Assessment of the seed safety indicators from oilseed cruciferous crops in the organization of complex processing technology

Ya V Smolnikova, M A Yanova, V L Bopp and J A Olentsova
Krasnoyarsk State Agrarian University, 90 Mira ave., Krasnoyarsk, 660049, Russia

E-mail: ya104@yandex.ru

Abstract. For the organization of complex processing technology of oilseed cruciferous crops in the Siberian region varieties of spring rapeseed (Brassica napus), spring ginger (Camelina sativa) and white mustard (Sinapis alba) were investigated. The short characteristics of rapeseed, ginger and mustard varieties promising for cultivation in agro-climatic conditions of the Krasnoyarsk region are given. Safety indicators were evaluated, concentrations of toxic elements, mycotoxins, benzopyrene of pesticides, radionuclides in grain were determined. It is established that the studied varieties of cruciferous meet the safety requirements in accordance with the Technical regulations of the Customs Union TR CU 015/2011 for all analyzed indicators.

1. Introduction
Oil-fat complex in Russia is one of the central places in the food industry. Products of oilseeds processing are the most valuable food products of daily consumption, as well as raw materials for many sectors of the economy, as evidenced by the steady growth of production in the fat-oil industry [1].

The development of the national oil-fat industry should take place both in the direction of creating innovative technologies, new, physiologically favorable and that meet the modern requirements of healthy and medical - preventive food products, and in the direction of the development in the raw material base for their production. The increase in the production of vegetable oils should be solved by finding new types of raw materials.

The latest achievements of selection science make it possible to process a number of varieties and hybrids of new generation oilseeds with a different set of fatty acids, high content of fat-soluble vitamins, in particular tocopherol group, increased resistance of oils to oxidative damage on an industrial scale.

In recent years, the national selection of oilseeds has come to a fundamentally new stage of development, the essence of which is the expansion of the species limits of genetic variability of fatty acid composition of oil in seeds. The quality of the oil, its nutritional, biological and technological properties depend on the composition and molecular position of fatty acids in triacylglycerol, as well as on the presence of various fat-soluble related components (tocopherols, sterols, pigments, etc.) [2].

The source of valuable biologically active components and essential fatty acids can serve as oilseeds cruciferous: rapeseed, ginger, and mustard. Achievements of the last decades allow speaking about expediency of cultivation and processing of the considered crops which are capable to give steady harvests in the conditions of risky agriculture zones.
Representatives of the cruciferous: rapeseed, ginger and mustard, are valuable oilseed and forage crops. As a source of food oil and feed protein, they occupy an important place in solving the problems of food security of the population.

Throughout the world, the area with the main oilseeds has decreased. Moreover, the market price for them in the EU has increased more than doubled, and the demand for oilseeds — about 3%. The greatest yield of oilseeds grown in our country has winter rapeseed (20 c/ha), while soybean and sunflower, have respectively 9.3 and 11.5 c/ha. In world agriculture, rapeseed is one of the main oilseeds.

Data on export-import in Russia indicate a significant demand for rapeseed oil in the internal market. From 130 to 170 thousand tons of rapeseed oil are imported to Russia from abroad, which is about 20% of the vegetable oil production in the country [3], [4].

Also, the issue of import replacement has a significant impact on the development of the fat-oil complex in the Siberian region. Representatives of cruciferous are successfully cultivated in zones of critical agriculture and can be used as an alternative source of oilseeds, as a replacement for soybean oilseeds.

It is necessary to develop a set of methodological, technological and organizational measures to improve the technological processes of complex processing of rapeseed, ginger, mustard to decide the issue of import replacement, increase production.

Creation of complex high-technology production of vegetable oil raw materials of cruciferous and products of its processing in the conditions of Siberia assumes use of both natural factors, and modern achievements of agricultural biotechnology and original developments of deep processing of grain.

The main purpose of the complex processing of cruciferous seeds is to justify approaches and implementation of effective waste-free, environmentally pure biotechnological methods for obtaining national food and feed products, vegetable protein preparations, lecithin.

