Prospects for using rosehip powder in drinks

Vladimir Volkov[1], *Yuliya* Frolova[2*], *Irina* Perova[2], and *Elena* Alekseenko[1]

[1]Russian Biotechnological University, Moscow, Russia
[2]Federal Research Centre of Nutrition and Biotechnology, Moscow, Russia

Abstract. This study aimed to investigate the biochemical composition of rosehip powder and to develop a recipe for a dry drink mix incorporating this ingredient. The research employed modern physicochemical and organoleptic methods of analysis. Ascorbic acid, carotenoids, and flavonoids were identified in the rosehip powder. Physicochemical parameters of the developed drink were analyzed. The primary calculated indicator, osmolarity index, was 420 mOsm/kg. A carbohydrate component consisting of maltodextrin, fructose, and dextrose was experimentally selected, resulting in a single serving of the drink providing 6-8% of the daily physiological requirement for carbohydrates, 15-30% for minerals (15% for Mg and K, 30% for Na and Zn), 11% for vitamin C, and 15-25% for B vitamins.

1 Introduction

Rosehip (*Rosa canina L.*) is cultivated globally due to its adaptability to diverse climatic conditions and has long been recognized as a valuable food source [1-2].

Rosehip powder retains a significant portion of the beneficial properties found in fresh fruits, providing a convenient and practical means of obtaining various bioactive compounds. Its nutritional value stems from a rich composition including vitamins C, A, and B group vitamins; minerals such as Fe, Ca, Mg, and K; organic acids; tannins; polyphenolic compounds; and polyunsaturated fatty acids [3-4]. Rosehip's organoleptic properties and firm texture limit its fresh consumption. The pulp is considered the most valuable component due to its high antioxidant activity, followed by the seeds, which are rich in essential fatty acids [5]. Rosehip seeds, typically a byproduct of processing, have been identified as a potential dietary component, serving as an excellent source of polyunsaturated fatty acids (PUFAs) and exhibiting antioxidant properties [4].

Recent years have witnessed a growing consumer awareness of health concerns, leading to increased interest in bioavailability and functional foods with enhanced health benefits. Consumers increasingly scrutinize product composition, favoring ingredients with improved characteristics such as extended shelf life, reduced fat and carbohydrate content, and enhanced texture. Consequently, rosehip powder finds applications not only as an integral part of healthy diets, incorporated into various functional and enriched food products, exhibiting beneficial effects on human health (immunostimulant, antioxidant [6-7], prebiotic [8], anti-inflammatory [9], and antibacterial [10-11]), but also as a standalone

* Corresponding author: Y.operarius@yandex.ru

food additive in the food industry. Rosehip powder enhances both the nutritional profile and physicochemical characteristics of dairy products like yogurt [8] and serves as a natural colorant in dairy products, beverages, confectionery, etc. [6]. Research [10] demonstrates that incorporating rosehip powder into sausage formulations reduces microbial growth in intentionally contaminated samples due to its antibacterial activity against certain bacteria. In bread and baked goods, rosehip powder enhances nutritional value [6] and can replace synthetic ascorbic acid, improving dough characteristics such as volume, moisture content, acidity, and porosity [12].

The incorporation of plant-derived extracts into drinks imparts adaptive, tonic, immunostimulant, antioxidant, and other beneficial properties attributed to their bioactive compounds [13]. Plant-based ingredients commonly used in drink formulations include ginseng, turmeric, green tea, grape powder, ginger, guarana, elderberry, rowanberry, mint, and nettle [14-15]. Rosehip powder, with its diverse bioactive compound profile, represents a promising plant-based ingredient in this context.

This study aimed to investigate the biochemical composition of rosehip powder and to develop a recipe for a dry drink mix incorporating this ingredient.

