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ENRICHMENT OF PASTA PRODUCTS USING BEETROOT

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Abstract: *Beetroot has numerous advantageous health effects due its chemical composition, such as fibres, mineral elements, vitamins and phenolic compounds. It has not only anti-tumour effects but its consumption is favourable for the cardiovascular system, too. It is used as natural colouring agent in several products. In this research wheat pasta products were made with 8 and 16% beetroot juice and pulp addition to evaluate that the advantageous nutritional effects of beetroot could be utilized in pasta production as well and the consumer's opinion on these products. Besides the general physical parameters (dry matter content, drying water loss, cooking water absorption) total phenol content and flavonoid concentrations were measured and a sensory analysis was performed. It was found that the beetroot addition did not influence the most the physical properties of pasta as compared to the control, but the use of beetroot pulp resulted in a significant increase in the water absorption during cooking. Unfortunately the high polyphenol content of beetroot could not be utilized in pasta consumption. Although the dry pasta had significant total phenol content, the cooking led to serious leaching and the same value were experienced as for the control pasta. Despite these facts, this kind of product can be beneficial for the producers as the sensory analysis showed that the overall acceptance and the taste and texture were found to be advantageous for potential consumers.*

Keywords: *beetroot, pasta products, fortification, antioxidants.*

1. Introduction

Red beetroot (*Beta vulgaris* L.) is grown all over the world and it can be consumed in many ways, such as canned vegetable and juice, but it is used more and more in the food industry in dried and frozen form as natural colouring agent in different products [1]. Besides, its health promoting effect it is more and more widely known, therefore it became more and more popular. Its health-benefiting compounds are both inorganic compounds (like minerals such as calcium, iron, zinc, sodium, potassium, phosphorus) and organic ones like vitamins (biotin, folic acid, niacin, vitamin B6) and it contains high amounts of high soluble fibres. Beetroot is one of those vegetables, which contains large concentrations of bioactive substances, like betalain, nitrate, antioxidants and phenol [2].

Betalains are water soluble nitrogen containing pigments and the food industry uses it as a natural colouring agent. Betalains are claasified in two main groups: red-violet betacyanins and yellow-orange betaxanthins, these two main pigments determine the colour of the beetroot variety. The antioxidant activity of betalains is well known, it is referred as being higher than that of the ascorbic acid [3]. Betacyanins have strong antitumor effect, being able to slow tumour growth and help treat prostate, ovarian and lung cancer [4, 5].

Beetroot effects on the vasculature is attributed to its high nitrate content, and several reports indicate its potential for significantly reducing blood pressure in humans [6] and improves the results of athletes by the increase of O_2 supply of muscles, as it was found in an experiment that the beetroot juice consumption made the results of swimmers better [7].

The red beetroot is a good source of fibres. Pectin is its water soluble polysaccharide, fibre that bypasses enzymatic digestion of the small intestine, but it is easily degraded by the microflora of the colon. Due to this aspect, it improves cholesterol and lipid metabolism and diabetes control and prevention [8]. Due to its antioxidant, antiinflammatory, anticarcinogenic and vascular effect, beetroot is very popular in nutrition.

Pasta products are one of the most popular staple foods nowadays because they are easy to use, quickly ready to consume, can be combined with a wide range of foods, have a diversified appearance both by shape and size and can be stored for a long time. On the other hand, there are many criticisms against it because of its low nutritional value. Pasta products are rich in carbohydrates and therefore energy and the modern trends in dietetics suggest other side dishes instead of it. A trend in the development of the pasta products is the improvement of its nutritional value by addition of plant and animal originated health promoting components to increase its protein, fatty acid or mineral composition or fibre content [9-12].

This study aimed to answer the question whether the positive effects of beetroot consumption could be utilized in the case of pasta products. Beetroot is used as natural colourant in these products but the question is open that its advantageous components can be useful in pasta products too. To answer this question we made wheat pasta products with different concentrations of beetroot juice and pulp and their phenol and flavonoid contents were evaluated by the main physical and sensory parameters.

2. Matherials and methods

Preparation of experimental samples

Flour samples used for the evaluation were of BL 55 type commercial flour (white wheat fine flour with 0.55% ash content). The beetroot was also purchased from a local market. The beetroots were peeled, washed and shredded by a commercial juicer. The beetroot was added to the flour as pulp containing all the juiced parts of the beetroot and as juice when the solid particles were removed from the liquid part. In the case of pulp the ratio of solid and liquid parts were measured by laboratory scale and applied in their original ratios avoiding the differences resulted by the sedimentation of fibre parts.