One of the first tasks for the creation of such technology is the selection of the most promising varieties and safety assessment of breeding low-erucic varieties of rapeseed, ginger and mustard.

2. Methods and results
Decisive parameters for the selection of varieties for cultivation in agro-climatic conditions of experimental fields of the Krasnoyarsk state agrarian university and JSC "Salyanskoe" are as follows:

- seed germination at +1+5 °C (optimum germination temperature +12+15 °C);
- resistance to frost shoots to -3-5 °C;
- resistance of mature plants to frost up to -8 °C
- requirements for heat in the summer months at +18-20 °C (during flowering +20+25 °C);
- the required amount of temperatures for the growing season 1700-2100 °C;
- the ability to guarantee yield on moderately saline soils with the reaction of the soil environment 6.3-7.7.

The following varieties and hybrids of spring rapeseed included in the State register of selection achievements approved for use in the Krasnoyarsk region were selected as objects of research:

- hybrid Miracle, hybrid 00 type, the average seed yield in the East Siberian region - 24 c/ha (+22.1% to the standard level), the fat content in seeds - on average from 46.7 % to 47.7 %, oil gathering - 11.3 c/ha in the East Siberian region, the growing season - 102 days. Plant height - 115 cm;
- hybrid Lumens, hybrid 00 type, the average yield in the East Siberian region - 18.1 c/ha, 3.1 c/ha above the standard, the highest yield obtained in 2016 at the Irkutsk complex GSU - 34.9 c/ha, vegetation period - 103 days, weight of 1000 seeds - 3.1 - 4.1 g, resistance to lodging - 4.2 - 5.0 points, to falling - 3.2 - 4.1 points, fat content in seeds - 42.0 - 48.8%, exceeds the standard 6.3 %;
• hybrid Trapper, medium early hybrid, non erucic, low glucosinolate, the average yield - 24.4 c/ha, the seeds contain - 40.6% of fat, 0.5 % of glucosinolate, the protein content in the flakes - 26.3 %, the yield of oil per hectare to 8.6 C, protein 5.6 C, the content of erucic acid in the fat - 0.46 %, oleic - 60.9 %, linoleic - 21.4 %, linolenic - 8.63 % palmitic - 4.48 %, stearic - 1.93 %;
• Siberian variety, variety 00 type, included in the State register for West Siberian (10) and East Siberian (11) regions, recommended for cultivation in the republics of Khakassia, Tyva and V zone of the Krasnoyarsk territory for seeds and feed, the average seed yield in the West Siberian region - 14.1 c/ha, 1.6 c/ha above the standard, the highest yield obtained in 2016 at the Ishim GSU of the Tyumen region - 27.9 c/ha, the growing period - 94 days, 2-7 days shorter than standard, the fat content in seeds - 44.7 %, exceeding the standard by 1.1 % [5].

Taking into account the peculiarities of the agro-climatic zone and varietal characteristics for tests on cultivation of oilseeds, the following varieties of spring ginger and white mustard were studied:

• variety of spring ginger Uzhurskaya, weight of 1000 seed - 1.35 g, average seed yield - 1.5 t/ha, vegetation period - 71 days, the fat content in the seeds - 36-40 %, resistant to rust, susceptible to real and false powdery mildew;
• variety of white mustard Snow White, included in the State register of the Russian Federation for the zones of crop cultivation for use on seeds, green mass, green fertilizer, diploid, seed yield - 21.0-23.0 c/ha, green mass - 260-300 c/ha, fat content in seeds - 43.0-45.0 %, erucic acid content in oil - 0.1 %, the glucosinolate content in the flakes - 17.0 mm/year, the vegetation period - 65-80 days, resistant to crucifers blossom weevil.

Oilseeds were collected in the stage of technological maturity in 2018.

