Studying the properties of oils from secondary raw materials

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Abstract. The article analyzes the properties of wild rose and black current oils, received from wastages of fruit and berry processing. Oils from secondary materials are usually used as food and processing additives. We suggest their utilization as functional additives to cosmetic soap. Functional properties of oils are conditioned by fatty acid composition, which was determined with Gas Chromatography. It has been noted that both types of oil contain linoleic, oleate, alpha-linolenic acid, and some medium-chain-length fatty acids. Besides, black currant oil has high content of gamma-linolenic acid. The recommended dosage of additives has been determined with the account of interaction with other components of soap by Delphi method. The best ratio is 1.5…2.0 % of wild rose or black current oils to the mass of the soap base.

1. Introduction

Plant oils are the source of essential substances necessary for normal functioning of the human organism. They have high content of fat-soluble vitamins, sterine and other biologically active components and essential fatty acids [1, 2].

Besides oilseeds and fruit, the source for plant oils for food and industrial use can be secondary oil containing products received during processing of plant agricultural raw material. Fruit and berry stones and press residues have a special role among the wastes formed when jam, confiture, puree, juice and syrups with flesh or without it are produced.

Wild rose and black currant oils have been used as food additives or cosmetic substances. Their application as functional components of soaps has not been estimated yet.

Due to the tendency to use super-fatted soap formulas a consumer is interested in natural additives. Due to this, it is important to develop formulas of soaps with strong softening, hydrating and protective attributes [3, 4, 5].

To determine the functional attributes of wild rose and black currant oils we studied their oil-acid composition and peculiarities of their interaction with other components of the soap.

2. Materials and methods

Wild rose and currant oils after press processing of fruit-berry raw material were used as objects of the study.

As application of black currant oil in soap production is conditioned by the peculiarities of triglyceride composition, gas chromatography method of studies was applied.

Components separation and identification has been conducted with the system of chromatography-mass spectrometry by Agilent. It includes a gas chromatograph HP6890 Plus and a mass-spectrum detector MSD 5973N.
The samples for analysis were prepared by converting fatty acids into methyl ether [6, 7, 8]. Chromatographic conditions: capillary bolster DB-5ms (5% biphenyl and 95% dimethylpolyorganosiloxiane, film thickness 0.25 mkm) 30 m × 0.25 mm in size. The initial temperature of the column heating oven is 40°C; execution time at the initial temperature is 1 min; temperature programming is from 40 to 210 °C at the speed 15 °C/min, from 210 to 280 °C at the speed 5°C/min. Execution time at the finite temperature is 20 min. Carrier-gas is helium, 1 cm³/min (constant flow). The test portion is 0.2 mcl without split ration (liner HP5062-3587 splitless), evaporation is 280 °C. The evaporator temperature and the interface detector is 280 °C.

Optimum oil dose with the account of interaction with other components of the soap were determined by Delphi method with a number scale.

3. Study of triglyceride composition of the wild rose and black current oils with gas chromatography.

| Acid name in basic nomenclature | Fatty acid designation | Mass content, % from the total of fatty acids |
|---------------------------------|------------------------|---------------------------------------------|
| Linolic                          | C₁₈:2 n6c (cis)         | 55.146                                      |
| Oleic                           | C₁₈:1 n9c (μ)           | 30.39                                       |
| Palmitic                        | C₁₆:0                   | 7.7684                                      |
| Stearic                         | C₁₸:0                   | 3.3559                                      |
| Gondoinic                       | C₂₀:1                   | 1.0482                                      |
| Behenic                         | C₂₂:0                   | 0.62907                                     |
| Hamma-linolenic                 | C₁₀₁:0 n5               | 0.43109                                     |
| Arachic                         | C₂₀:1                   | 0.26504                                     |
| Ligiocerinic                    | C₂₄:0                   | 0.21589                                     |
| Linolenic                       | C₁₈:3 n9                 | 0.20884                                     |
| Myristic                        | C₁₄:0                   | 0.14373                                     |
| Palmitoleic                     | C₁₂:0                   | 0.12298                                     |
| Linolenelaidic                  | C₁₈:2 n3f (Iwusw)       | 0.074771                                    |
| Heptadecolic                    | C₁₇:0                   | 0.051411                                    |
| Tricoseric                      | C₂₃:0                   | 0.040457                                    |
| Margaroelic                     | C₁₇:1                   | 0.030134                                    |
| Pentadecolic                    | C₁₈:0                   | 0.023365                                    |
| Dodecolic                       | C₁₂:0                   | 0.019169                                    |
| Eicosadienoic                   | C₂₀:2 (μ)               | 0.012848                                    |
| Heiekozanoic                    | C₂₁:0                   | 0.007994                                    |
| Arachidonionic                  | C₂₀:4 n6                | 0.006587                                    |
| Myristoleic                     | C₁₄:1                   | 0.004362                                    |
| Eicosatrienoic                  | C₂₃:3 n8 (μ)            | 0.001499                                    |
| Erucic                          | C₂₁:1 n9                | 0.001284                                    |
| Cis-pentadecenic                | C₁₃:1                   | 0.000982                                    |

