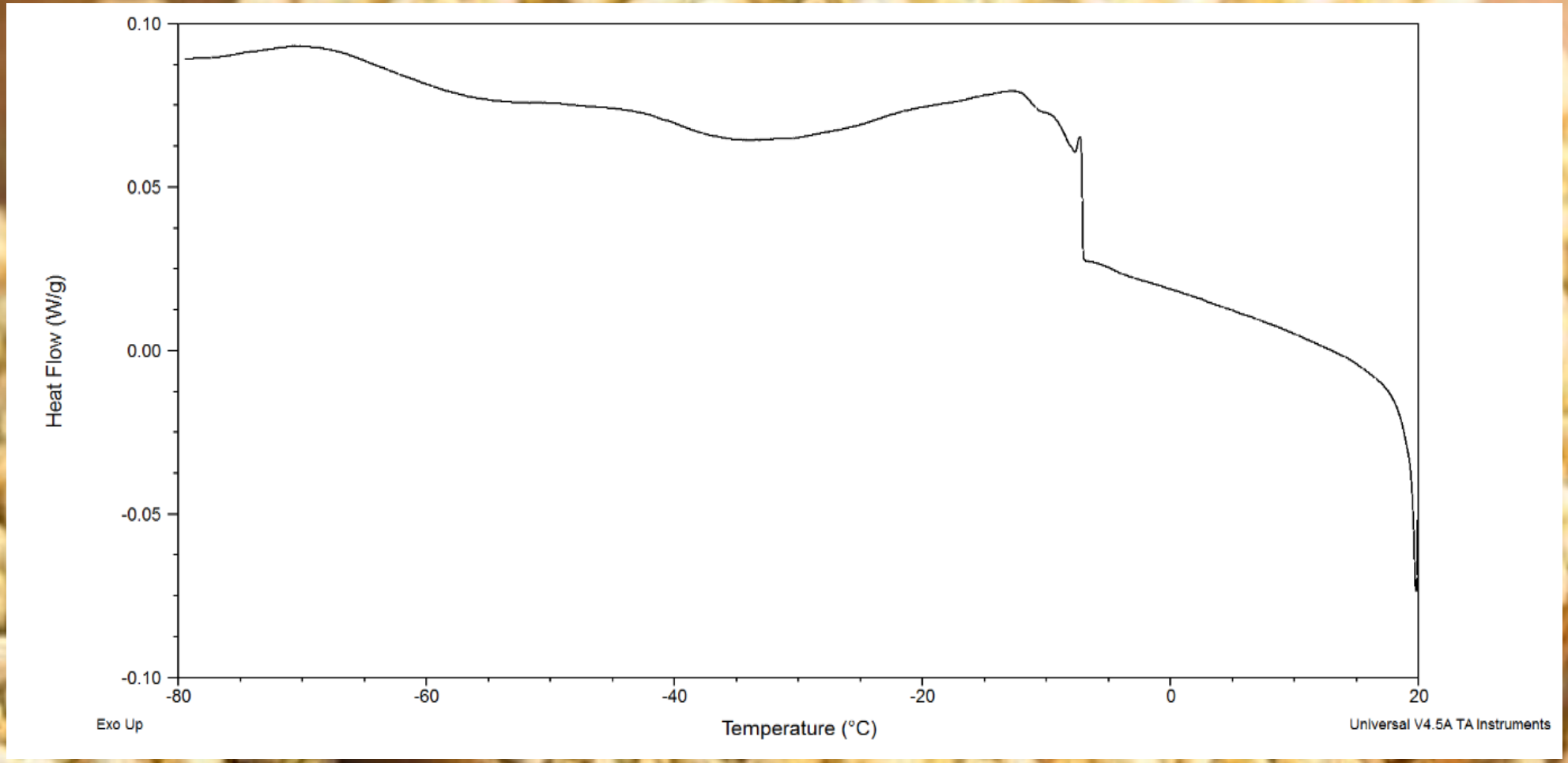

Figure 3. DSC curve of amaranth oil crystallization.

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Results

Fatty Acid	Perecentage (%)	Standard deviation
Linoleic C18:2 n-6c	34.65	±0.07
Oleic C18:1 n-9c	18.05	±0.07
Palmitic C16:0	15.05	±0.21
Others	20.2	±0.14
Docozadiene C22:2 n-6	8.85	±0.07
Stearic C18:0	3.1	0

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Table 1. Fatty acid composition of expanded amaranth seed oil

Results

Three peaks present on the DSC melting curves of amaranth oil, were connected with the presence of low-melting triacyloglicerols with polyunsaturated fatty acids (first peak) and medium-melting fraction rich in triacyloglicerols with monounsaturated and saturated fatty acids (second and third peaks). An exothermic reaction took place in amaranth oil at 120°C. The oil was oxidized after 42.70 minutes. Poppy seed oil analyzed under the same conditions oxidized after about 22.86 minutes. In the case of rapeseed oil, the oxidation time was 60.62 minutes, which means that it is more stable than amaranth seed oil. The analysis carried out at the temperature of 130°C showed an increase in the rate of the oil oxidation process. The oil was oxidized after 17.53 minutes. According to the Van't Hoff rule, an increase in the reaction temperature by 10°C results in a 2-4 times faster reaction. The analysis carried out at 140°C showed an increase in the rate of the oxidation process. The mean value of the two repetitions was 7.44 minutes. The oxidation time tested at 130°C increased 2.4 times compared to the oxidation time at 140°C. PDSC analysis showed good resistance of the oil to oxidation.

Conclusions

On the DSC melting curves of amaranth oil, 3 peaks occurred, corresponding to: fatty acids of the low-melting fraction, monounsaturated fatty acids and saturated fatty acids. The low-melting fraction includes oleic acid, which is also a monounsaturated acid. PDSC analysis of the oil showed its good resistance to oxidation compared to poppy seed oil or hemp oil. However, the oxidation time was definitely shorter than that of rapeseed oil or pumpkin seed oil. Two peaks are visible on the curve obtained as a result of crystallization temperature analysis. The first of them characterizes the low-melting fraction of the oil, the second - the high-melting fraction. The low-melting fraction consists of short-chain, medium-chain and monounsaturated fatty acids. The high-melting fraction includes mainly saturated fatty acids. The composition of fatty acids obtained in the tested amaranth oil confirms the high content of essential fatty acids.