The development of a beverage with a dispersion structure from pea grains of domestic selection

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Abstract. In the new global economy, the problem of deficiency of quality protein consumption seems to be acute despite of the lack of hungering and food redundancy. Milk products are supposed to be one of the main resources of protein. The assortment of milk products is quite wide nowadays but it’s not enough when we consider the variety and volume of production of foodstuffs for healthy diets, vegetarians, and consumers with lactose deficiency. The results of this investigation are based on the collaborative research of the scientists from Omsk State Agrarian University, Bashkir State Agrarian University, and Saratov State Agrarian University. The development of healthy foodstuffs with the use of legumes of domestic selection started in 2014. The objective of this research is to work out and make sufficient scientific evidence of pea cultivars usage in the technology of production of a drink with a dispersion structure. Selected pea cultivars of Bashkir Scientific and Research Institute of Agriculture are used. Combined analysis of technological criteria and indicators, which make nutritive and biological value of selected pea cultivars of Bashkir Scientific and Research Institute of Agriculture (harvest 2019), allows recommending pea cultivar “Chishminsky 229” as the main resource for production of a non-alcoholic beverage with a dispersion structure. The cultivar contains high concentration of amino-acids (tryptophan, lysine, and methionine). It is rich in protein and starch. We suppose the developed beverage will help to solve the problem of protein deficiency and make up a deficiency of nutrients and food fibres.

1. Introduction
Legumes, as a source of valuable vegetable protein, are widely cultivated in the territory of the Russian Federation. There is a dynamic increase in the number of domestic agricultural land areas used in legumes cultivation. According to the data, agricultural areas with legume crops increased from 3173,700 thousand hectares to 4328.16 thousand hectares in the period of 2015 – 2019 [1]. So legumes made from 2.01% to 2.7% of all agricultural crops. The structure of arable lands with legumes cultivation includes 52.7 – 74% of pea, 12% of chickpea, 7% of lupine, 6% of vetch, 2% of soybean. Most legume crops such as pea and soybean are used in the production of cereal products.
and combined feed despite of fast increase of production of non-alcoholic beverages from vegetable raw material (“vegetable milk”) on the global scale [2]. Experts estimate the Russian market size of traditional milk products at 9 million tons. The ratio of vegetable foodstuffs, which we can consider a part of this market segment, makes up 0.2% (11,000 tons). According to prognosis, it will make up to 10.7% (664 000 t) by 2029 [3]. Non-alcoholic beverages from vegetable raw material are very popular nowadays: for example, “soybean milk Alpro” (Danone Company). The company “Sady Pridoniya” produces a wide range of products from grain crops (oat, rice, corn, faro, etc.) and nut, including the brand product “Nemoloko”. However, legume crops are not often used and taken in consideration for this purpose. Far too little attention has been paid to high protein content with the absence of GMO, lack of allergens, minimum phytoestrogens content and low glycaemic index in legume crops.

The previous collaborative research made sufficient evidence of high phytochemical potential of soybean of the selection of Omsk State Agrarian University (OmSAU) and pea of the selection of Bashkir Scientific and Research Institute of Agriculture (BSRIA). We proved the necessity of usage of “accessible” technologies (hydrothermal grain processing, germination), which allowed decreasing trypsin inhibitors activity to 50%-60% from initial value. Therefore, we increased accessibility and nutrition value of legume crops based products [4]. Many Russian and foreign researchers have developed food technologies for sports nutrition, for production of vegetable beverages, and dairy and vegetable products, composite mixtures for production of bread and bakery products to fill the deficiency of food protein, necessary vitamins, minerals and food fibres in the diet of population [5,6].

The main purpose of this study is to find out pea cultivars mostly suitable for creating a non-alcoholic beverage with a dispersion structure and to work out a technology of its production.

2. Materials and methods

The object of the research is pea grain of the following cultivars: standard “Chishminsky 95” (cultivar code number – 9601708), “Chishminsky 229” (cultivar code number – 9610174), “To the memory of Hangildin” (cultivar code number – 9154334), “Yuldush” (cultivar code number was passed to the State Cultivar Commission in 2016). These cultivars were selected by Bashkir Scientific and Research Institute of Agriculture. The presented samples were harvested in the period of 2017-2019 years.

Drinking water Sanitary Regulations and Standards (SanPiN) 2.1.4.1074-01. Drinking water. Hygienic requirements to quality of water centralized systems of drinking water supply;

Non-alcoholic beverage from vegetable raw material. “Soybean milk” according to GOST 28188-2014;

Non-alcoholic beverage from vegetable raw material. “Oat milk” according to GOST 28188-2014;

The study of chemical and amino-acid compositions, organoleptic and physical and chemical indicators was carried out in collaboration with the Centre of Collective Work “Agricultural and technological research”. Traditional and modern instrumental methods, as well as special methods of raw material research, were used in the study.

