Pectin-containing drinks with antioxidant action

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Abstract. The article presents the results of a study of the chemical composition, as well as the
content of phenolic compounds and anthocyanins in dark grape varieties. These results confirm
the feasibility of using this raw material as a source of antioxidants. The results of the study of
the amino acid and fractional composition of pectin substances in the sea grass of the family
Zostera marina L. are also presented. Its high biological value is noted. The obtained data on the
physical and chemical composition of the new pectin-containing drink based on grape juice allow
us to speak about the presence of functional properties.

1. Introduction
For a modern person, the leading trend is a healthy lifestyle, where the main role is played by "proper",
full-fledged nutrition. Thanks to a healthy diet, we can improve the quality and increase the duration of
our lives. To do this, it is necessary to make requirements for the products that we eat, they must be not
only delicious, but useful, high-quality and safe.

An urgent task in almost all industrialized countries of the world is to increase the duration of a
healthy life to 70 years or more.

In achieving this goal, functional foods (antioxidants, minerals, vitamins) can play an important role.
These are foods enriched with various ingredients, intended for systematic use for all age groups of a
healthy population, which have a beneficial effect on the state of the body and help reduce the risk of
developing many diseases. Among many of such ingredients, the most interesting are antioxidants
(biological antioxidants) – a group of compounds that includes carotenoids, minerals, and vitamins.
These substances protect the health of cells. Main function of antioxidants is to protect human body
from excess of free radicals. Free radicals are molecules that lack one or more electrons [1].

Under the influence of free radicals develop: cancer, atherosclerosis, heart disease, varicose veins,
cataracts, arthritis, asthma, depression [2,3].

Antioxidants neutralize free radicals, prevent damage to the membranes, preserve the strength and
beauty of a person. Antioxidants not only prevent the violation of the integrity of cells, but also
accelerate the restoration of the destroyed cells increase the body’s resistance to infections. Thus, the
compounds protect against aging, adverse effects of environmental factors, cancer, and cardiovascular diseases [4-6].

So, to neutralize free radicals and protect the body from many diseases, it is necessary to add antioxidants to the diet. Substances with antioxidant properties include: carotenoids, lycopene, vitamin C, flavonoids, anthocyanins, etc. To determine the antioxidant capacity of products, scientists have developed the ORAC scale (Oxygen Radical Absorption Capacity) – the absorption capacity of free radicals. According to this scale, you can determine the foods with the highest antioxidant activity, for example, wild blueberries (9.621 ORAC points), dark chocolate (20,816 ORAC points), beans (8,606 ORAC points), cranberries (9,090 ORAC points).

Also, due to the current unfavorable environmental situation around the world, detoxification of the body is no less important.

The most acute problem is the contamination of food with heavy metals, which occupy a leading position (135 points) in terms of the degree of negative impact on the body, according to the Corte-Dubinin scale, which was developed to assess the toxicity of pollutants and recommended by the World Health Organization (WHO). Then the second place is taken by pesticides (130 points) and nitrates (65 points).

It is known that pectin substances are a natural sorbent and have a high complexing ability. Once in the body, they bind and retain ions of toxic metals and radionuclides, which leads to their use in the design of functional food products.

The best form of delivery of all the necessary physiologically active components in the body are drinks, they occupy a special place in the human diet and are in great demand among various segments of the population.

Every year, the rate of consumption of soft drinks in the world is growing. For example, according to various studies, in 2013, one person on average drank 84.1 liters of soft drinks per year, then in 2018, the global figure rose to 91.9 liters.

In recent years, Russia has seen a dynamic growth in the volume of production of soft drinks, compared to 2014, this figure increased by 7.8 %. According to Businessstat, in 2016, the production of beverages in Russia amounted to 18 million liters, and in 2019 this figure was 20 million liters, but it is still not possible to fully meet the demand of the population for this type of product.

Despite the background of a high level of competition, there is a tendency to expand the range of useful products. The manufacturer strives to meet any consumer needs. That is why soft drinks should be useful and have a functional orientation.

According to analysts, the demand for functional drinks in Russia has been growing and will continue to grow.

Taking into account all the above, the purpose of our research is to develop recipes for a pectin drink based on raw materials with antioxidant activity.

To achieve this goal, the following tasks were set:

- study the chemical composition of industrial raw materials to determine the physiologically active ingredients;
- evaluate the nutritional value of the developed beverages;
- determine the functional orientation of the developed drinks.

2. **Theoretical and experimental research methods**

We chose two regions of the South of Russia – the Krasnodar Territory and the Republic of Crimea.