The determination of these indicators was carried out in accordance with the established methods:
GOST 33780-2016 Food, feed, compound feeds. Determination of aflatoxin B content with index 1 by high-performance liquid chromatography using aluminum oxide purification; GOST 30178-96 Raw materials and food products. Atomic absorption method for determination of toxic elements; GOST 26927-86 Raw materials and food products. Methods for mercury determination; GOST 31481-2012 Compound feeds, compound feed raw materials. Method for determination of organochlorine pesticide residues; GOST 32161-2013 Food. Method for determination of cesium Cs-137; GOST 32163-2013 Food. Method for determination of strontium content Sr-90; GOST 32164-2013 Food. Sampling method for strontium Sr-90 and cesium Cs-137 determination.

One of the important factors in the organization of complex high-technology production of vegetable oilseeds and products of its processing is the assessment of oilseeds safety indicators.

The study on the oilseeds safety indicators was carried out on the basis of the Technical regulations of the Customs Union TR CU 015/2011- About the safety of grain supplied for food purposes. Concentrations of toxic elements, mycotoxins, benzopyrene, pesticides, and radionuclides in grain were determined as safety indicators.

Test results are presented in table 1.

| Indicator | Measure units | Miracle | Lumens | Trapper | Siberian | Ginger | Mustard | Permissible levels, not more than |
|-----------|---------------|---------|--------|---------|----------|--------|---------|---------------------------------|
| Lead      | mg/kg         | 0.36±0.1 5 | 0.62±0.24 | 0.22±0.06 | 0.39± 0.19 | 0.59± 0.21 | 0.77± 0.30 | 1.0 |
| Cadmium   | mg/kg         | 0.102± | 0.091± | 0.133± | 0.08± | 0.13± | 0.115± | 0.3 |
As it can be seen from the results of table 1, the studied varieties of cruciferous meet the safety requirements of the Technical regulations of the Customs Union TR CU 015/2011 - About grain safety for all analyzed indicators.

3. Conclusion
A comprehensive system of oilseeds deep processing using methods of biotechnology, freeze drying, extrusion processing and other advanced technologies will improve the quantity and quality of products developed. The use of seeds grown in local Siberian conditions for production will ensure high productivity of plants and efficiency of industrial processing of oilseeds.

Among the key scientific and technical problems solved by the creation of high-technology production are: the production and processing of oilseeds, safety assessment of raw materials, the creation of new employment creations, increasing tax revenues. The creation organization of effective non-waste, environmentally pure biotechnological methods of oilseeds complex processing of cruciferous crops will provide the population of Siberia with high-quality vegetable oils from non-traditional raw materials, food and feed products, vegetable protein preparations.

Acknowledgments
The results were obtained with the financial support of the Ministry of science and higher education of the Russian Federation (a subsidy for the implementation of a comprehensive project to create high-technology production) in the framework of research and development on the theme "Creation of a comprehensive high-technology production of vegetable oilseeds and products of its processing in Siberia".

References
[1] Bykova S F, Davidenko E K, Efimenko S G and Efimenko S C K 2017 Ways to expand the range of food vegetable oils Bulletin of the all-Russian research institute of fats 1-2 15-9
[2] Lisitsyn A N, Bykova S F, Davidenko E K and Efimenko S G 2013 Prospects for the development of raw materials for the new types production of food vegetable oils Bulletin of the all-Russian research institute of fats 2 9-13
[3] Gorkovenko L H and Osepchuk D V 2011 The use of rapeseed and its products in feeding pigs and meat poultry North-Caucasian research institute of animal husbandry 192
[4] Oleynikova E N, Yanova M A, Pyzhikova N I, Ryabtsev A A and Bopp V L Spring rapeseed – a promising culture for the development of agro-industrial complex of the Krasnoyarsk region 2019 Bulletin of the KrasSAU 1 74 – 80
[5] Rogozhina T G, Aniskina J V, Karpachev B B and Shilov I A 2015 The use of microsatellite analysis to identify biotypes in varieties of spring rapeseed (Brassica napus L.) Oilseeds Scientific and technical bulletin of the all-Russian research institute of oilseeds 2(162) 27-33