INFLUENCE OF ADDING WILD BERRY POWDERS ON THE QUALITY OF PASTA PRODUCTS

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Abstract

Pasta is a popular food item among consumers all over the world. They have high energy value, low cost and long shelf life. However, the biological value of these products is quite low. Adding components rich in dietary fiber, vitamins and minerals to their composition will significantly improve their nutritional value. The purpose of the article is to analyze the possibility of producing pasta with the addition of derivatives from the processing of wild berries *Sambucus nigra*, *Viburnum opulus*, *Hippophae rhamnoides L.*, which have a rich nutrient composition and are available raw materials. The technology, developed in the work for processing berries by osmotic dehydration, allows the use of gentle drying modes, which contributes to the maximum preservation of their biological value. Sensory evaluation of pasta was carried out according to the Croatian Official Methods, moisture content of pasta was determined by drying to constant weight. Sensory analysis of pasta showed that the addition of powders does not lead to a deterioration in their quality. Their appearance, taste, smell, shape and elasticity are improved. The quality of the pasta samples, containing 5 % of the powder, was determined as "good" according to the results of the evaluation of the tasting group. And the samples with a powder content of 10 % have a "high" quality. The addition of powders has practically no effect on the drying conditions and moisture content of the finished products. With the addition of *Viburnum opulus* powders, the moisture content is reduced compared to controls. Humidity of all samples is within the permissible limits, which indicates their resistance to storage.

Keywords: pasta, berry processing derivatives, *Sambucus nigra*, *Viburnum opulus*, *Hippophae rhamnoides L.*, sensory evaluation

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1. Introduction

Pasta is a traditional and popular food product around the world, known for its nutritional quality, ease of preparation, shelf stability (when dried), low cost, easy preparation, and low glycemic index [1]. They mainly include carbohydrates (70–76 %), proteins (10–14 %), lipids (1.8 %), dietary fiber (2.9 %), and a small amount of minerals and vitamins [2]. A large amount of vitamins is lost during the grinding of grain. This problem can be solved by adding vitamin-rich tissues, such as spinach, tomatoes, mushrooms, veal liver, sunflower seeds, chicken meat or fish meat [3].

Nowadays, fortified foods are becoming a new trend, and pasta is a good product to fortify. The addition of various food additives to pasta can increase the nutritional and biological value of these products, but when any additives are added, the physicochemical and rheological properties of the dough change [4–6].

Over the past two decades, many research efforts have been made to improve the nutritional value of pasta by incorporating non-traditional ingredients through the demand of health-conscious

consumers for functional foods. Considering the increase in the biological value of finished products, researchers take into account technological aspects [7].

At the same time, there are experimental studies to improve the nutritional and functional properties of pasta [8–10]. The addition of quinoa helps to increase the content of fiber, protein and amino acids in the composition of pasta [8]. The introduction of non-traditional raw materials (oat bran, psyllium fibers) into the composition of pasta affects the culinary, texture and color characteristics [9]. Cooked noodles, supplemented with 10 % and 20 % sprouted barley, had no negative sensory characteristics [10].

Bran-fortified pasta had undesirable sensory and processing properties, especially at 30 % addition. Although enriched products contained more dietary fiber, antioxidants, ash, proteins, fats, Ca, Fe, Mg, Cu compared to conventional pasta [11]. The presence of fiber in pasta leads to a deterioration in texture characteristics. Raw pasta, enriched with fiber, has a darker color [12]. It has been established, that when adding powders from grape pomace, there is no loss of solid mass in the paste. However, antioxidant properties were lost during cooking [13].

In pasta, enriched with grape pomace extract, a higher content of phenols, flavonoids and a higher antioxidant activity were observed [14].

It is obvious, that the addition of vegetable additives to pasta increases their biological value, but affects the physicochemical parameters. Since the demand for healthy food has increased significantly in the world recently and there is an active promotion of reducing the number of by-products, many scientists are developing food products, enriched with biologically active substances from by-products [15]. The analysis showed that, basically, the use of primary raw materials is proposed as additives. And there are practically no studies on the use of plant waste. Although, they are rich in dietary fiber, proteins, antioxidants and other biologically active substances.