Krasnodar territory is located in the south of the European part of the Russian Federation, and is part of the Southern Federal District. It borders the Rostov Region, the Stavropol Territory, the Karachay-Cherkess Republic and the Republic of Crimea.

The Republic of Crimea is also located in the south of the European part of the continent and is washed by the Black and Azov Seas. The territory of the peninsula is rich in minerals, has a mild climate, a warm sea, and picturesque landscapes.
Due to its geographical location in the Krasnodar Territory and on the Crimean Peninsula, agriculture, tourism and trade are developed, the climate here is moderately continental, dry in summer, which causes a great demand for drinks, both among the indigenous population and vacationers.

Grape varieties of dark-colored varieties, sea grass of the family Zostera marina, pectin extract from grape pomace, zosterin, black currant were selected as the objects of our research.

For the study, we selected the following grape varieties:

Pinot fran. Dark-colored grape variety, in the Crimea grows mainly in the western part of the region, in the area of Balaklava. Small round berries are characteristic, covered with a thin but strong skin, the flesh is juicy, without much taste and aroma, the cell juice is not colored, matures early.

Ancellotta. A red grape variety imported from Italy. The juice obtained from this grape is characterized by a rich color and floral taste, good acidity. The skin is dark, it contains a large amount of anthocyanins.

Merlot. Late-maturing grape variety, has a consistently high yield, resistant to adverse weather conditions. The berries are round, dark blue in color, covered with a waxy coating. The flesh is watery, dense and dark, but the juice is clear. It is popular because of its harmonious and rich taste and aroma.

Syrah. French classic red grape variety. It has unique characteristics, as drinks from it are obtained with a spicy taste and a light aroma of black pepper. The pulp and skin of grapes contain a high content of antioxidants.

Selechenskaya 2. Early-maturing dessert variety of black currant. The bush is erect, powerful, reaches 1.5-2 m. The brushes are long, loose. Berries are glossy, black, round, weighing from 2.5-3 to 5.5 g, with a thin and strong skin. Taste with a slight sourness and a delicate aroma. Maturation is friendly, ripe berries are resistant to shedding. The productivity of young bushes is 2 – 3 kg. The variety is resistant to powdery mildew, is slightly affected by anthracnose and is rarely destroyed by a plant bud mite. It adapts well in different climatic zones, has high winter hardiness and drought resistance.

Zostera marine (Zostera marina) – a perennial sea grass, grows in the Caspian, Azov, Black and Far Eastern seas, most of the plant lives in shallow water or at a depth of 1-4 m (sometimes 10 m), mainly on a soft sandy or muddy bottom in the calm waters of bays. The presence of pectin (zosterin) in sea grass has always aroused great interest among Russian scientists, this is due to the unique nature of sea pectin, namely its complex structure, due to which it has a high adsorption capacity.

Studies of the chemical composition were carried out using standard methods adopted in complex chemical analysis: the total content of nitrogenous substances – by the Kjeldahl method using an autoazotoanalyzer; mineral substances – gravimetrically, after burning at a temperature of 600 – 700 ° C, the composition of macro and microelements – by capillary electrophoresis, pectin substances – by the calcium-pectate method. The content of free and esterified carboxyl groups in pectin preparations was also studied, and the degree of esterification was studied by the conductometric method.

For the correct assessment of the chemical composition of the studied varieties, the grapes were selected in technical maturity.

Also, as an object of research, samples of sea grass Zostera marina L., collected in August 2019, in the waters of the Kerch Strait, served as an object of research. Samples of sea grass were washed with fresh water and dried in the air at a temperature of 25 ° C.

3. Results and discussion

The studied grape varieties belong to technical types and are used for the production of dry, dessert, sparkling wines and juices. The fruits have a rich black and blue color, the shape of the berries ranges from round to slightly elongated, the flesh is elastic, very juicy, has a bright sweet taste and aroma.

Also, the fruits of grapes have useful properties, are a good nutritious product. Berries contain a significant amount of sugar, of which sucrose accounts for up to 5 %, organic acids, minerals, vitamins, amino acids, tannins, of particular interest are flavonoids and anthocyanins.
In the studied grape varieties, the moisture ranged from 85 % (Syrah variety) to 89 % (Merlot variety).

Sugars and organic acids of grapes are a group of substances that play an important biological role in the plant and form its taste. So to form the taste characteristics of the drink, it is necessary to take into account the ratio of sugar and acids in the raw material.

Due to its geographical location, fertile soil composition and favorable warm climate in the Krasnodar Territory and the Republic of Crimea, grape varieties have their own unique chemical composition and sweet taste. The sugar content in grape berries is higher here than in other regions.

