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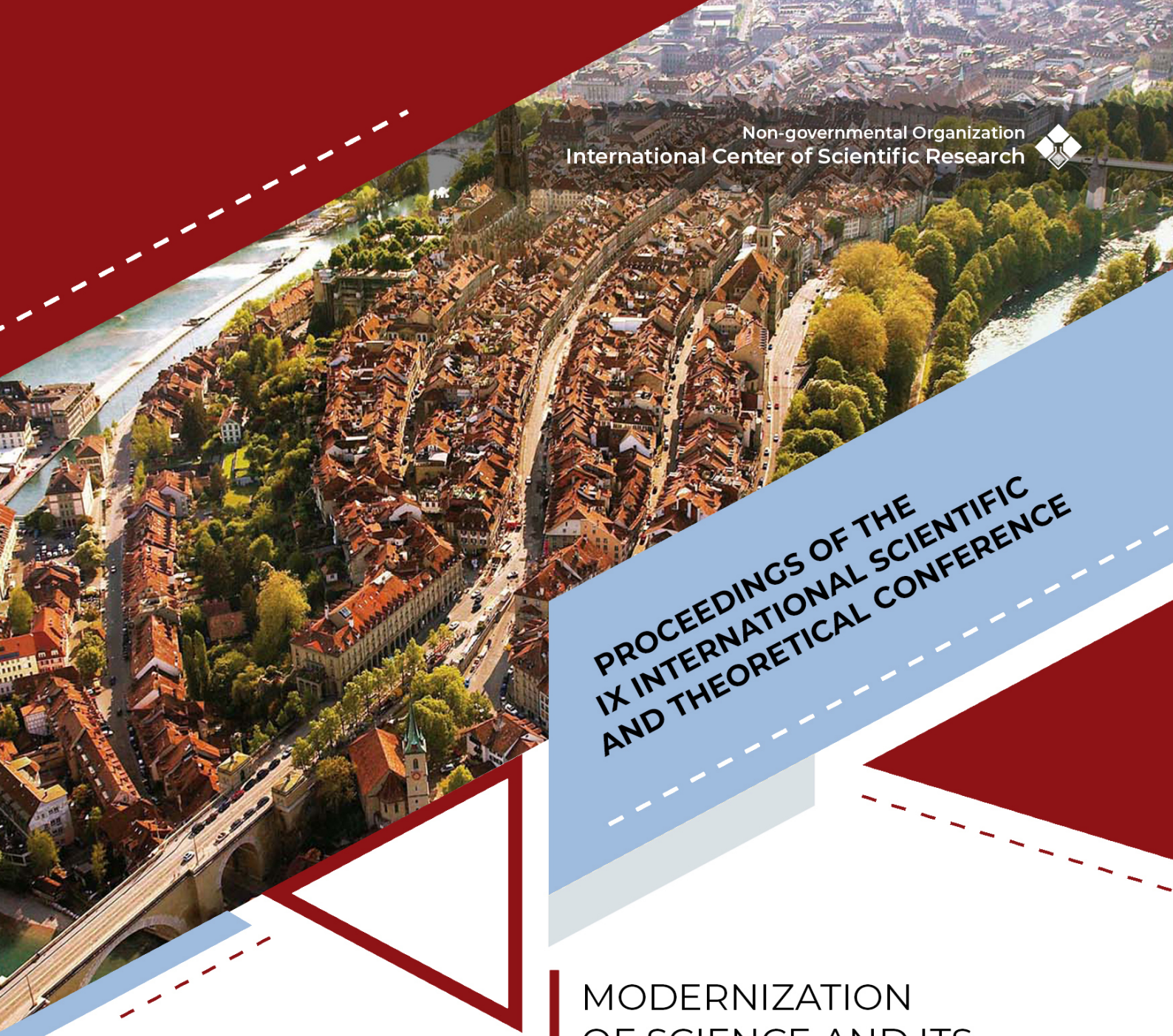

