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Биологически активные вещества в сортах малины казахстанской селекции

РЕЗЮМЕ

Актуальность темы. Наиболее известными биологически активными веществами являются природные антиоксиданты, которые состоят из: полифенолов, флавоноидов, различных ароматических гидроксикислот, антоцианов, витаминов С и Е, каротиноидов и других соединений. Малина богата фенольными фитохимическими веществами, особенно флавоноидами, такими как антоциановые пигменты, которые придают малине темно-красный цвет. Целью исследования является анализ биологически активных веществ малины казахстанской селекции в лабораторных условиях.

Задачи исследования: теоретический анализ, сбор и структурирование лабораторных данных о биологически активных веществах, соответствующее заключение.

Материалы и методы. Объектом исследования были ягоды малины казахстанской селекции. Для оценки химического состава использовались признанные и доступные методы исследования. Метод определения количества растворимых твердых веществ основан на использовании рефрактометра. Найденное значение выражается в единицах массовой доли сахарозы в водном растворе сахарозы, который при заданных условиях имеет тот же показатель преломления, что и анализируемый раствор, в %.

Результаты. Установлено, что среди рассмотренных сортов малины самые высокие значения химические показатели: сахарокислотный индекс, содержание аскорбиновой кислоты (витамина С), общее содержание фенолов и общее содержание флавоноидов — у сорта Анар. Общие содержания фенолов и флавоноидов в сортах Анар (860 мкг/мл и 188 мкг/мл соответственно), Арай (870 мкг/мл и 189 мкг/мл соответственно) и Салем (855 мкг/мл и 187 мкг/мл соответственно) имеют близкие значения.

Ключевые слова: антиоксиданты, антоцианы, биологически активные соединения, флавоноиды, полифенолы, черешня

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Biologically active substances in raspberry varieties of Kazakhstan selection

ABSTRACT

Relevance. The most well-known biologically active substances are natural antioxidants, which consist of: polyphenols, flavonoids, various aromatic hydroxy acids, anthocyanins, vitamins C and E, carotenoids and other compounds. Raspberries are rich in phenolic phytochemicals, especially flavonoids, such as anthocyanin pigments, which give raspberries a dark red color. The aim of the study is to analyze biologically active substances of raspberries of Kazakhstan breeding in laboratory conditions.

Research objectives: theoretical analysis, collection and structuring of laboratory data on biologically active substances, appropriate conclusion.

Methods. The physicochemical properties and chemical indicators in the various raspberry varieties of the Kazakhstan selection were studied, such as: Anar, Arai and Salem. Mostly the recognized and available research methods were used. The method of determining the amount of soluble solids is based on using a refractometer. The found value is expressed in units of the mass fraction of sucrose in an aqueous solution of sucrose, which under given conditions has the same refractive index as the analyzed solution, in % (Brix) (GOST 51433: 1999).

Results. Physico-chemical parameters were studied: the dry matter content, total sugars and titrated acidity. It is established that among the raspberry varieties considered, Anar variety has the highest values. Anar also has the highest chemical indicators: the sugar acid index, the content of ascorbic acid (vitamin C), the total content of phenols and the total content of flavonoids. The total content of phenols and flavonoids in the varieties Anar (860 µg/ml and 188 µg/ml, respectively), Arai (870 µg/ml and 189 µg/ml, respectively) and Salem (855 µg/ml and 187 µg/ml, respectively) have similar values. Extracts of these raspberries sorts could be advised for the enrichment of the nutritional value composition of food products.

Key words: raspberry, antioxidants, biologically active substances, phenols, flavonoids

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Введение / Introduction

The most well-known biologically active substances are natural antioxidants that consist of polyphenols, flavonoids, various aromatic hydroxy acids, anthocyanins, vitamins C and E, carotenoids and other compounds [1].

Specifically, phenolic compounds are aromatic compositions, where a benzene ring is associated with one or more hydroxide groups. All phenolic compounds are divided into groups by structure and fragment's type. There are about 10 000 types of different phenolic compounds structures that are found in plants raw materials and food products [2].

Raspberry (*Rubus idaeus*), a member of the *Rosaceae* family, has attracted great interest due to not only having good flavor and attractive color but also having an abundance of bioactive compounds that have been proved to have beneficial effects on health. Bioactive compounds, such as polyphenols, anthocyanins, flavonoids and ellagic acids, found in raspberries, play important roles in antioxidant activity and inhibition effects on obesity, cancer, inflammation, neural degeneration and other diseases [3].

The total content of phenolics and/or flavonoids in fruits or berries is a good indicator of total antioxidant activity. Raspberries are high in phenolic phytochemicals, particularly flavonoids such as anthocyanin pigments, which give raspberries their deep red color. These potent antioxidants, along with naturally high levels of Vitamin C, minerals, and fiber, make raspberries especially good for people [4].

