

**DETERMINATION OF EXTRACTION RATIOS FOR OBTAINING NATURAL FOOD
COLORANTS FROM THE AMARANTH PLANT**

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Аннотация: В данной статье рассматриваются технологии получения окрашивающих экстрактов из растения амаранта, их химические свойства, а также перспективы применения в пищевой промышленности. Приводятся сведения о содержании растворимых веществ в процессе экстракции и обосновывается целесообразность использования амаранта в качестве источника натуральных красителей. Полученные результаты подтверждают значимость амаранта как сырья, позволяющего не только улучшать органолептические характеристики пищевых продуктов, но и обогащать их биологически активными соединениями.

Ключевые слова: Амарант, экстрагент, натуральный краситель, напитки, минеральные соли, эфирные масла, беталиновый пигмент.

Abstract: This review explores the technologies used for obtaining natural coloring extracts from the amaranth plant, highlighting their chemical properties and potential applications in food products. Special attention is given to existing research on extraction methods, including data on the concentration of soluble compounds obtained during the extraction process.

Keywords: Amaranth, extractant, natural dye, beverages, mineral salts, essential oils, betalain pigments.

INTRODUCTION

In the context of the rapidly growing global population, ensuring adequate access to food, clothing, and housing has become one of the most pressing challenges not only for Uzbekistan but also for countries worldwide. This highlights the importance of studying the biological characteristics of food crops and improving their productivity. Amaranth, with its nutritional richness, forage potential, and medicinal properties widely recognized in traditional medicine, represents a promising solution. Its cultivation as a conventional agricultural crop opens up new perspectives for both agriculture and the national economy.

To fully meet the increasing demand of the population of the Republic of Uzbekistan for high-quality and unique food products, comprehensive strategies have been outlined. These include diversifying the range of food products, improving their quality, enhancing nutritional value, strengthening health-promoting properties, enriching their composition with biologically active substances, and ensuring a sustainable supply of raw materials for production. Rational and efficient use of plant-based resources—particularly medicinal plants and natural colorants—offers significant potential for achieving these goals. Therefore, the expansion of refreshing and functional beverages derived from medicinal and naturally coloring plants is considered a highly promising direction for the food industry.

Amaranth is one of the plants with significant potential for use as a natural colorant in the food industry. Its seeds, leaves, and flowers contain high levels of betalain pigments, particularly amaranthine and betanin, which serve as natural sources of red and purple coloration. In recent years, growing concerns about the adverse health effects of synthetic colorants have intensified interest in natural alternatives.

MATERIALS AND METHODS

Aromatic and flavoring plants have been used since ancient times. For the proper development of the human body, food products prepared with natural colorants and aromatic plants are regularly consumed in certain quantities.

Natural food colorants, as well as aromatic and flavoring plants, are rich in carbohydrates, fats, vitamins, mineral salts, essential oils, flavonoids, and other biologically active compounds [1].

Depending on the concentration of pigments and essential oils, these plants can be conditionally grouped as follows: 11 species contain more than 3% essential oils, 21 species contain more than 2%, 60 species more than 1%, 269 species more than 0.5%, 192 species more than 0.1%, and 269 species up to 0.1%. Different plant organs—buds, leaves, flowers, seeds, fruits, bark, roots, rhizomes, tubers, and bulbs—are known to store essential oils [2].

Amaranth is particularly rich in nutrients and bioactive compounds, especially betalains (betacyanins and betaxanthins). Shoniyozov and Ortikov emphasize in their studies that analyzing the chemical composition of amaranth is crucial for understanding its nutritional requirements and assessing product quality. Their research investigated the nutritional value of amaranth by determining the concentrations of nitrogen, phosphorus, and potassium. The pigment properties of betalains, which are present in high concentrations in amaranth leaves and seeds, make this plant a valuable natural source of colorants for food applications [3].

Cai et al. investigated the antioxidant properties and thermal stability of betacyanin pigments in amaranth and demonstrated their high potential for applications in food products. The chemical structure of betalains provides stability in acidic environments,

which makes them particularly suitable for use in beverages and confectionery products [4].

