Fatty acid composition of seeds of pumpkin (Cucurbita) varieties cultivated mechanized in the conditions of the Nonchernozem zone of the Russian Federation

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Abstract. One of the most important factors for maintaining human health is a good nutrition of macro and micronutrients. Insufficient nutrition of essential nutrients leads to various disorders of the body. In recent years, more and more malnutrition has been observed, especially a deficiency of polyunsaturated fatty acids, vitamins and minerals. Of great interest is pumpkin seed oil, which is rich in linoleic acid. Linoleic acid belongs to the polyunsaturated fatty acids of the omega-6 family, which is not formed in the body and must be constantly supplied with food. Cultivation of pumpkin in the temperate zone is very important. This will provide the population with vegetable oil with high biological efficiency due to the content of linoleic acid. The fatty acid composition of pumpkin seeds is influenced by many factors: climatic data, varieties, agricultural practices, etc. Mechanized industrial crops of pumpkin are located mainly in the southern regions, due to the fact that this crop is thermophilic. In recent years, there has been a change in climate, in the temperate zone, the growing season has increased due to the earlier onset of spring and later autumn, the sum of active temperatures, etc. There is a certain tendency to increase the area occupied by this crop in the temperate zone. The correct selection of varieties and variety samples for mechanized cultivation becomes an urgent task. The experiments were carried out in the Moscow region. 16 varieties and variety samples were studied according to the standard method. A high oil content in the studied samples was revealed - The studied varieties and variety samples have a high oil content: from 33.6 to 54.6%. When studying the fatty acid composition, the highest content is represented by the essential polyunsaturated fatty linoleic acid up to 68.55% - in the Pivdenny variety.

1. Introduction

The nutritional value of pumpkin and a wide range of biological activity have long been known. The kernel of pumpkin seeds is used for food. They are rich in fatty acids, proteins, minerals and a large number of various vitamins. Essential polyunsaturated fatty acids play a particularly important role; they are not formed in the human body and can only come from food. According to some scientists,
pumpkin seeds also contain more than 50 macro- and microelements [2;4;7]. The use of pumpkin seeds in various dishes and supplements will allow improve the nutrition of the population with high nutritional value and biological activity, cultivating them in this region.

The great interest is pumpkin seed oil [5-6;12]. The composition of pumpkin seed oil includes oleic, palmitic, stearic and linoleic [10-11]. The biological effectiveness of oils depends on the content of linolenic and linoleic fatty acids. They are called indispensable, since they are not formed in the human body and can only come from outside, i.e. with food, while they are important components for ensuring the normal functioning of the human body. Other fatty acids can be formed under certain conditions, for example, arachidonic acid is formed in the presence of vitamin B6.

The level of total lipid content and fatty acid composition is influenced by climatic conditions of cultivation [8;13]. There are scientific studies on the negative relationship between fat and protein, as well as between the amount of fat and cultivation temperature. With a decrease in the amount of solar energy in autumn, the formation of proteins in the plant decreases, but the formation of fats sharply increases. Therefore, in the conditions of the temperate zone (Moscow region), pumpkin seeds have a higher content of fatty acids [9;11]. As is known, to provide protection from low temperatures, plants in the northern regions form a larger amount of lipids [5;7], vitamins, and organic acids. Pumpkin is grown mainly in the southern regions of Russia, the features of cultivation in the conditions of the Moscow region have not been sufficiently studied. In terms of the gross harvest of vegetables, the Moscow region ranks first in the Central Federal District of the Russian Federation (600 thousand tons) [8]. The assortment of pumpkin in the State Register of Breeding Achievements approved for the use of domestic varieties in the Russian Federation is small [14], foreign varieties are also used for cultivation. In recent years, new varieties have been introduced. The selection of varieties for the mechanized cultivation of pumpkins in the Non-Chernozem zone of the Russian Federation is very important and will provide the population with essential fatty acids for the use of dietary and therapeutic nutrition, as well as in pharmacology.

2. Materials and methods
The studies were carried out in the field area of the open ground of the Russian State Agrarian Extramural University (55° 80' 9.4“ north latitude, 37° 95' 81.9“ east longitude at an altitude of 145 m above sea level). The soil is soddy-podzolic on podzolic loam with a plow horizon of 23...29 cm, mobile potassium - 24.2 ... 26.1 mg, pHsol. - 5.8 ... 6.6, humus content - 2.4 ... 2.9%.