As a raw material for the production of herbal nutritional supplements, we have proposed derivatives of wild-growing berries of sea buckthorn (*Hippophae rhamnoides L.*), viburnum (*Viburnum opulus*) and black elderberry (*Sambucus nigra*). Sea buckthorn berries (*Hippophae rhamnoides L.*) are the most nutritious and rich in vitamins, essential fatty acids, amino acids, phytosterols and flavonoids, vitamin E (160 mg/100 g), B1, B2, K, carotenoids (314 to 2139 mg/10 g), pigments and lipoproteins [16]. Elderberry is a rich source of proteins, amino acids, dietary fiber, phytochemicals, vitamins B, A and C. Elderberries are high in organic acid and lower in sugar, and high in polyunsaturated fatty acids (omega-3: 38.12 g/100 g and omega-6: 39.54 g/100 g of fatty acids) [17, 18]. Kalina is a natural source of various compounds with antioxidant properties, such as ascorbic acid (vitamin C), α-tocopherol (vitamin E), carotenoids, chlorophylls, and phenolic compounds [19].

The analysis showed that the enrichment of pasta with powder additives, containing dietary fiber, vitamins and minerals, will increase their nutritional and biological value. One of the sources for obtaining a high-quality additive for enriching pasta is the derivatives of processing wild berries. Their use will contribute to the development of the processing industry, since this type of raw material is mainly used on an industrial scale for the manufacture of dietary supplements and very rarely for the production of food products.

Thus, the aim of the study is to analyze the possibility of producing pasta with the addition of derivatives from the processing of wild berries *Sambucus nigra*, *Viburnum opulus*, *Hippophae rhamnoides L.*, which have a rich nutrient composition and are available raw materials.

2. Materials and Methods

2. 1. Sensory evaluation of pasta

The sensory assessment of pasta was performed according to the Croatian Official Methods [20]. The external shape and appearance of the dried pasta was checked visually, while their elasticity was measured by tearing the pasta by hand and examining the broken surface. Analyzed samples of dried pasta, weighing 50 g each. The study involved non-professional tasters. Samples for the study were presented on white paper. The maximum score for dried pasta properties was 20 points (maximum 5 points for shape, 10 for appearance, and 5 for firmness). The score for cooked pasta was a maximum of 40 points (loss from cooking – 25 points, water absorption –

10 points, increase in volume – 5 points). Smell, stickiness, texture, and taste were scored with a maximum of 40 points (maximum 10 for smell, 10 for stickiness, 10 for texture, and 10 for taste). Samples were freshly prepared for optimal cooking times and served on a white plate with a glass of water. The quality of cooking was defined as high if the pasta reached 90–100 points, good when receiving 80–89 points, satisfactory 70–79 points, and poor below 70.

Based on these characteristics, the tasting participants also rated the overall quality of both cooked and raw samples using the same 100-point scale.

2. 2. Moisture Determination of Pasta

To determine the moisture content of pasta, 50 g of each of the samples was ground first in a porcelain mortar, and then using a LZM-1 laboratory mill (Ukraine) until the ground particles completely passed through a stamped sieve (1 mm). Two portions (5.0±0.1 g) are taken from the crushed fraction into pre-dried and weighed metal cups with lids. Weighed samples in open cups with lids, placed on the bottom, were placed in an oven and dried at a temperature of 130 °C for 40 min. After drying, the cups were capped and cooled in a desiccator for 30 min. Chilled cups with lids were weighed on an analytical balance. Humidity was calculated by the formula:

$$W = \frac{(m_1 - m_2)\cdot 100}{m}, \quad (1)$$

where m_1 is the mass of a cup with a sample before drying, g; m_2 is the mass of a cup with a sample after drying, g; m is the mass of the product sample, g.