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MODERNIZATION OF SCIENCE AND ITS INFLUENCE ON GLOBAL PROCESSES

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JUSTIFICATION FOR THE USE OF RED CURRANT POMACE POWDER IN BAKERY PRODUCT TECHNOLOGY

Abstract. *The feasibility of using red currant pomace powder in bakery product technology has been considered. The purpose of the article is to determine the optimal drying parameters for red currant pomace in order to maximize the preservation of biologically active substances, particularly vitamin C, as well as to investigate the effect of pomace powder at different concentrations on the physicochemical and organoleptic characteristics of finished products. An analytical review of scientific literature regarding the enrichment of bakery products with biologically active substances through powders obtained from non-traditional raw materials was conducted. The possibility of using red currant pomace powder to enhance the nutritional value of products in other technological processes was analyzed. It was established that currant fruits are a natural multivitamin concentrate and represent an important plant-based raw material for the food industry. The content of biologically active compounds in currants varies depending on the cultivar, growing region, climatic factors, and weather conditions. A method for drying red currant pomace using a combi steamer was proposed. The influence of red currant pomace powder on the physicochemical and sensory quality indicators of finished bakery products was investigated. It was determined that the addition of the powder at a dosage of 6% relative to the mass of premium wheat flour leads to a decrease in the gas-retaining capacity of the dough and deterioration in the quality of the finished products. It is recommended to incorporate the additive together with wheat flour at the dough mixing stage. It was noted that the addition of red currant pomace powder contributes to an increase in the porosity of finished products. Based on organoleptic evaluation and physicochemical analysis of bakery products, the optimal dosage of red currant pomace powder was substantiated at the level of 2–4%.*

Keywords: *bakery products, red currant pomace powder, vitamin C, porosity, gas-retaining capacity, microbiological indicators.*

Problem statement. As a strategically important commodity, bakery products are taken into account when determining almost all indicators of food security, including the daily energy value of the diet; the adequacy of grain stocks in state reserves, which reflects the level of population provision with bakery products; and the economic component, since bread is the most affordable food product. Bread belongs to the group of socially significant food products and is included in the consumer basket of goods (services) used for calculating the consumer price index (its weight structure составляет nearly 9%). Therefore, an adequate level of bread supply and, in general, food grain resources is one of the decisive elements of the state's food independence [1]. According to the data of the State Statistics Service of Ukraine, there has been a significant decline in industrial production of bakery products as well as in their consumption in Ukraine [6, 13].

During the processing of berries for the production of juices, purees, and wines, waste products—pomace (skins and seeds)—are accumulated annually. These by-products contain valuable biologically active substances. The incorporation of berry pomace powders into bakery products may improve their nutritional value and, due to the presence of antioxidant compounds in the powders, extend shelf life. Therefore, studying the possibility of using additives derived from fruit processing products in bakery technology is a relevant issue of today.

A promising raw material for bakery product enrichment is powders obtained from non-traditional plant materials, since fresh produce is seasonal and does not ensure a regular supply of biologically active substances in human diets. During drying, moisture is removed from plant raw materials, while the concentration of substances in the cellular juice and its osmotic pressure increase, which inhibits the development of microorganisms. In terms of chemical composition, dried fruits and berries represent a concentrated source of physiologically beneficial nutrients, including pectin substances, minerals, vitamins, organic acids, polyphenols, etc. [10].

Grinding dried plant raw materials into a powder fraction makes it possible to stabilize biologically active compounds and increase the bioavailability of vitamins and minerals due to the destruction of intermolecular bonds, as well as significantly increase the specific active surface area for product assimilation. In addition, phytopowders are characterized by high sensory properties, a high concentration of biologically active substances, and low moisture content, which enables their long-term storage without quality deterioration. Vegetable and berry powders, in contrast to purees and juices, are concentrates of the original raw material, retain their quality characteristics longer, and are more suitable for transportation. Due to their valuable

chemical composition, they are considered promising ingredients for enriching bakery and confectionery products. The presence of natural pigments in some of them allows their use as natural colorants, while dietary fiber and polyphenols positively affect product shelf life [3].