In her dissertation, Rasulova examined the improvement of technologies for extracting oils and pigments from amaranth varieties cultivated under the climatic conditions of Uzbekistan. She analyzed methods for isolating betalains through aqueous extraction and the use of organic solvents. The study revealed that the quality and color parameters of amaranth pigments are influenced by temperature, pH, and the type of solvent applied during the extraction process [5].

Natural colorants derived from amaranth have wide applications in the food industry. International research, such as the work conducted by Stintzing and Carle (2004), has investigated the stability of betalains in food products and their impact on organoleptic properties. Their findings indicate that amaranth pigments remain stable at low temperatures and in acidic environments, making them suitable for incorporation into a broad range of food products [6].

RESULTS AND DISCUSSION

Dependence of the amount of soluble substances in the extract on the ratio of plant material to extractant

In this experiment, water was used as the extractant to obtain extracts from dried and ground *Amaranthus (gultojixo'roz)* flowers. A constant amount of plant material (100 g) was subjected to extraction under varying ratios of plant mass to extractant volume: 1:5, 1:10, 1:15, 1:20, and 1:25. Accordingly, the samples were prepared by mixing 100 g of plant material with 500 ml, 1000 ml, 1500 ml, 2000 ml, and 2500 ml of water, respectively.

The extraction process was carried out at 90 °C for 30 minutes, after which the mixture was cooled, separated from the plant residue, and filtered. The volume of the obtained extract constituted approximately 74.5–76% of the initially used extractant volume.

The concentration of soluble substances in the extracts was determined using a refractometer, while the dry matter content was measured by evaporating a known volume of the extract. The color intensity, on the other hand, was quantified by spectrophotometry. Based on these analyses, the following results were obtained.

Table 1.

Dependence of the Amount of Soluble Substances in the Extract on the Ratio of Plant Material to Extractant

Ratio of Plant Material to Extractant	Soluble Substances in Extract, % (by refractometer)	Dry Matter Content, %	Volume of Extract Obtained, ml	Absolute Amount of Soluble Substances, g/100 g
1:5	1,4	1,5	360	5,4
1:10	0,8	0,87	748	6,5
1:15	0,5	0,59	1125	6,6

1:20	0,42	0,44	1500	6,6
1:25	0,32	0,36	1872	6,7

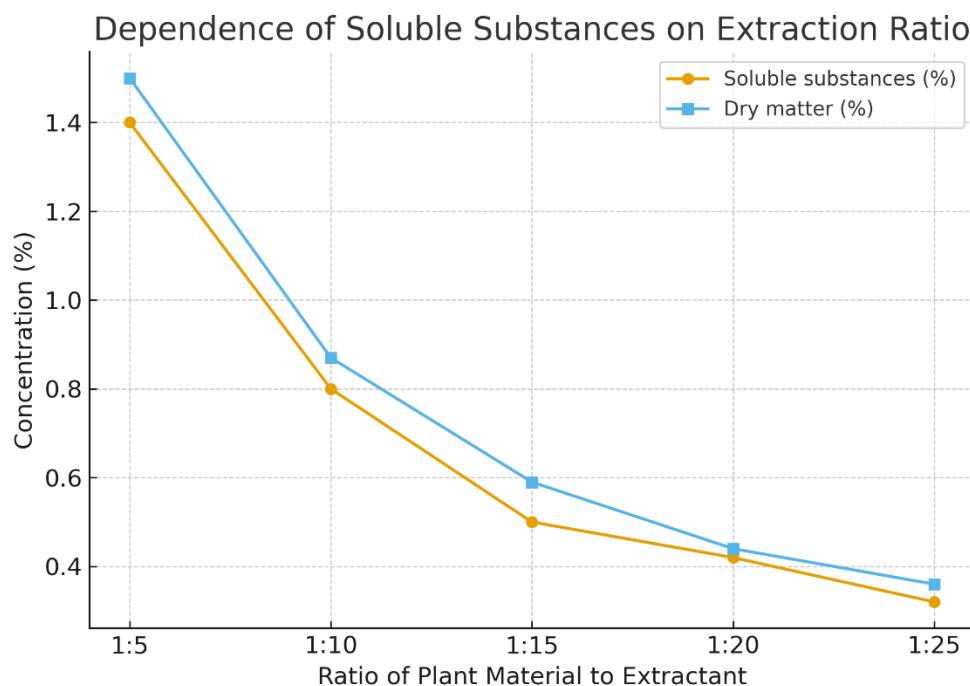


Рисунок 1 *Dependence of soluble and dry matter concentrations on the extraction ratio*