2 Materials and methods

2.1 Materials

The study utilized rosehip powder from GreenFood (Russia). The drink formulation incorporated maltodextrin from OMNIA NISASTA SAN, TIC. A.S. (Turkey); fructose from Neokemikal (Russia); dextrose (China); a vitamin premix (Russia); emulsified zinc powder from KUK-Rascha LLC (Russia); dihydrated lactic magnesium (food grade) (Russia); tripotassium citrate (food grade) from PrimeChemicalsGroup LLC (Russia); and food-grade sodium chloride from Slavyanochka (Russia).

The quantification of bioactive compounds employed the following standards: rutin trihydrate (≥95%, Roth, Germany); hyperoside (≥95%, HWI ANALYTIK GMBH, Germany); isoquercitrin (≥94%, HWI ANALYTIK GMBH, Germany); avicularin (ChromaDex, USA); kaempferol-3-glucoside (≥95%, PhytoLab, Germany); isoliquiritigenin (≥95%, Shanghai Tauto Biotech Co., China); quercetin (≥98%, Sigma-Aldrich, USA); kaempferol (≥99%, Extrasynthese, France); isorhamnetin (≥99%, Fluka, Germany); ellagic acid (≥95%, Sigma, USA); ascorbic acid (≥99%, Fluka, Germany); β-carotene (≥97%, Sigma-Aldrich, USA); and lutein (≥96%, Sigma-Aldrich, USA).

2.2 Moisture Content Determination

Moisture content of the rosehip powder was determined gravimetrically using a MJ 33 moisture analyzer (Mettler Toledo, Switzerland) at 105 °C for 30 min.

2.3 FTIR Spectroscopy

FTIR spectroscopic analysis of the rosehip powder was performed using a Tensor 27 spectrometer (Bruker Optik GmbH, Billerica, MA, USA) equipped with a MIRacle ATR accessory featuring a germanium crystal (attenuated total reflection, ATR) and Opus 6.0 software. Measurements were conducted at 23 ± 1 °C. Spectra were acquired in the range of 4000-600 cm^{-1}, with 64 scans per sample. Automated data processing included correction for atmospheric water vapor and carbon dioxide, baseline correction, and min-max normalization. The average of three spectra was used for subsequent calculations.

2.4 Chemical Composition Analysis of Rosehip Powder

Total polyphenol content (expressed as gallic acid equivalents) was determined using a modified Folin-Ciocalteu method [16] with a SpectroQuest 2800 spectrophotometer (UNICO, USA). Sample preparation involved extracting 2.5 g of powder with 25 mL of 20% ethanol for 1 hour at 75 °C and 120 rpm, followed by filtration.

The polyphenol profile (flavonoids, chalcones, ellagic acid), ascorbic acid content were analyzed according to GOST 31643-2012. Carotenoid content was determined according to R. 4.1.172-03 using reversed-phase high-performance liquid chromatography (HPLC) on an Agilent 1100 liquid chromatograph (Agilent Technologies, USA) equipped with a diode array detector. A triple quadrupole mass spectrometer (TSQ Endura) was additionally employed for flavonoid identification. Bioactive compound quantification was performed using external standard calibration.

2.5 Determination of Rosehip Powder Antiradical Activity

Antioxidant activity was determined using the DPPH method [17], based on the reaction between 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radicals and antioxidants, resulting in a change in optical density. Measurements were performed using a SpectroQuest 2800 spectrophotometer (UNICO, USA) at $\lambda = 517$ nm. The inhibition percentage was calculated as the difference between the optical density of the control and the sample.

2.6 Determination of Drink Characteristics

Acidity was determined titrimetrically according to GOST 6687.4-86. pH was measured using a S20_K pH meter (Mettler Toledo, Switzerland) at room temperature. Osmolarity was measured cryoscopically using an MT-5-01 cryoscopic osmometer (Russia) in accordance with GOST R 55578-2013.

The organoleptic profile of the developed drink was assessed according to GOST ISO 13299-2015. Panelists (aged 18-22 years) were required to be healthy, non-smokers, and to abstain from coffee and spicy food for 3 hours prior to the analysis. Sensory evaluation conditions, including sample preparation, sensory evaluation, and group discussion areas, complied with GOST ISO 8589-2014. Organoleptic evaluation was conducted using a 5-point scale for the following descriptors: appearance, odor, taste, color, tart taste, sour taste, sweet taste, harmonious taste.

