Characteristics of the fatty acid composition of naked oats of Russian selection

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Abstract. The fatty acid composition of acyl lipids of 7 naked oat cultivars was studied. Lipids are source of energy and plastic material; promote metabolic processes in the body. In the grain of studied lines the content of raw lipids varied from 5.91 to 7.87 %. The main fatty acids of the investigated lines of naked oats are linoleic (36.2-38.7 %), oleic (33.5-36.7 %), palmitic (15.3-17.8 %). According to the content of oleic and linoleic fatty acids and their ratio (1: 1), lipids of naked oats belong to the oleic-linoleic group of vegetable oils.

1. Introduction

It is known that the basis of the world food system is made up of cereals. Annually, the production of cereals is approximately 3 times higher than the total production of other crops, including leguminous plants.

Today, all nutritionalists advise to keep cereals as the central part of our diet because of their natural high content of carbohydrate complex, characterized, in particular, by their large prebiotic and bifidogenic ability.

Epidemiological studies have shown that consumption of whole-grain products, obtained from such traditional crops for northern regions of Russia as rye and oats, is associated with a decrease in the incidence of a number of chronic diseases, in particular diabetes, cardiovascular diseases.

At present, extensive work is carried out on the selection of naked oats, effective for growing in various soil and climatic zones and resistant to pathogenic organisms and abiotic factors [1].

Benchmarking of the production and processing of naked oats has shown that the strong side of the naked oat is a high nutritional value [2].

The presence of lipids distinguishes oat grain from other cereals [3,4,5]. Oat grain lipids mainly consist of unsaturated oleic (18:1) and linoleic (18:2), and saturated palmitic (16:0) acids and low levels of stearic (18:0) and linoleic (18:3) acids [6,7].

Currently, in different oat cultivars, the lipid content is in the range of 5-8 % [7,8]. It makes the oat a potentially oilseed crop. The oil content in the seeds of such cereal crops as wheat, barley, rye and triticale is only 1-3 % [8,9].

Acyl (saponifiable) lipids are sources of acyl radicals ω-9, ω-6 and ω-3 fatty acids, of which ω-6 and ω-3 are considered as essential nutrition factors. In general, speaking about the functionality of saponifiable lipids, as sources of essential fatty acids, we can state:

- monounsaturated fatty acids (ω-9) are equivalent in their effectiveness to polyunsaturated fatty acids in terms of lowering the level of cholesterol in the blood;
- (ω-3) fatty acids have a healing effect and are considered as indispensable nutritional factors, especially in childhood;
- there is a relationship between specific fatty acids (γ- and α-linolenic acid) and physiological response in some diseases [10].

**The purpose of this study** was to study the fatty acid composition of acyl lipids of naked oats of domestic selection.

2. **Objects and methods of research.**

For the study were selected samples of cultivated and new cultivars of naked oats. As the morphological characteristics of the grain were used the parameters of the grain volume weight and 1000 seeds weight (Table 1).

Samples of grain were provided by the Zonal Scientific Research Institute of Agriculture of the Northeast named after N.V. Rudnitsky (city of Kirov).

| No. | Cultivar   | Origin (parental forms)         | 1000 seeds weight, g | Grain volume weight, g/L |
|-----|------------|---------------------------------|----------------------|-------------------------|
| 1   | 1h07       | K-2108 Pushikinsky Golozerny    | 25.9                 | 698                     |
| 2   | 766h05     | Borys x Mozart                  | 26.0                 | 701                     |
| 3   | 41h04      | Faust x Mernime                 | 24.6                 | 701                     |
| 4   | 74h12      | 86h04 x BAI 3                  | 27.8                 | 703                     |
| 5   | 8h12       | 1h07 x 543h02                  | 24.5                 | 710                     |
| 6   | 857h05     | OA-503-1 x Tyumensky Golozerny | 26.1                 | 710                     |
| 7   | 37h12o     | Sallust x Vyatsky               | 25.8                 | 723                     |

The content of lipids in the selection oat cultivars was determined in accordance with GOST 10857-64 "Oilseeds. Method for determination of oil content". The fatty acid composition of oat oil was determined by gas-liquid chromatography according to GOST R ISO 5508:2010 "Animals and vegetable fats and oils. Determination of methyl esters of fatty acids (FAME) by gas chromatography". Preparations of methyl esters were carried out in accordance with GOST R ISO 5509:2000 "Animal and vegetable fats and oils: Preparation of methyl esters of fatty acids".