Researchers have studied the feasibility of using vegetable powders (from carrot, beetroot, viburnum, rowanberry, sea buckthorn and rosehip) obtained through waste-free processing of plant raw materials in the production of flour confectionery and bakery products [2, 4, 7, 9, 15]. The sensory characteristics of the products were sufficiently high and were distinguished by a characteristic mild vegetable aftertaste, attractive appearance, well-developed porosity, and tenderness. The microbiological indicators of the raw materials and finished products remained within acceptable limits. It was noted that the incorporation of vegetable powders makes it possible to obtain products with increased biological value and reduce their energy content due to decreasing the amount of eggs, sugar, and fat in the formulation without compromising product quality, thus providing a certain economic effect [5].

Despite the variety of existing plant-based additives, the selection of those intended for bakery production remains limited. In this regard, the use of by-products from currant processing appears promising. Currant fruits are a natural multivitamin source and an important plant raw material for the food industry. Currants contain significant amounts of vitamin C and vitamin A, as well as B-group vitamins, minerals, organic acids (malic, phosphoric, and citric), essential oils, tannins, phytoncides, anthocyanins, and pectin [14].

Since resource-saving technologies are currently of particular importance in the development of the food industry [11], in this series of experiments we investigated the effect of adding red currant pomace powder on the physicochemical and sensory properties of semi-finished products and finished bakery goods. Pomace obtained during pressing retains, in terms of chemical composition, nearly all properties of the raw material; therefore, enrichment of finished products with biologically active substances is expected, as well as the development of functional bakery products.

Presentation of the main research material. Prolonged exposure to air and heating in the presence of oxygen destroys ascorbic acid; therefore, the stability of vitamin C in the enriched product depends on both the product itself and the production technology. In order to obtain red currant pomace powder, at the first stage we selected a drying method that would ensure maximum preservation of vitamin C.

To preserve L-ascorbic acid, pomace was dried at temperatures ranging from 50 °C to 70 °C. Experimental drying was performed in a drying oven and in a combi steamer. Based on the physicochemical indicators of the dried pomace (Table 1), it was established that the best characteristics were observed in pomace dried at 60 °C. At 50 °C, the drying time was longer, whereas at 70 °C a significant loss of vitamin C was recorded (Table 2). As a result of the conducted studies, the optimal parameters for drying red currant pomace in a combi steamer were determined as follows: temperature +60 °C, duration 2 hours, and pomace layer thickness during drying 1.5–2.0 cm.

Subsequently, the dried pomace was ground into particles sized 0.10–0.15 mm. The obtained powder represented a homogeneous mass of yellowish brick color with taste and aroma characteristic of currants.

The vitamin C content in the powders (determined by the iodometric method via direct titration with a working solution of 0.005 N I_2) depended on the drying regime. In particular, after drying currant pomace at 70 °C, the vitamin C content was 30 mg/100 g, whereas after drying at 50 °C it reached 70 mg/100 g (Table 1).

Table 1

Effect of pomace drying temperature on vitamin C content

Drying temperature	Vitamin C content, mg/100 g	Drying time, min
50 °C	70	180
60 °C	60	160
70 °C	30	120

Source: author's development

The moisture content of the obtained powder was within the permissible limits according to the regulatory documentation for food powdered additives (Table 2). A relatively high content of tannins is a desirable indicator, since these compounds possess anti-inflammatory and antimicrobial properties. Furthermore, the subsequent use of the powder in bakery product technology contributes to the inactivation of amylases and results in less dough thinning during fermentation.

For the experimental studies, the additive was incorporated into the dough formulation at levels of 2, 4, 6, and 8% relative to the flour mass. Red currant pomace powder was characterized by lower moisture content, higher acidity, and a larger particle size compared to wheat flour; however, it exhibited nearly twice the water absorption capacity, which can be explained by the high content of pectin substances.