Seedlings were grown in a greenhouse for a total duration of 20–27 days, depending on the weather and climatic conditions, where the air temperature was maintained at 25–27 °C until emergence of seedlings; after emergence, the air temperature was lowered by 4–5 days to 15–16 °C during the day and 12...14 °C at night; then the temperature regime was 15...17 °C at night, 17...18 °C in cloudy weather, and 20...21 °C on sunny days. Seedlings were periodically watered with water and the greenhouse was ventilated to remove excess moisture. The seedlings were then planted in the field. The cultivation technology is standard, the experience was laid according to the method of field experiment B.A. Dospekhov [1]. Scheme of planting plants of varieties of pumpkin fig-leaved 1.4 m x 2.1 m; pumpkins of nutmeg, hard-bark and large-fruited - 1.4 m x 1.4 m.

The following variety specimens of four types of pumpkin served as the material for research:

- Hard-barked pumpkin: Spaghetti (Czech Republic), Pivdennaya (Ukraine), Mozoleevskaya 49 (Russia).
- Large-fruited pumpkin: Pastila champagne (France), Ambar (Russia), Marine Di Chioggia (Czech Republic), No. 119-C (Russia).
- Muscat pumpkin: Butternut (Czech Republic), No. 19-Pgv (Russia), Muscat of Provence (France), Beauty (Russia), Vitaminnyaya (Russia), No. 13-M (Russia), No. 26-Mch (Russia), No. 28-IG (Russia).
- Fig-leaved pumpkin: No. 4480 (Russia).
Determination of crude fat content was determined by the extraction method in accordance with GOST 10857-64 Oilseeds. Methods for determining oil content; determination of the fatty acid composition of the lipid fraction from varieties and variety specimens was carried out in accordance with GOST 30418-96 Method for determining the fatty acid composition.

3. Results and Discussion
The nutritional value of pumpkin seeds is determined by their oil content (figure 1). The studied varieties and variety specimens have a high oil content: from 33.6 to 54.6%. Variety specimen No. 119-C (large-fruited) has an average of 54.6% of oil over the years, slightly lower in variety Pivdennaya (hard bark), from the group of nutmeg gourds, variety specimen No. 28-Ig (49.8%) is distinguished by a higher oil content. The fig-leaved gourd (No. 4480) has a low oil content - 34.8% on average over the years.

Figure 1. Oil content (%) in seeds of variety specimens of different types of pumpkin (in the kernel), average for 2008 ... 2012.

The fatty acid composition of pumpkin seeds is represented by fatty acids: myristic, palmitic, palmetoic, stearic, oleic, linoleic, α-linolenic, arachidonic. Of these, the highest content is represented (table 1) by linoleic acid from 55.48 to 65.19%, depending on the variety and variety specimen; In the range of 8.99 ... 14.00%, pumpkin seeds contain oleic acid (the maximum content in the Pastila champagne variety and the minimum in the Krasavitsa variety). In the range of 3.05 ... 5.69% there is stearic acid, the minimum content is in the variety specimen Pastila champagne (3.05%) and the maximum content is in the variety specimen No. 119-C (5.69%).

Polyunsaturated fatty acids (PUFAs) are essential nutrients, since they are not synthesized in the human body and are irreplaceable, they are part of all cells and tissues, are biologically active substances, form hormone-like substances, etc. The amount of polyunsaturated fatty acids, depending on the variety and variety specimen, is 55.90 to 65.86%. Therefore, all seeds of the studied varieties and varieties can be used to saturate various PUFA dishes.

Pumpkin seeds also contain saturated fatty acids (SFA) - 17.76 ... 22.67%. These are refractory fats, they take longer to digest and are less absorbed by the body.

And there are also monounsaturated fatty acids (MUFA), it is represented by oleic acid. Oleic acid has a beneficial effect on lipid metabolism, and is also classified as a possible, nutritional factor that reduces the risk of cardiovascular disease. In pumpkin seeds, from 8.99 to 14.00% MUFA, the main part is oleic acid.
Table 1. Fatty acid composition of seeds of variety specimens of different types of pumpkin, average for 2008 ... 2012.