3. **Results and discussion.**

The content of raw lipids varies from 5.91 to 7.87 % in the grain of the investigated naked oat cultivars (Table 2). The average lipid content is 6.9 % ± 0.98 %.

The noted limits of variation of this measurement are characteristic for grain of cultural types of oats, both hulled and naked. The content of lipids above 7-9 % is very rare for them [11]

| No | Cultivar   | Humidity, % on dry matter | Fat content, % on dry matter |
|----|------------|---------------------------|-------------------------------|
| 1  | 1h07       | 9.13                      | 7.71                          |
| 2  | 766h05     | 9.43                      | 5.91                          |
| 3  | 41h04      | 9.18                      | 7.87                          |
| 4  | 74h12      | 8.99                      | 6.59                          |
| 5  | 8h12       | 8.78                      | 7.58                          |
| 6  | 857h05     | 9.44                      | 6.10                          |
| 7  | 37h12o     | 8.88                      | 6.32                          |

The lipid complex of investigated naked oat cultivars was characterized by fatty acid composition (Table 3).
Table 3. Fatty acid composition of lipids of naked oats

| Fatty acids                        | Designation  | Content, % of the amount | 1h07 | 766h05 | 857h05 | 41h04 | 37h12o | 74h12 | 8h12 |
|-----------------------------------|--------------|--------------------------|------|--------|--------|-------|--------|-------|------|
| Saturated acids                   |              |                          |      |        |        |       |        |       |      |
| Hexanoic (caproic)                | C6:0         |                          | 0.17 | 0.07   | 0.14   | 0.19  | 0.23   | 0.21  | 0.08 |
| Tetradecanoic (myristic)          | C14:0        |                          | 0.36 | 0.38   | 0.37   | 0.31  | 0.35   | 0.28  | 0.27 |
| Hexadecanoic (palmitic)           | C16:0        |                          | 16.63| 17.41  | 17.8   | 16.60 | 16.58  | 15.38 | 15.34|
| Octadecanoic (stearic)            | C18:0        |                          | 1.70 | 1.05   | 1.25   | 1.87  | 1.38   | 1.23  | 1.24 |
| Monounsaturated acids             |              |                          |      |        |        |       |        |       |      |
| cis-9-hexadecenoic (palmitoleic)  | C16:1        |                          | 0.19 | 0.37   | 0.29   | 0.17  | 0.36   | 0.33  | 0.17 |
| cis-11-octadecenoic (vaccenic)    | C18:1        |                          | 0.89 | 1.03   | 1.00   | 0.89  | 0.66   | 0.87  | 0.74 |
| cis-9-octadecenoic (oleic)        | C18:1        |                          | 35.74| 33.74  | 33.49  | 36.42 | 36.18  | 36.34 | 36.73|
| cis-11-eicosenoic (gondoic)       | C20:1        |                          | 0.82 | 0.88   | 0.73   | 0.85  | 0.79   | 0.85  | 0.73 |
| cis-11-docosenoic (cetoleic)      | C22:1        |                          | 0.70 | 0.24   | 0.24   | -     | -      | -     | 0.24 |
| cis-13-docosenoic (erucic)        | C22:1        |                          | 1.11 | 0.68   | 0.89   | 0.88  | 0.76   | 0.67  | 0.91 |
| Diunsaturated acids               |              |                          |      |        |        |       |        |       |      |
| all cis-9,12-octadecadienoic (linoleic) | C18:2      |                          | 36.25| 38.68  | 38.37  | 35.89 | 37.12  | 37.61 | 37.83|
| all cis-9,12-tetracosanoic         | C24:2        |                          | 1.13 | 1.31   | 1.00   | 1.06  | 1.29   | 1.26  | 1.48 |
| Triunsaturated acids              |              |                          |      |        |        |       |        |       |      |
| all cis-9,12,15-octadecatetraenic (α-linolenic) | C18:3    |                          | 1.46 | 1.5    | 1.61   | 1.12  | 1.43   | 1.69  | 1.25 |
| No data                           |              |                          | -    | 2.85   | 2.67   | 2.83  | 3.75   | 2.86  | 3.29 |