As a result of research, it was found that the total amount of sugar in grape varieties ranged from 15.3 % (Pinot Franc variety) to 17.3 % (Merlot variety). Their level of content consists of glucose, sucrose and fructose, and other substances also accumulate: galactose, ribose, maltose, raffinose, xylose. In all varieties, the content of glucose and fructose is approximately the same. When the grapes are already fully ripe, gaining color and sweetness, there is a breakdown of sugary substances and organic acids are formed.

Basically, about 90% is dominated by tartaric and malic acid, in much smaller amounts contains citric, oxalic, succinic and other acids (figure 1).

![Figure 1. Fractional composition of organic acids in the studied grape samples.](image)

Tartaric acid is mainly involved in the chemical processes of the plant, metabolism, determines the final taste of the product, has a pleasant and mild flavor. It is also known that tartaric acid exhibits antioxidant activity, has antimicrobial properties, and is widely used in the food industry.
Almost the same amount of malic acid in all the samples studied. The content of this acid also plays a big role from a technological point of view, a high content creates technological difficulties, since the taste of the drink may turn out to be too acidic. Therefore, when designing drinks, it is necessary to use grapes of technical maturity, since the content of malic acid is reduced.

There is no doubt about the potential of beneficial effects of substances of phenolic nature (flavonoids, anthocyanins) on the human body. Flavonoids are natural substances contained in plant raw materials. They belong to the class of polyphenols, which have antioxidant activity, have a beneficial effect on human health.

It is known that the highest content of flavonoids is in red grape varieties. Berries contain a bioflavonoid such as resveratol, which affects the cardiovascular system, reduces cholesterol in the blood, and reduces the risk of blood clots. One of the most important properties is the strengthening of the capillary walls, reducing their permeability.

Grape anthocyanins are the coloring substances of grape berries, which are associated with sugars in the form of glycosides. They are mainly found in the skin of berries, have antioxidant activity and bactericidal effect. It is known that the accumulation of anthocyanins during the ripening of grapes is slow. We determined the total content of phenolic compounds and anthocyanins in berries of dark grape varieties, mg / dm$^3$, the results of the studies are presented in figure 2.

![Figure 2. Content of phenolic compounds in berries of dark grape varieties, mg / dm$^3$.](image)

The diagram shows that the highest content of phenolic compounds and anthocyanins in the Syrah grape variety. In other objects of the study, the content of phenolic compounds ranged from 521 mg / dm$^3$ to 635 mg/dm$^3$, and anthocyanins from 2.1 mg/dm$^3$ to 12.4 mg / dm$^3$.

Vital components for the human body are vitamins and minerals, which also determine the nutritional value of the product. We have studied the content of essential vitamins and minerals in dark grape varieties.

The vitamin composition of grapes is mainly represented by water-soluble vitamins (mg / 100 g): vitamin C-4 mg, thiamine-0.06 mg, riboflavin-0.02 mg, niacin-0.2 mg, pyridoxine-0.12 mg, biotin-0.34 mcg, and grapes also contain carotene-18 mcg. When consuming 100 g of grapes, the degree of daily availability in vitamin C will be 8 %, pyridoxine-6 %, and niacin-1.3 %.

The minerals in the grapes contains sodium-2.0 mg, potassium-213 mg, calcium-12 mg, magnesium-7 mg, phosphorus-19 mg, iron-0.32 mg, copper-0.13 mg, zinc-0.1 mg. The macronutrients, according to the degree of daily availability, only sodium is among outstanding (50 %). For other minerals, the
degree of daily availability is low and is in the range of 1-8 %. In this regard, the samples under study cannot be considered as a source of vitamins and minerals.

Therefore, in order to expand the functional orientation and improve the organoleptic parameters, we considered the fruits of black currant as possible components of the formulation of a new antioxidant drink, and the sea grass of the Azov-Black Sea basin, Zostera marina L., is proposed as a source of pectin substances.

Data on the vitamin and mineral composition of black currant are presented in table 2.

**Table 2.** The content of vitamins and minerals in black currant (in 100 g of the product).

| Vitamins    | Content | Minerals | Content |
|-------------|---------|----------|---------|
| Vitamin C, mg | 143     | Sodium, mg | 2.4     |
| Vitamin B₁, mg | 0.04   | Potassium, mg | 378     |
| Vitamin B₂, mg | 0.07   | Calcium, mg | 66      |
| Vitamin B₃, mg | 0.4    | Magnesium, mg | 18      |
| Vitamin B₆, mg | 0.08   | Phosphorus, mg | 41      |
| Vitamin B₇, mcg | 2.6    | Iron, mg | 1.4     |
| Carotene, mcg | 115    | Copper, mg | 0.15    |
| Vitamin E, mg | 1.0    | Zinc, mg | 0.4     |

From the tabular data, it can be seen that the most valuable in currants is vitamin C. When using 50 g of currant, you can provide 100 % of the daily need for this vitamin. It is known that vitamin C is an antioxidant, participates in the regulation of redox processes, strengthens blood vessels and the immune system. In this regard, it can be argued that currant juice is recommended to be used as a functional source of vitamin C. Also, black currant berries contain a large amount of fiber, flavonoids, pectin and tannins.