| View, variety specimen | Acid content, % | Amount of PUFA, % | Amount of NFA, % | Amount of MUFA, % |
|------------------------|-----------------|-------------------|-----------------|-------------------|
|                        | myristic | palmitic | palmitoleic | stearic | oleic | linoleic | α-linolenic | arachidonic |               |               |               |
| Mozoleevskaya a 49 (st.) | 0.19     | 15.02    | 0.22         | 0.23     | 4.51  | 11.63    | 65.10       | 0.22         | 0.26        | 65.58       | 19.95        | 11.85        |
| Pivdenny               | 0.21     | 13.37    | 0.19         | 0.26     | 3.96  | 13.24    | 65.19       | 0.36         | 0.31        | 65.86       | 17.80        | 13.43        |
| Spaghetti              | 0.18     | 15.00    | 0.17         | 0.21     | 4.57  | 11.06    | 65.11       | 0.23         | 0.24        | 65.58       | 19.96        | 11.23        |
| No. 4480               | 0.17     | 13.61    | 0.33         | 0.21     | 4.89  | 12.83    | 65.11       | 0.18         | 0.40        | 64.79       | 18.88        | 13.16        |

Hard-barked pumpkin

| Pastilla champagne  | 0.19     | 13.42    | 0.20         | 0.30     | 3.05  | 14.00    | 65.01       | 0.25         | 0.31        | 65.57       | 17.76        | 14.20        |
| Barn                 | 0.11     | 13.81    | 0.18         | 0.19     | 5.29  | 12.89    | 58.94       | 0.28         | 0.38        | 59.60       | 19.80        | 13.07        |
| Marine Di Chioggia  | 0.15     | 14.64    | 0.14         | 0.33     | 4.66  | 11.02    | 56.90       | 0.19         | 0.26        | 57.35       | 19.78        | 11.16        |
| No. 119-C            | 0.10     | 14.68    | 0.13         | 0.28     | 5.69  | 13.18    | 61.83       | 0.25         | 0.17        | 62.25       | 20.45        | 13.31        |

Large-fruited pumpkin

| Butternut            | 0.18     | 15.00    | 0.11         | 0.19     | 4.94  | 9.11     | 64.08       | 0.36         | 0.31        | 64.75       | 20.31        | 9.22         |
| No. 19-Pgv           | 0.13     | 16.30    | 0.16         | 0.28     | 4.61  | 10.80    | 65.13       | 0.31         | 0.27        | 67.51       | 21.32        | 10.96        |
| Muscat of Provence   | 0.16     | 17.06    | 0.21         | 0.34     | 5.11  | 10.16    | 62.12       | 0.19         | 0.26        | 62.57       | 22.67        | 10.37        |
| Beauty               | 0.16     | 16.61    | 0.25         | 0.21     | 5.28  | 8.99     | 55.48       | 0.26         | 0.16        | 55.90       | 22.26        | 9.24         |
| Vitamin              | 0.11     | 15.12    | 0.11         | 0.25     | 5.00  | 10.00    | 57.80       | 0.33         | 0.19        | 58.32       | 20.48        | 10.11        |
| No. 13-M             | 0.18     | 16.00    | 0.14         | 0.19     | 4.44  | 11.09    | 60.39       | 0.21         | 0.20        | 60.80       | 20.81        | 11.23        |
| No. 26-Mch           | 0.10     | 17.01    | 0.19         | 0.30     | 5.09  | 10.49    | 59.87       | 0.30         | 0.25        | 60.42       | 22.50        | 10.68        |
| No. 28-lg            | 0.19     | 15.03    | 0.24         | 0.24     | 4.12  | 9.45     | 59.05       | 0.35         | 0.33        | 59.73       | 19.58        | 9.69         |

Palmitic acid is found in sufficient quantities in pumpkin seeds, it is the most common fatty acid in nature - from 13.37 to 17.06%. The maximum amount of it is in the variety Muscat of Provence (17.06%) and in the variety specimen No. 26-Mch (17.01%), the minimum is in the variety Pivdennaya (13.37%).

Thus, the studied varieties and variety specimen of pumpkin cultivated in the temperate zone (Moscow region) have a wide range of fatty acid composition. The seeds of the investigated pumpkin varieties contain 55.48 ... 65.19% of the essential fatty acid (linoleic), which determines the nutritional value. The maximum content is in the variety Pivdennaya (t. hard-bark). Cultivation of various types of pumpkin in a temperate climate will reduce the need for a valuable product and improve the nutrition of the population.

4. Conclusion
Thus the addition of light sprouting of tubers in the technology of early potato cultivation does not require significant energy costs and provides a high net energy income, high coefficients, as well as a low energy cost. Such cultivation can be considered resource-saving.

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