Triglycerides of oat lipids of the studied genotypes are represented by three types of fatty acids — saturated (palmitic acid), monounsaturated (oleic acid), dinosaturated (linoleic acid). The proportion of these acids in the lipids of the studied lines accounted for an average 89.4 %. The ratio of linoleic acid to oleic acid is close to 1. It allows to attribute oat oil to the oleic-linoleic group of oils (Table 4). The noted features of fatty-acid composition of lipids of naked oats are characteristic for tetraploid species, such as A.barbata, A.magna, A.vaviloviana [12].

It is actual to study lipid changes during grain storage so the oats is marked by a significant variety of lipases and lipoxidases [18]. Human body does not have effective chemical systems for the transformation of the compounds of one family of essential fatty acids into compounds of another family, therefore in assessing the nutritional properties of oat lipids metabolic pathways of linoleic acid, the family of n(ω)-6 essential fatty acids, are considered (Figure 1).
Essential fatty acids, including linoleic (ω-6), are important as precursors of hormonal compounds. So linoleic acid is the basis of the formation of hormone-like compounds called eicosanoids, such as prostaglandins and leukotrienes, which play an important role in maintaining the body's homeostasis. There is a positive effect of linoleic acid on the lipid profile of blood serum of patients with diabetes mellitus. On the contrary, a deficiency of linoleic acid contributes to the development of atherosclerosis. Optimum consumption of linoleic acid is 5-8 % of the total caloric value [10,13].

Fatty acid composition of selected lipids allows attribute oat oil to the oleic-linoleic group, which includes such vegetable oils as sesame, peanut (Table 4).

| Vegetable oils | Saturated | Monounsaturated | Polyunsaturated |
|----------------|-----------|----------------|-----------------|
|                |           |                | Linolic | Linolenic |
| Oat            | 18.4±1.1  | 38.5±1.4       | 37.4±1.4 | 1.5±0.2   |
| Peanut *       | 19.5      | 37.0           | 42.0     | 1.5       |
| Pumpkin *      | 19.2      | 28.0           | 52.0     | 0.8       |
| Corn *         | 14.5      | 32.5           | 52.0     | 1.0       |
| Sesame *       | 13.5      | 42.0           | 44.0     | 0.5       |
| Wheatgerm *    | 16.0      | 22.0           | 57.0     | 5.0       |
| Sunflower *    | 12.5      | 24.0           | 63.0     | 0.5       |

* borrowed from [14]

The optimal ratio in the daily diet of ω-6 to ω-3 fatty acids should be 5-10 : 1 [15].

The lines of the naked oats 41h04 and 857h05 were transferred to the State Test, respectively, as Bekas and Bagel cultivars for the production of functional and gluten-free foods – the content of oleic acid is 36.42 and 33.49 %, linoleic 35.89 and 38.37 % respectively, gluten is less than 0.2 mg/g of product [16,17].

4. Conclusions.

1. Lipids of naked oats by fatty acid composition belong to the oleic-linoleic group of vegetable oils according to the content of oleic and linoleic acids and their ratio (1:1);
2. The content of crude lipids varied from 5.91 % to 7.87 % and averaged 6.9 % ± 0.98 % in the grain of the studied lines;
3. Linoleic (36.2-38.7 %), oleic (33.5-36.7 %), and palmitic (15.3-17.8 %) acids are the main fatty acids of lipids of naked oats of the selection studied lines;

4. When designing the food matrix of functional and specialized products based on or with the addition of oatmeal, it is necessary to take into account the metabolic aspects of the main nutrients taking into account their bioavailability.

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