Fatty acids are in the triglyceride composition of natural oil and fats. The functional ingredients are medium-chain-fatty acids, mono- and polyunsaturated fatty acids, including some omega-6 and
omega-3 [9, 10].

Fatty acid composition of wild rose and black currant oil is in tables 1, 2.

| Acids name in basic nomenclature | Fatty acid designation | Mass content, % from the total of fatty acids |
|----------------------------------|------------------------|---------------------------------------------|
| Linolic                          | \( C_{18:2 \text{ n-6}} \) | 64.864                                      |
| Oleic                           | \( C_{18:1 \text{ n-9}} \) | 21.704                                      |
| Palmitic                        | \( C_{16:0} \)           | 6.8502                                      |
| Stearic                         | \( C_{18:0} \)           | 4.1499                                      |
| Gondoinic                       | \( C_{22:0} \)           | 0.67121                                     |
| Behenic                         | \( C_{20:1} \)           | 0.41016                                     |
| Hamma-linolenic                 | \( C_{20:3} \)           | 0.2651                                      |
| Arachic                         | \( C_{16:0} \)           | 0.24758                                     |
| Ligoesteric                     | \( C_{24:0} \)           | 0.18695                                     |
| Linolenic                       | \( C_{20:3} \)           | 0.10543                                     |
| Myristic                        | \( C_{18:1 \text{ n-9}} \) | 0.081947                                    |
| Palmitoleic                     | \( C_{16:1} \)           | 0.049024                                    |
| Linolenelaidic                  | \( C_{12:0} \)           | 0.047972                                    |
| Heptadecoic                     | \( C_{20:0} \)           | 0.04464                                     |
| Tricosoic                       | \( C_{17:0} \)           | 0.030776                                    |
| Margaroelic                     | \( C_{15:0} \)           | 0.027196                                    |
| Pentadecoic                     | \( C_{17:1} \)           | 0.02327                                     |
| Dodecoic                        | \( C_{18:1 \text{ n-trans}} \) | 0.012935                                  |
| Eicosadienoic                   | \( C_{18:2 \text{ n-6}} \) | 0.011776                                    |
| Heiokozanoic                    | \( C_{20:2 \text{ n-6}} \) | 0.0081502                                   |
| Arachidonic                     | \( C_{20:4 \text{ n-6}} \) | 0.0056897                                   |
| Myristoleic                     | \( C_{16:1} \)           | 0.0046407                                   |
| Eicosatrienoic                  | \( C_{21:0} \)           | 0.0015169                                   |

Analyzing the data we can note that both kinds of oil mostly contain linolenic and oleic acids, alpha-linolenic acid, and some amount of medium-chain fatty acids. Besides, black currant oil has a high content of hamma-linolenic acid compared with other oils.

This composition determines lipid barrier support, skin elasticity and hydration, and compensates irritating effect of soap surface active agents [11].

The fatty acid composition of soap influences homogeneity, solvability, consumption rate, foaming and detergency efficiency, level of skin irritation.