Sample selection and weighed quantity were run according to GOST 13586.3-83. Moisture content was determined in accordance to GOST 13586.5-93. We defined the weight of 1000 grains according to GOST 10842-89. The Kjeldahl method was used to find out protein content in accordance to GOST 10846-91. The starch content was measured according to GOST 10845-98.

Size and corn evenness were set with the use of laboratory shaking machine. Filminess (the content of seed glume) was searched in several steps: soaking weighed grain into hot water; glume peeling; dehydration to permanent weight; weighing; calculation of percentage content. Sample grain selection and determination of pea technological properties were performed according to traditional methods of State Cultivar Commission and GOSTs.

3. Results and discussion

Assessment of pea grain of the selection of BSRIA for usage in the technology of non-alcoholic beverage with a dispersion structure production

Based on pea grain dispersion, the beverage seems to be an alternative to non-alcoholic drinks from
vegetable raw material, for example, “soybean milk”. Organoleptic, physical and chemical, as well as other requirements to the beverage, should correspond to market demands. So the beverage should contain optimal amount of protein and dry matters; have detectable flavour, colour, and compound. Most of these characteristics are specified by initial grain technological features – grain size, linear size, content of seed glume, uniformity of seed lobe colour, moisture and protein content.

R.K. Vahitova and other scientists were mainly interested in questions concerning some economically valuable characteristics of pea grain cultivars. Also they made conclusions on stable high productivity of new selected cultivars [7]. It should be mentioned that purposeful work on systematic and complex assessment of pea cultivar quality (cultivars of the selection of BSRIA “Chishminsky 95”, “Chishminsky 229”, “To the memory of Hangildin”) has not been carried out yet. Supposingly that is the reason why new selected cultivars with significant technological and phytochemical potential are almost never used. Food grain is important for country’s export potential realization and raw material for production of a non-alcoholic beverage with a dispersion structure. The results of assessment of technological characteristics of pea grain of the selection of BSRIA are presented in Table 1.

| Table 1. Average weighted criteria of technological characteristics of pea grain of the selection of BSRIA (harvest 2017-2019) |
|---------------------------------------------------------------|
| Criteria | Cultivar | Chishminsky 95 | Chishminsky 229 | To the memory of Hangildin | Yuldush |
|------------------------------------|----------|-----------------|-----------------|--------------------------|--------|
| Actual weight of 1000 grains, g | 253.83   | 268.63          | 348.96          | 241.88                   |
| Weight of 1000 grains in g, in terms of dry matters | 231.73   | 238.56          | 314.31          | 216.76                   |
| Content of seeds cover, % | 9.61     | 9.72            | 8.89            | 11.83                    |
| Moisture content, % | 11.04    | 10.44           | 9.98            | 10.81                    |
| Uniformity, % | 88.7     | 83.5            | 89.9            | 69.3                     |
| Protein content, % | 23.60    | 21.6            | 24.85           | 20.2                     |
| Starch content, % | 38.1     | 39.11           | 38.58           | 37.83                    |

Figure 1 presents linear size and pea grain colour of the studied cultivars. These cultivars allow complementing and developing of grain morphometric characteristics.

Figure 1. Morphometric characteristics of pea grains: a – “Chishminsky 95”; b – “Chishminsky 229”; c – “To the memory of Hangildin”; d – “Yuldush”.

Complex analysis of technological characteristics of pea grains shows strong cultivar distinctions of “Yuldush” pea grains from three others: a grain is plump and less in size (minimum actual weight
of 1000 grains contains 241.88 g; maximum content of seeds cover makes 11.83% and their thickness is 0.4 micron). Also there is the lowest level of protein and starch content within this cultivar.

As for the cultivar “To the memory of Hangildin”, the results indicate minimum quantity of seeds glume at 8.89% with its thickness of 0.3 micron. Maximum actual weight of 1000 grains makes 348.96 g. We also observe stable high protein and starch content from 21.6 to 24.85% and from 38.1 to 39.11% accordingly within pea cultivars Chishminsky 95, Chishminsky 229, “To the memory of Hangildin”.

There is no significant difference in colour. These cultivars are characterised by stable yellow colour of different tones (with transparent cotyledon coming through seed glume). The fineness indicator has changed from 83.5% to 89.9% among the pea cultivars under research. It allows making conclusion on grain uniformity in cotydelon colour and grain evenness. According to GOST 28674-2019 Pea. Technical requirements, the studied pea cultivars belong to food type, the first subtype. They can be recommended for industrial processing. For example, pea cultivars Chishminsky 95, Chishminsky 229, “To the memory of Hangildin” can be used as the main raw material for production of a non-alcoholic beverage with a dispersion structure.