2.7 Statistical Analysis

Data are presented as mean values with confidence intervals. Statistical analysis was performed using SPSS Statistics 20 software.

3 Results and Discussion

FTIR spectroscopic analysis of the rosehip powder revealed characteristic peaks in the 1800–1000 cm^{-1} region, indicative of stretching vibrations of C=O, C=C, and C-O-H groups, bending vibrations of CH_2 and CH_3 groups, and hydroxyl groups. Maximum absorption peaks were observed in the 1100–1000 cm^{-1} range (attributed to C-O-H group vibrations and certain phenolic compounds) and the 3000–2900 cm^{-1} range (consistent with the presence of carbohydrates due to CH_2 stretching vibrations) [18]. The presence of primary (1000–1075 cm^{-1}), secondary (1125–1000 cm^{-1}), and tertiary alcohols (1210–1100

cm^{-1}), phenols (1275–1150 cm^{-1}), and carboxylic acids (C=O stretching at 1800–1740 cm^{-1}, C-O stretching at 1330–1050 cm^{-1}, and symmetrical C-O-C stretching at 1310–1000 cm^{-1}) was identified, further suggesting the presence of phenolic compounds [18].

These results indicate a significant polyphenol content in the rosehip powder, consistent with findings from other studies [19-20]. This was further supported by the biochemical composition analysis (Table 1).

Table 1. Content of some natural components in rosehip extract powder.

Indicator	**Content, mg/100 g**
Total moisture content in powder, %	5.15±0.2
Ascorbic acid	180.0±11.0
Carotenoids (beta-carotene)	5.6±0.3
Total content of polyphenolic compounds, mg-eq. gallic acid	7380.0±710.0
Flavonols and their glycosides including	27.4±1.8
Flavoneglycosides	25.3±2.0
Quercetin	1.1±0.1
Isoramnetin	2.0±0.1
Chalcones and their glycosides	6.2±0.4
Ellagic acid and its derivatives including	32.7±2.8
Ellagic acid	18.6±1.3
Minerals:	
Na	11.0±1.4
K	50.0±4.0
Ca	60.0±4.0
Mg	17.0±1.2
Fe	3.0±0.2

Table 1 shows that the powder contains substantial amounts of polyphenols (7380.0 ± 710.0 mg/100 g). Identified polyphenolic compounds include tannins (ellagic acid and its derivatives); flavonoids (flavonols and their glycosides, such as quercetin and isorhamnetin); and chalcones and their glycosides. All these compounds possess antioxidant properties, potentially benefiting athletes' recovery processes after training. The powder demonstrated antiradical activity, with a DPPH radical inhibition rate of 38%. The rosehip powder also contains macro- and micronutrients such as Na, K, Mg, Ca, and Fe, which are involved in athletes' metabolism and are lost in significant quantities through sweat during training. Therefore, these results suggest that rosehip powder is a promising ingredient for developing a drink.

Considering the need for acceptable organoleptic characteristics, particularly taste, in the developed drink, studies were conducted to determine the optimal dosage of rosehip powder as a base ingredient. The sensory profile of rosehip powder alone was unsatisfactory, exhibiting a harsh, astringent, and sour taste that could negatively impact the final product. To optimize the rosehip powder content, 3.5–10.0 g of powder was dissolved in 300 mL of water, and the appearance, taste, color, and odor were evaluated. "Taste" and "Odor" were the determining factors based on the organoleptic assessment. At 5.0 g of rosehip powder in 300 mL of water, the system displayed a moderately sour taste and an aroma reminiscent of the raw material. Lower amounts resulted in a "watery" taste and almost no odor, while higher amounts increased the intensity of sourness and astringency, negatively affecting the overall score.

Ingredient selection for the drink formulation considered the target consumer group. Therefore, a mixture of simple (fructose, dextrose) and complex (maltodextrin) carbohydrates was used to replenish muscle glycogen.