Raspberry holds a special position among the berries due to their ideal nutritional profile of low calories, fat, and saturated fats, high content, presence of several essential micronutrients, and phytochemical composition. It contains a whole range of polyphenolic antioxidant compounds that play a significant role in mitigating the damaging effects of oxidative stress on cells and reducing the risk of chronic diseases. Among the polyphenolic compounds, raspberry contains significant levels of ellagitannins and anthocyanines [5].

Bioactive components in berries include phenolic compounds, flavonoids, and tannins apart from vitamins, minerals, sugars, and fibers. It has previously been observed that in addition to valuable phenolic compounds, berries contain other natural compounds, including carbohydrates, essential vitamins, dietary fibers, and minerals [6].

Phenolic phytochemicals are the largest group of phytochemicals and are ubiquitous in plants, including raspberries. They serve many diverse biological functions including roles in plant growth, development, and defense. They provide pigmentation, antimicrobial and antifungal functions, insect-feeding deterrence, UV- radiation protection, chelation of toxic heavy metals, antioxidant quenching of free radicals generated during photosynthesis, and much more [7].

Polyphenolic structures are characterized by the presence of one or more six-carbon aromatic rings and two or more phenolic hydroxyl groups. There are four main classes of polyphenols: flavonoids, phenolic acids, lignans, and tannins. Raspberry polyphenols primarily consist of anthocyanins and hydrolysable tannins. More specifically, they are a particularly rich source of cyanidin glycosides and are unique among the berries for their high ellagitannin content, which when hydrolyzed yields ellagic acid [8].

Compared with other fruits, raspberry is also an excellent source of anthocyanins which provide vegetables and fruits with red, blue, and purple colors. It seems to be promising to use extracts from raspberry as a natural colorant and a potent antioxidant [9].

Plants such as blueberries, cranberries, raspberries, blackberries, cherries, grapes and others are rich in anthocyanins. Anthocyanins are powerful antioxidants and neutralize free radicals; assist in the prevention of violations of cardiac and vascular activity; inhibit inflammatory processes; activate the body's resistance to carcinogens, viruses; protect blood vessels, reduce capillary fragility; detoxify chemicals and pollutants; and also increase a human life span [10].

In recent years, the scientists of the Kazakhstan Research Institute of Fruit Growing and Viticulture have developed the following new raspberry varieties: Anar, Arai and Salem, that have various sizes, cultivation time and organoleptic indicators.

The relevance of the article is justified by a large number of biologically active substances with which you can make biologically active additives.

The purpose of the research is to analyze biologically active substances of raspberries of Kazakhstan breeding in laboratory conditions.

Research objectives: theoretical analysis, collection and structuring of laboratory data on biologically active substances, relevant conclusion.

Материал и методы исследования / Materials and method

The physicochemical properties and chemical indicators in the various raspberry varieties of the Kazakhstan selection were studied, such as: Anar, Arai and Salem. Mostly the recognized and available research methods were used.

The method of determining the amount of soluble solids is based on using a refractometer. The found value is expressed in units of the mass fraction of sucrose in an aqueous solution of sucrose, which under given conditions has the same refractive index as the analyzed solution, in % (Brix) (GOST 51433, 1999).

Determination of the mass concentration of titratable acids in terms of malic, tartaric or citric acids (g/dm³) was carried out using potentiometric titration with sodium hydroxide solution to pH = 8.1. Measure the volume of solution used for titration (GOST 34127: 2017).

The permanganate method is based on the ability of sugar carbonyl groups to reduce copper (II) oxide to copper (I) oxide in an alkaline medium. When dissolved with iron ammonium alum, the resulting copper (I) oxide, oxidized to copper (II) oxide, reduces iron (III) to iron (II), the amount of which is determined by titration with a solution of potassium permanganate (GOST 8756.13: 1987).

Fruits and berries contain mainly three types of sugars: glucose and fructose (monosaccharides) and sucrose (disaccharides). Glucose-dextrose, or grape sugar, is a component of sucrose, polysaccharides — starch, cellulose, hemicellulose, and many glucosides. Fructose-levulose, or fruit sugar, is part of sucrose and inulin polysaccharide. The sugar-acid index is used to assess the palatability of the tested product, i.e. the ratio of the percentage of the sum of sugars (fructose, glucose and sucrose) and acid. Fruits and berries are especially rich in sugars, in average they made up to 8–12% of total mass [11].

The method of determining ascorbic acid (vitamin C) content is based on the extraction of vitamin C with an acid solution (hydrochloric, metaphosphoric or a mixture of acetic and metaphosphoric) followed by visual or potentiometric titration with a solution of sodium 2,6-dichlorophenolindophenolate until a light pink color is established (GOST 24556: 1989).

The total phenolics content in the extract is determined by the colorimetric method using the Folin — Ciocalteu reagent. The Folin — Ciocalteu reagent contains phosphotungstic acids, which are reduced upon interaction with easily oxidized OH groups of phenol. In this case, tungsten blue is formed, which has a characteristic absorption band with a maximum at a wavelength 765 nm and imparts a blue color to the test solution (GOST 14502-1: 2010).