4. Determining the optimal oil dose

It is important that additives were in effective amount, considering not only usefulness, but combination with surface active agents. Optimum dose of black currant oil was determined with Delphi method with a number scale (table 3).
Table 3. The scale of organoleptic estimation of soap

| Quality parameter | Numerical value of quality levels | Characteristic of quality levels |
|-------------------|----------------------------------|----------------------------------|
| External view     | 5 Smooth surface, unbroken, without lines, sweat, spots | 4 Smooth or slightly roughened surface, unbroken, with minor lines, sweat, spots |
|                   | 3 Rough surface, unbroken, without sweat, with minor lines, spots | 2 Rough surface, unbroken, without sweat, with minor lines, spots |
|                   | 1 Rough surface, unbroken, without sweat, with minor lines, spots | 5 Hard to the touch. Uniform across |
|                   | 4 Hard to the touch, lines of different structure across | |
| Texture           | 3 Not very hard or a little fragile, lines of different structure across | 2 Not very soft and hard, nonuniform across |
|                   | 1 too gentle or fragile, nonuniform | 5 10…20 |
|                   | 4 21…25 | 3 26…30 |
|                   | 2 31…35 | 1 36…40 |
|                   | 1 Unbroken | 5 Unbroken |
|                   | 4 Easy splitting (Small amount of surface cracks) | |
| Soaking per 1 hour, % | 3 Average splitting (large amount of surface cracks or cracks of mean depth) | 2 Good foaming behaviour, sense of “clean hands” |
|                   | 1 Great | 5 Medium foaming behaviour, sense of “clean hands” |
|                   | 2 Medium foaming behaviour, medium washing off | 4 Poor foaming behaviour, medium washing off |
|                   | 1 Poor foaming behaviour, poor washing off | 5 Does not irritate the skin, softens and hydrates well |
|                   | 5 Level of skin irritation | 4 Does not irritate the skin, softens moderately |
|                   | 3 No irritation, moderate dry feeling | 3 Strong skin dryness |
|                   | 2 Strong skin irritation | 1 Strong skin irritation |

Some samples of soap have been done by the conventional recipe with black currant oil of different dosage.

Evaluation of organoleptic indicators is subjective as done with sense and vision organs. The basic characteristics are: appearance, form, color, smell, texture. It is necessary to introduce some specific quality attributes for the soap with functional additives. At the first stage of the experiment the dosage of natural oils is determined without introduction of flavorings and coloring agents, to exclude heir possible influence on the opinion of experts. Such attributes as “color” and “smell” were excluded.
from the scale of organoleptic estimation of soap samples.

When estimating the product by several attributes it is necessary to decide what aspects to take into account, that is, to determine the importance of each of them. Ten experts were invited. They enumerated the most important aspects which they took into account when estimating soap.

After that the estimations were ranked with the help of calculating the sum of ranks and constructing the ranks matrix [12].

Experts’ conformance has been estimated with concordance coefficient which was equal 0.24. Significance of concordance coefficient when number of factors is less than seven is proved with F-ratio test. Experts’ opinions are conformed.

According to the expert estimation, the main criteria of soap quality had coefficients of significance, further; the estimation of soap by points was done. The samples had different dosage of wild rose and black currant oils.

The best characteristics in reducing skin irritation were with high dosage of functional additives, but the appearance, foam formation and washing ability of soap samples worsened. The best complex parameter of quality was in samples with oil dosage 1.5…2.0 %.

5. Conclusions

The results prove that wild rose and black currant oils received from wastages of fruit-berry processing can be used as functional additives in soap technology.

High quality organic oils with cosmetic properties are a perspective group of products. Such properties of the oils under study as compensation of fatting off, softening, reducing skin dryness after washing – are proved by studies of fatty-acid composition.

The range of domestic goods in this group is rather wide, but there is no balance between the basic soap attributes for consumers and announced cosmetic effect. We have determined the optimal dosage of additives with the account of additional consumer parameters with the method of expert estimation. The most effective is introduction of 1.5…2.0 % wild rose or black currant oils relative to the mass of the soap basis.

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