3. Results

3. 1. Development of a recipe for pasta with wild berry powders

To prepare powders with functional properties, thoroughly washed berries of *Viburnum opulus*, *Hippophae rhamnoides L.*, and *Sambucus nigra* were frozen (–18 °C) and defrosted immediately before processing to improve taste properties. Mixed in a ratio of 1:1 with a 70 % sucrose solution, heated to 65 °C. The mixture was thoroughly stirred for 1 hour at a constant temperature of 50 °C. As a result, partial dehydration of the berries occurred. Water is removed by diffusion and capillary flow. Due to the osmotic pressure, created by the high concentration of sucrose in the sugar solution, water penetrated through the semi-permeable membranes of the berries. At the same time, the content of solids in the sucrose solution decreased by 10–12 %. Partially dehydrated berries were separated from the osmotic solution and sent for drying in an infrared laboratory dryer at a temperature of 50 °C. Dried derivatives of berries were ground into powders using a LZM-1 laboratory disk mill to a fineness that ensured complete passage of the material through a braided brass sieve (0.2 mm).

Ribbon-shaped wide pasta (noodles) was made according to the classical technology of home-made noodles, while part of the wheat flour was replaced with berry powders. The study was carried out in two stages. At the first stage, 5 % of powders were added, made from derivatives of the processing of wild berries *Viburnum opulus*, *Hippophae rhamnoides L.*, *Sambucus nigra*. With the addition of 5 % powders, the organoleptic and physico-chemical parameters of pasta did not practically change at the second stage of the study, the addition of powders was increased to 10 %. The formulation of the developed products is presented in **Table 1**.

Table 1

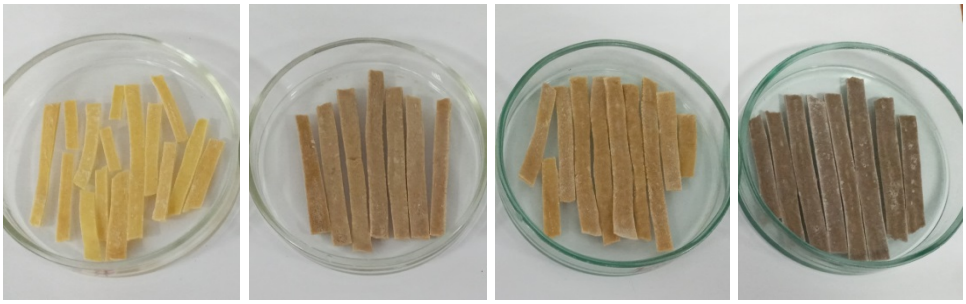
The recipe of the studied samples of pasta

Components	Experience 1				Experience 2			
	a	***b***	***c***	***d***	***a***	***b***	***c***	***d***
Flour, g	100	95	95	95	100	90	90	90
Berry powder, g	–	5	5	5	–	10	10	10
Salt, g	1	1	1	1	1	1	1	1
Chicken egg, pcs.	1	1	1	1	1	1	1	1
Water, g	30	30	30	30	30	30	30	30

It should be noted, that part of the water, provided by the recipe, was mixed with berry powder (about 20 g), the mixture was thoroughly mixed until a uniform suspension was obtained. Next, all the prescription components were mixed. The resulting dough was rolled out by hand (thickness no more than 2 mm) and cut into strips 3–5 mm wide. The length of the strips varied. Drying was carried out in an infrared laboratory dryer.