An important component of the new antioxidant drinks are pectin substances, the results of the study of the fractional composition and total content of pectin substances in sea grass are shown in figure 3.

![Figure 3](image_url)

**Figure 3.** Fractional composition and total content of pectin substances in the test samples, % to absolutely dry matter.

Amino acid composition of the protein of the sea grass Zostera marina L. and the amino acid score for essential amino acids, is shown in figure 4.
The amino acid balance of sea grass was evaluated according to a set of indicators recommended by N. N. Lipatov: the coefficient of difference in amino acid scores (CRA, %), biological value (BC, %), the coefficient of rationality of the amino acid composition (Rc, units). The calculated values of these indicators are shown in Table 3.

| Indicator                                      | Sea grass Zostera  |
|-----------------------------------------------|--------------------|
| Coefficient of difference of amino acid scores, % | 7                  |
| Biological value of protein, %                | 93                 |
| Coefficient of rational amino acid composition Rc, units | 37                 |

Sea grass *Zostera marina* L. it contains all the essential amino acids in its composition. The coefficient of difference in amino acid scores shows the excess amount of essential amino acids that are not used by the human body for plastic needs, and its value can be used to assess the biological value of the product. The coefficient of rationality of the amino acid composition characterizes the balance of essential amino acids in relation to the physiologically necessary norm.

After analyzing the data obtained, we proposed a method for producing a pectin-containing drink with an antioxidant effect. To do this, the following were selected: Merlot grape juice, sem sea grass extract, *Zostera marina*, blackcurrant juice.

When composing recipes, the method of profiling with the construction of profilograms was used to select the optimal ratio of components, to obtain a harmonious taste and aroma of drinks.

The results of the organoleptic evaluation of pectin-containing antioxidant drinks with the addition of pectin extract are shown in the profilogram (figure 5).

Based on the study of the profiles, it was found that sample 2 has the highest indicators. A harmonious, pronounced taste was noted. The color of the drink is dark red with a blue tint, the consistency is uniform. However, there is a slight smell of sea grass.

The tasting evaluation and the results of the obtained studies showed the feasibility of introducing a pectin-containing drink with an antioxidant effect into production.
The physical and chemical parameters of the developed drink are presented in Table 4.

**Table 4.** Physical and chemical parameters of the drink based on grape juice.

| Indicator             | Content | Indicator             | Content |
|-----------------------|---------|-----------------------|---------|
| Vitamin C, mg         | 18      | Sodium, mg            | 2.1     |
| Vitamin B₉, mg        | 0.01    | Potassium, mg         | 126     |
| Vitamin B₂, mg        | 0.02    | Calcium, mg           | 34      |
| Vitamin B₃, mg        | 0.09    | Magnesium, mg         | 7.3     |
| Vitamin B₆, mg        | 0.0000  | Phosphorus, mg        | 23.1    |
| Vitamin B₇, mcg       | 0.8     | Iron, mg              | 0.3     |
| Carotene, mcg         | 31.0    | Copper, mg            | 0.1     |
| Vitamin E, mg         | 0.12    | Zinc, mg              | 0.23    |
| Phenolic compounds, mg/dm³ | 290  | Dry substances, %    | 16.4    |
| Anthocyanins, mg/dm³  | 7.3     | Pectin substances, %  | 2.86    |

4. Conclusions

The optimal ratio of the components of a new pectin-containing antioxidant drink was experimentally established. The physico-chemical composition of the drink is investigated, which confirms its functional orientation. The resulting product is characterized by high commodity characteristics and can be recommended for inclusion into the human diet for the organization of a rational and balanced diet.

The presented results of studies of the nutritional value of grapes and black currants indicate the feasibility of their use as a source of antioxidant substances, since they contain a large amount of flavonoids, anthocyanins and vitamin C. The features of the amino acid composition of proteins, the fractional composition of pectin substances of sea grasses are determined, which allow us to make a conclusion on perspective of developments aimed at expanding the range of functional and specialized food products with their use.
5. Conflict of interest
The author confirms that the submitted data does not contain a conflict of interest.

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