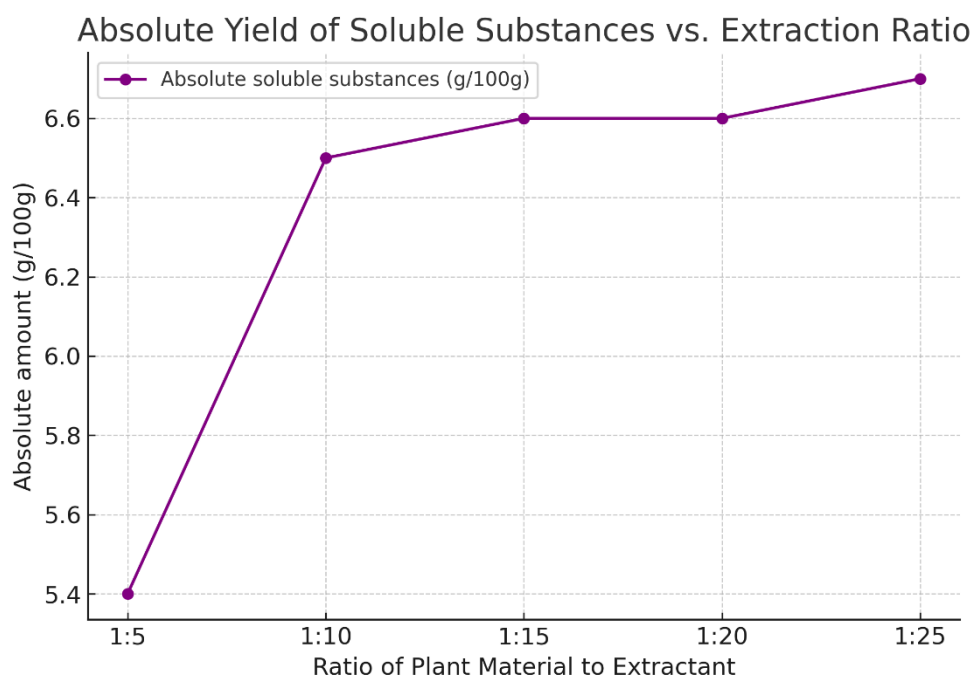


Рисунок 2 *Dependence of the absolute amount of soluble substances on the extraction ratio*

As can be seen from Table 1, the concentration of soluble substances and dry matter in the extract decreases as the extractant volume increases. At a 1:5 ratio, the soluble substances reached 1.4%, whereas at a 1:25 ratio this value dropped to 0.32%. This

demonstrates the dilution effect, where higher solvent volumes lower the concentration of dissolved compounds.

At the same time, the absolute amount of soluble substances (g/100 g of plant material) increased from 5.4 g at a 1:5 ratio to 6.7 g at a 1:25 ratio. This indicates that larger volumes of extractant allow more compounds to diffuse into the solvent. However, beyond the 1:15–1:20 ratios, the increase becomes negligible and the yield stabilizes.

These results highlight the importance of optimizing the solvent-to-material ratio in extraction processes. From a practical perspective, the ratios of 1:15–1:20 can be considered optimal, as they provide both sufficiently high absolute yield and acceptable solute concentration.

CONCLUSION

Amaranth plant possesses significant scientific and practical potential as a source of natural coloring extracts. Its betalain pigments exhibit strong antioxidant properties and maintain a certain degree of stability under thermal and acidic conditions, making them an effective alternative to synthetic colorants in the food industry.

Research conducted in Uzbekistan demonstrates that amaranth raw materials not only improve the color characteristics of food products but also enhance their biological value. Ongoing studies on amaranth cultivation, as well as pigment and oil extraction technologies, confirm the promising future of this field.

According to the results of our experiments, the amount of soluble substances in the extract is strongly dependent on the ratio of plant material to extractant. The 1:10 ratio (100 g of raw material : 1000 ml of solvent) was found to be the optimal condition, as it ensures the most efficient release of soluble compounds, making it one of the most suitable options for practical applications in the food industry.

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