The total flavonoids content in water-ethanol extracts was measured using an extract or a standard solution of catechin, with the addition of solutions of sodium nitrite and aluminum chloride. The absorbance was measured at 510 nm. Flavonoid content was expressed as μg catechin equivalent per 1 mL of dry weight [12].

Raspberries extracts were preliminarily prepared for research. The extracts were obtained by maceration, and by steeping raw raspberries in a ratio of 1:10 with 70% ethanol.

Результаты и обсуждение / Results and discussion

In the presented work, the following physicochemical parameters were studied: solids content, total sugars and titratable acidity. The results obtained are shown in table 1.

As a result, it was found that among the considered raspberry varieties the highest values had variety Anar.

The sugar-acid index, content of ascorbic acid (vitamin C), total phenolic content and total flavonoids compounds content in the extracts of raspberries were determined by the spectrophotometric method. The results are shown in table 2.

All raspberry varieties have high indicators, in average: $860 \pm 10 \mu\text{g/mL}$. The total phenolic and flavonoid contents of varieties Anar ($860 \mu\text{g/mL}$ and $188 \mu\text{g/mL}$, respectively), Arai ($870 \mu\text{g/mL}$ and $189 \mu\text{g/mL}$, respectively) and Salem ($855 \mu\text{g/mL}$ and $187 \mu\text{g/mL}$, respectively) were similar to each other. However, among them, Arai variety had the highest values and was determined as promising raspberry variety. Total flavonoids content, of varieties Anar and Salem is lower than that of Arai by 0.53% and 1.1%, respectively.

Raspberries are of undoubted value because of their unique ability to accumulate a whole complex of natural antioxidants in berries: ascorbic acid, P-active substances, pectin, organic and amino acids, fructose, minerals. However, since raspberries are poorly stored, it should be processed and products with BAS (biologically active substances) should be obtained.

Depending on the variety and growing conditions, raspberries can accumulate from 5 to 11% of sugars, among which fructose and glucose predominate, 0.5–0.8% protein, 0.6–0.9% pectin, 1.2–2.3% organic acids. A valuable component of raspberry fruits are biologically active substances, such as ascorbic acid (up to 50 mg%), catechins (up to 80 mg per 100 g of raw product), anthocyanins (100–250 mg/100 g), vitamins B₉, B₁₂, E, etc.

Table 1. Physico-chemical indicators of the raspberry varieties

Indicators	Name of the raspberry variety		
	Anar	Arai	Salem
Solids content, mg	0,655	0,670	0,650
Sugars, mg	0,100	0,115	0,105
Titratable acidity, $\mu\text{g/mL}$	8,0	8,5	7,3

Table 2. Chemical indicators of the raspberries sorts

Indicators	Name of the raspberry variety		
	Anar	Arai	Salem
Sugar-acid index	13,0	13,5	12,5
Vitamin C, $\mu\text{g/mL}$	18,2	19,0	16,7
Total phenolic content, $\mu\text{g/mL}$	860	870	855
Total flavonoids content, $\mu\text{g/mL}$	188	189	187

Of the mineral compounds in raspberries, there is quite a lot of iron (1200 mg/100 g), zinc (200 mg/100 g), copper (170 mg) and manganese (210 mg/100 g).

In comparison with the study [10], depending on the variety and growing conditions, raspberries can accumulate from 5 to 11% of sugars, among which fructose and glucose predominate, 0.5–0.8% protein, 0.6–0.9% pectin, 1.2–2.3% organic acids. A valuable component of raspberry fruits are biologically active substances such as ascorbic acid (up to 50 mg%), catechins (up to 80 mg), anthocyanins (100–250 mg), vitamins B₉, B₁₂, E, etc. Of the mineral compounds in raspberries, there is quite a lot of iron (1200 mg), zinc (200 mg), copper (170 mg) and manganese (210 mg per 100 g of raw product) [10]. In the studied varieties [10] of plum fruits contain 10–30% solids, 10–20% sugars, 0.4–2.7% acids, 0.3–2.1 mg/100 g of pectin substances, 15–18 mg/100 g of vitamin C, up to 80 mg/100 g of P-active substances, up to 350 mg/100 g anthocyanins et al. [10].

The obtained concentrates have a high content of phenolic substances with antioxidant activity, especially in raspberry berry concentrate (up to 2095 mg/dm³), which makes it possible to recommend the use of concentrates not only for enrichment, but also to increase the duration of food storage.

Выводы / Conclusion

Following raspberry varieties of the Kazakhstan selection were considered: Anar, Arai and Salem. Physico-chemical indicators were studied: solids content, total sugars and titratable acidity. It was found that among the considered raspberry varieties, the highest values had variety Anar. Also Anar has the highest chemical indicators: sugar-acid index, ascorbic acid (vitamin C) content, total phenolic content and total flavonoids content.

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All authors bear responsibility for the work and presented data.

All authors have made an equal contribution to this scientific work.
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