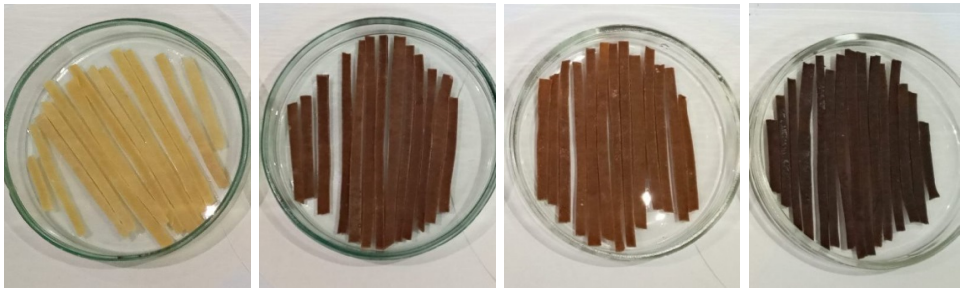
3. 2. Sensory scores

The effect of powders, derived from the processing of wild berries *Viburnum opulus*, *Hippophae rhamnoides L.*, *Sambucus nigra*, on the culinary properties of the final product, such as: weight loss during cooking, water absorption, increase in volume, as well as the effect on microstructure, color, taste, smell, consistency and general view, was studied. It was found, that increasing the amount of additive had a positive effect on the sensory properties of the product. The appearance of the samples is shown in **Fig. 1, 2**.



a *b* *c* *d*

Fig. 1. The studied samples of pasta with the addition of 5 % powders: *a* – control without additives; *b* – with *Viburnum opulus* powder; *c* – with *Hippophae rhamnoides L.* powder; *d* – with *Sambucus nigra* powder



a *b* *c* *d*

Fig. 2. The studied samples of pasta with the addition of 10 % powders: *a* – control without additives; *b* – with *Viburnum opulus* powder; *c* – with *Hippophae rhamnoides L.* powder; *d* – with *Sambucus nigra* powder

The sensory evaluation of raw pasta showed that the addition of powders from wild berry processing derivatives led to an improvement in some organoleptic properties. The color of the products became more saturated, matched the color of the additives. To a small extent, the smell of berries, which were used as raw materials, was felt. However, the consistency has slightly deteriorated. The total score of all studied samples is presented in **Table 2**.

It should be noted, that there was no significant difference between the samples, containing 5 % powders of different types. Their taste and smell practically did not differ from the control sample, but the consistency worsened somewhat. The samples had different shades of brown. The sample with *Sambucus nigra* powder received the highest score for appearance. The elasticity of

the products was determined by manual rupture and inspection of the surface. The addition of powders had a positive effect on this indicator. Since the powders contain dietary fiber, this contributed to the strengthening of finished products. Samples 1b, 1c, 1d according to the results of the sensory analysis were rated "good".

Table 2

The results of the organoleptic evaluation of pasta

Indicators	Assessment results, points							
	Experience 1				Experience 2			
	a	*b*	*c*	*d*	*a*	*b*	*c*	*d*
Raw pasta								
Appearance	10	8	8	9	10	10	10	10
The form	5	3	3	4	5	5	5	5
Elasticity	3	4	4	4	3	5	5	5
Cooked pasta								
Smell	10	10	10	10	10	10	10	10
Stickiness	10	8	8	8	10	9	9	9
Consistency	10	7	7	7	10	8	8	8
Taste	10	9	9	9	10	10	10	10
Mass loss during cooking	25	24	24	24	25	24	24	24
Water absorption	10	7	7	7	10	8	8	8
Volume increase	5	3	3	3	5	4	4	4
Total score	98	83	83	85	98	93	93	93

Usually, consumers prefer products with bright colors. It has been established, that products with a dosage of 10 % powders to the mass of flour from derivatives of processing wild berries acquire a rich color, a characteristic color of powders and a slight taste of berries, which does not impair the taste properties of the product. Most of the taste and aroma was observed in the sample with the added powder of *Sambucus nigra*. The cooking properties of products with additives deteriorate somewhat, in particular, the products increase in volume after cooking, the transition of solids into cooking water increases. This indicates that the constituents of berry powders have a dehydrating effect in pasta dough and prevent wheat flour biopolymers from forming dough. A decrease in stickiness (the highest score) was recorded compared to the samples, containing 5 % powders. The quality of samples 2b, 2c, 2d was recognized by the tasters as "high".

3. 3. The results of determining the moisture content of pasta

Humidity of pasta affects their shelf life. It should not exceed 12–13 %. The results of the study of the moisture content of pasta with the addition of wild berry powders are shown in **Fig. 3**.