Table 2

Organoleptic and physicochemical characteristics of red currant pomace powder

Parameter	Characteristic
Appearance	fine-dispersed dry powder
Colour	light brick-red
Taste and odour	characteristic of the product, without foreign odours
Moisture content, %	8.0 ± 2.0
pH value	2.9 ± 0.2
Tannin content, %	4.71 ± 0.1
Ash content, %	2.78 ± 0.1
Vitamin C content, mg/100 g	60 ± 1.2

Source: author's development

It was established that the addition of red currant pomace powder, compared to the control sample, has a positive effect on the main dough characteristics, namely: the initial dough acidity increases; inhibition of amylase activity during baking is observed, which prevents the formation of low-molecular dextrins and reduces the risk of increased crumb stickiness; the final dough acidity increases due to the presence of compounds with an acidic reaction, mainly as a result of the formation and accumulation of acids that positively affect the intensity of yeast cell reproduction; the leavening power of the dough increases, which makes it possible to reduce fermentation time. The optimal dosage of the powder was found to be 2–4%, whereas the addition of higher amounts (up to 6–8%) leads to a decrease in gas-retaining capacity.

With an increase in the dosage of red currant pomace powder, the moisture content of wheat bread increases by 0.6–1.0%, which may be explained by the significant content of pectin substances in currants, capable of binding large amounts of water and preventing its evaporation. The porosity of the finished bread increases by 1.9%; however, when the dosage is increased to 6–8%, porosity decreases, which is associated with the higher dispersity of the fruit powder compared to wheat flour. Minerals, vitamins, and acids contained in currants stimulate yeast activity, thereby improving bread porosity.

The incorporation of red currant pomace powder into the bakery formulation also increases the acidity of the finished products; however, it remains within the limits of regulatory requirements. In turn, increased acidity and moisture contribute to extending the shelf life of the product and inhibiting the development of microflora, such as *Bacillus mesentericus* (rope spoilage bacteria).

Microbiological indicators of the experimental bakery samples containing red currant pomace powder were determined immediately after production and after

72×60² s of storage (Table 3).

Table 3

Microbiological indicators of bakery products

Samples	Storage period (days)	MAFAM, CFU/g	Coliform bacteria, CFU/g	Moulds, CFU/g	Yeasts, CFU/g
Bread (control)	0	2.6×10^2	not detected	not detected	not detected
	3	5.1×10^2	not detected	0.3×10^1	not detected
Standard requirement (DSTU)	1–3	$\leq1\times10^3$	not allowed	$\leq1\times10^2$	not regulated
Bread with red currant pomace powder	0	1.7×10^2	not detected	not detected	not detected
	3	4.2×10^2	not detected	not detected	not detected

Source: author's development

In all studied samples, the absence of coliform bacteria as well as other pathogenic microorganisms was confirmed. Total microbial contamination remained within the range of 1.0×10^3 CFU/g, which corresponded to the indicators of the current standard.

The obtained experimental bread samples had a regular shape, a surface without cracks or ruptures, and a pleasant colour; no unacceptable defects in appearance or colour were detected. The bread was characterized by a pleasant typical bread taste and aroma, without a strongly pronounced additive flavour or foreign odours. With an increase in powder content, an increase in crumb density and a decrease in porosity were observed.

It was established that the use of secondary raw materials, namely red currant pomace powder at a level of 2–4% relative to the flour mass as a natural improver of yeast dough properties, contributes to the intensification of biochemical processes and improvement of its structural and mechanical characteristics.

The conducted studies on the use of secondary products of currant processing made it possible to develop an accelerated method for yeast dough preparation, with a 25% reduction in dough formation time.

Thus, currant processing products contain valuable biologically active substances, including vitamins, antioxidants, carbohydrates, organic acids, pectin substances, macro- and microelements. This makes it possible both to enrich flour-based products with essential nutritional components and to use them for correcting the technological properties of raw materials.

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