While the research a comparative analysis of pea cultivar amino-acid composition was carried out. The table below illustrates the results of this analysis.

| Amino-acid and weight percentage, % | Chishminsky 95 | Chishminsky 229 | To the memory of Hangildin |
|-----------------------------------|----------------|----------------|---------------------------|
| Tryptophan                        | 0.39±0.16      | 0.44±0.15      | 0.44±0.15                 |
| Threonine                         | 0.25±0.12      | 0.28±0.14      | 0.37±0.18                 |
| Lysine                            | 1.26±0.63      | 1.35±0.68      | 1.29±0.65                 |
| Methionine                        | 0.98±0.34      | 1.02±0.56      | 0.93±0.46                 |
| Cystine                           | 0.12±0.06      | 0.22±0.11      | 0.15±0.08                 |

As can be seen from the table (above), Chishminsky 229 pea cultivar differs from other cultivars in increased content of such amino-acids as tryptophan, lysine, methionine. Therefore we recommend it for further research in terms of production technology of an alcohol-free beverage with a dispersion structure.

Use of “accessible” technologies in production of a non-alcoholic beverage with a dispersion structure from pea

The primary purpose of the research was to establish the possibility of using the studied pea cultivars in the technology of a non-alcoholic beverage with a dispersion structure. Vegetable beverages, as noted earlier, are a fast-growing market segment, the demand for which increases every year in the territory of the Russian Federation [2]. Growth ratio is connected with the deficiency of quality protein. Different solutions and technologies of foodstuffs from legume material production are worked out for solving the problem of insufficient consumption of balanced protein. Also biological and nutrition value is validated. I.Yu.Potorko and others see legume, cereal, oil grains and nut as a key component (both individually and combined with fruit-and-vegetable crops solutions) in developing different products for functional purpose [8, 9].

According to A.Bonke, pea cultivars have potential in the technology of a non-alcoholic beverage production [10]. Some researchers (S.Jeske et al.) suggest developing a polycomponent solution of vegetable milk from a combination of lentil and pea or only pea grain as additives to an oat beverage. That will improve nutrition value and amino-acid profile. The developed compounds, which include pea as a main component, seem to be more effective in achieving high organoleptic indicators and getting a maximum well-balanced product with low glycaemic index [11].

Technological operations were run in the laboratory according to the stages, presented in Figure 2.
Assessment of pea grain quality

- Pea grain washing, germination with an automatic germination machine (at \( t = 21\, ^\circ C; \tau = 13-15 \) hours in the range of automotive moisture regulation from 40 to 90\%, till seedling emergence 5-7 mm)

- Grain washing

- Grain refinement to particles not more than 1 mm, composition of irrigation module (pea grain /water) 1/5

- Homogenisation at \( t = 35-40\, ^\circ C, \rho \) not less than 3 mPa

- Extraction at \( t = 35-40\, ^\circ C; \tau = 20-30 \) minutes

- Filtration

- Dispersion pasteurisation at \( t = 80-95\, ^\circ C; \tau = 5-10 \) minutes

- Cooling \( t = (6 \pm 2)\, ^\circ C \)

- Realisation

**Figure 2.** Flow-chart of production of a non-alcoholic beverage with a dispersion structure

The developed non-alcoholic beverage with a dispersion structure is characterised by homogeneous consistency (particle size not more than 50 micromicron); by gentle, pleasant and weak aroma and light pea taste. A comparative analysis of the nutrition value of non-alcoholic beverages from vegetable raw materials (“soybean milk”, “oat milk”) and a non-alcoholic beverage from pea with a dispersion structure (hereinafter referred to as “pea milk”) is presented in Table 3.

**Table 3.** Comparative analysis of nutrition value of alcohol-free beverages from vegetable raw material

| Indicator        | Alcohol-free beverage from vegetable raw material |
|------------------|--------------------------------------------------|
|                  | “Oat milk” | “Soybean milk” | “Pea milk” |
| Protein content, % | 1.0        | 2.0            | 2.8        |
| Fat content, %    | 1.0        | 1.0            | 1.0        |
| Dry matters content, % | 8.7       | 8.8            | 10.0       |

Taking into account lack of allergens in the product, organoleptic indicators, increased nutrition value (including high content of protein and dry matters), the developed beverage can be recommended for healthy diets and diets for special purpose.

Taken together, these results suggest that the usage of pea cultivars in production of non-alcoholic beverages from vegetable raw materials will allow developing the assortment of commercially viable products for healthy diets. These foodstuffs are able to satisfy modern hygienic requirements to diets of different social groups and minimize negative influence of environment upon people’s organisms.

**4. Conclusion**

The present results contribute to technologies of production of foodstuffs from vegetable raw material. It is possible and advantageous to use Chishminsky 229 pea cultivar (selected by Bashkir Scientific
and Research Institute of Agriculture) in production of a non-alcoholic beverage with a dispersion structure. Organoleptic indicators and nutrition value of the product have been studied. During experimental work technological parameters were set for developing a non-alcoholic beverage with a dispersion structure.

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