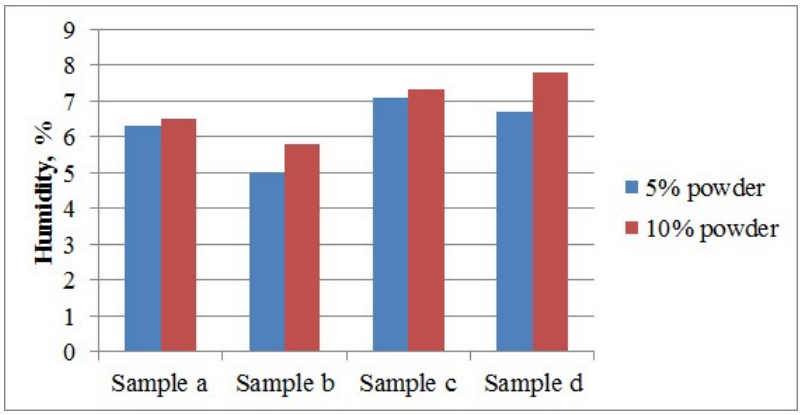


Fig. 3. Pasta Moisture

The results of the moisture analysis showed that the amount of added powder did not significantly affect the change in the indicator. The samples were dried under the same conditions in a laboratory infrared dryer. During the first 30 min the drying temperature was 100 °C, and then the drying process was carried out at a temperature of 85 °C for 1 hour. The highest moisture content was observed in samples with the addition of *Sambucus nigra* powder (1d – 6.7 %, 2d – 7.8 %), apparently, this is due to the high moisture-binding capacity. The lowest humidity was observed in pasta with *Viburnum opulus* powder (1b – 5 %, 2b – 5.8 %). It should be noted, that an increase in the amount of powders does not significantly affect the increase in moisture content. The moisture content of the control samples (without additives) is higher than that of the samples with *Viburnum opulus* powders.

4. Discussion

Pasta is not recognized as a balanced product due to the low biological value of their proteins and low dietary fiber content. The addition of powders from derivatives of processing wild berries contributed not only to an increase in their biological value [21], but also increased their elasticity by increasing the amount of dietary fiber. This indicator is of great importance for the commercial quality of pasta, especially noodles. Similar results were obtained when chestnut flour and gyrazole powder were added to pasta for waffle dough [20, 22]. When adding powders, the consistency of the dough worsens, its extensibility decreases. This is explained by an increase in the amount of saccharides in powders, which do not allow the formation of an elastic cellulose framework and increase the viscosity of the dough. It has been established, that vegetable powders have a similar effect on biscuit dough [23]. The limitations of this study include the fact that there is no specialized equipment for osmotic dehydration. In industrial conditions, without such equipment, it is difficult to maintain the necessary modes of dehydration of berries. But the design of the apparatus for osmotic dehydration has already been developed, and now this development is being patented [24].

Further research will be focused on the possibility of using wild berries (sea buckthorn, viburnum, elderberry) in the technology of bread, sour-milk and meat products.

5. Conclusions

A recipe for pasta (noodles) with the addition of powders from processing derivatives of wild berries *Sambucus nigra*, *Viburnum opulus*, *Hippophae rhamnoides L.* has been developed. The use of osmotic dehydration for processing wild berries and the mild mode of their drying increased the nutritional and biological value of pasta.

The sensory evaluation of pasta showed that the addition of powders from the processing of wild berries has a positive effect on appearance, taste, smell, shape and elasticity. The consistency, stickiness and water absorption are somewhat reduced, but this does not significantly reduce the overall quality of the product. All samples with the addition of 5 % of the powders were rated "good", and with the addition of 10 % of the powders, the pasta was of high quality.

The addition of powders has practically no effect on the drying conditions and moisture content of the finished products. With the addition of *Viburnum opulus* powders, the moisture content is reduced compared to controls. Humidity of all samples is within the permissible limits, which indicates their resistance to storage.

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