The selection of carbohydrates considered their absorption rate, impact on drink osmolarity, and the fact that a mixture of maltodextrin and fructose (combining low and high glycemic index carbohydrates) enhances the oxidation rate of exogenous carbohydrates compared to using each carbohydrate individually. Based on the rosehip powder's chemical composition (Table 1), a vitamin premix was selected to supplement any deficient vitamins. Water solubility and the functional significance of each vitamin for athletes were considered, leading to the selection of a premix containing B vitamins. This group is readily absorbed and crucial for athletes; some (B_2, B_6, B_{12}, B_9) exert anabolic effects or enhance protein synthesis, while others (B_1, B_3) promote carbohydrate and lipid oxidation [21]. Considering the functional importance of micronutrients in athletes' metabolism during training, sources of Na, K, Mg, and Zn were included. The quantitative dosages of the selected ingredients were optimized to ensure acceptable sensory characteristics, appropriate osmolarity, and sufficient vitamin and mineral content to meet the physiological needs of an athlete with a single serving. The final formulation of the rosehip-based drink is presented in Table 2.

Table 2. Recipes for drinks.

Ingredient	**Contents in 40 g**
Maltodextrin	17.49
Dextrose	14.1
Rosehip powder	5.0
Fructose	2.55
Sodium chloride	0.39
Potassium citrate 3-substituted	0.375
Vitamin premix	0.06
Magnesium lactate dihydrate	0.06
Emulsified zinc powder	0.015

The developed drink is intended for post-workout consumption by athletes; 40 g of the dry mix is dissolved in 300 mL of liquid with vigorous stirring. The physicochemical properties of the prepared drink are presented in Table 3.

Table 3. Physicochemical properties of the finished drink.

Indicator	**Value**
Osmolality, mOsm/kg	420 ± 2
pH	4.93 ± 0.02
Acidity, cm^3 of NaOH solution	1.102 ± 0.020
Viscosity, MPa•s	12.2 ± 0.1

Based on the results, the drink's osmolarity classifies it as a hypertonic drink. A final organoleptic evaluation of the developed drink was conducted (Figure 1).

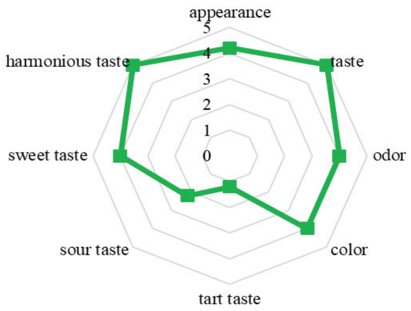

Fig. 1. Organoleptic characteristics of the developed drink.

Panelists noted a harmonious taste, combining a moderately sweet flavor with a mild sourness attributable to the carefully selected amount of rosehip powder. However, the use of rosehip powder resulted in lower scores for "Appearance" and "Color," due to the light brown hue imparted to the drink.

4 Conclusion

This study analyzed the chemical composition of rosehip powder and developed a formulation for a dry drink mix based on it. The inclusion of rosehip powder yielded a product rich in bioactive compounds (vitamin C, β-carotene) and minor components (ellagic acid, quercetin, isorhamnetin, chalcones, and their glycosides), possessing potent antioxidant properties beneficial for athletes' post-workout recovery. The addition of a vitamin and mineral complex enriched the drink with B vitamins, as well as Na, K, Mg, and Zn, essential for restoring physical performance. The proposed formulation (40 g dry mix) involves dissolving a single serving in 300 mL of water. The resulting drink exhibits acceptable organoleptic characteristics (taste, color, aroma) and, with an osmolarity of 420 mOsm/kg, falls into the hypertonic category. Consumption of a single serving provides 15.75–25.0% of the daily physiological requirement for B vitamins, 11% for vitamin C, and 15.1–30.0% for Na, K, Mg, and Zn.

Acknowledgements

The authors express their gratitude to senior researcher, PhD in biology Vorobyeva I.S. for her assistance in conducting the research.

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