The control pasta was made using 70 g wheat flour, 30 g tap water and 1 g NaCl. The other samples contained 8 and 16% beetroot pulp or juice in the amount of dough, i.e. 8 or 16 g beetroot was added to 100 g pasta, while the amount of water was decreased to 22 or 14 g, respectively. The preparation and molding of dough were done by hand. The short-cut pasta was dried at room temperature for 3 days avoiding the nutrient losses caused by the high drying temperature.

The dried pasta samples were boiled in hot (100°C) water until they reached the ready-to-eat texture and the time required for boiling was measured.

Evaluation of pasta samples

For the determination of drying weight loss 100 g of pasta was separately dried and their weights were measured after drying by a laboratory scale. The drying weight loss (DWL) was determined using the following Eq. (1):

$$DWL\ (m/m\%)=\frac{100-y}{100g}*100 \qquad (1)$$

where y is the weight of the dried pasta. Dry matter content was determined by the measurement of weight loss during drying to constant weight by the MSZ 20500/2-85 Hungarian standard. For the cooking water absorption capacity (CWA) 10 g of pasta was cooked in boiling 400 ml tap water. After the pasta was cooked, it was rinsed by cold tap water, let to rest for cooling down and weighted by a laboratory scale. The water absorption during cooking was determined using Eq. (2):

$$CWA\ (m/m\%)=\frac{x-y}{y}*100 \qquad (2)$$

where x is the weigh after cooking and cooling and y is the weight before cooking. The acidity degree of pasta was determined by the MSZ 20500/2-85 Hungarian standard. Pasta samples were grinded under 315 µm particle size by laboratory grinder and 10 g was measured and added to 100 ml distilled water. After 15 minutes phenolphthalein indicator was added and this mixture was titrated by 0.1 mol/l NaOH until reaching pink colour. The used NaOH in cm^3 is the acidity degree of the pasta.

Total phenol content was determined by the method of Kim *et al*. [13]. 10 g of grinded samples were extracted by 100 ml of 80% aqueous methanol and it was filtered and 0.5 ml was measured and 2.5 ml Folin-Ciocalteu's reagent was added. After 5 minutes 2 ml 75 g/l $NaCO_3$ was added and this mixture was rested for two hours in dark at room temperature. After resting, the absorbance of mixture was measured using a spectrophotometer on 760 nm and the total phenol content was determined by a calibration line which was made from gallic acid. Total phenol content is presented as mg gallic acid equivalent (GAE)/100 g sample.

The total flavonoid content was determined by the method of Meda *et al.* [14]. The same filtered 80% aqueous methanol extract was used as in the case of total phenol content. In a test tube the following was added in the following order: 4 ml distilled water, 1 ml extract, 0.3 ml $NaNO_3$ and five minutes later 2 ml 1 mol/l $AlCl_3$. The test tubes were completed to 10 ml by distilled water and the absorbance was measured at 510 nm. The total flavonoid content was determined by a calibration line what was made from catechin and the total phenol content is presented as mg catechin equivalent (CE)/100 g sample.

Sensory analysis of pasta samples was performed by the MSZ 20500/3-1986 Hungarian standard. The pasta samples were boiled and a five-member committee performed the sensory analysis. Four parameters: appearance, odour, taste and texture had to be evaluated and scored from 0 to 5. The values were corrected by weighting factors: 1.1 for the appearance, 0.7 for the odour, 0.9 for the taste and 1.3 for the texture. The final score is the sum of the corrected scores and the result of test report that the pasta is first class when this score is higher than 18, the product is classified into the second class when it is between 16 and 18. A preference order and opinion were also asked from the testers.

3. Results and discussion

The different kinds of beetroot added to the pasta did not influence significantly the dry matter content of the dried pasta products; the values ranged from 87.2 to 87.7%. The lowest value was found in the case of control product while the beetroot addition increased this value in all the cases. The requirement on the moisture content of pasta products is 13% at most; therefore all the products meet this demand (Table 1). The other legal requirement on the quality parameters of these products is the acidity value: it has to be less than 5 cm^3. It can be seen in Fig. 1 that all the pasta products met this requirement too, but the beetroot addition increased the acid value. The 8% pulp and juice addition resulted in one and a half to two times higher values in comparison to the control product, but the 16% beetroot addition resulted in three times higher values.

Table 1.
Dry matter content, drying loss, cooking water absorption and cooking time of pastas made with beetroot juice and pulp addition

	Dry matter content, %	Drying loss, %	Water absorption during cooking, %	Cooking time, min
Control	87.3	27	226.60	11
8% beetroot juice	87.7	27	223.38	14
16% beetroot juice	87.6	30	222.92	17
8% beetroot pulp	87.7	28	261.32	20
16% beetroot pulp	87.7	25	259.52	22

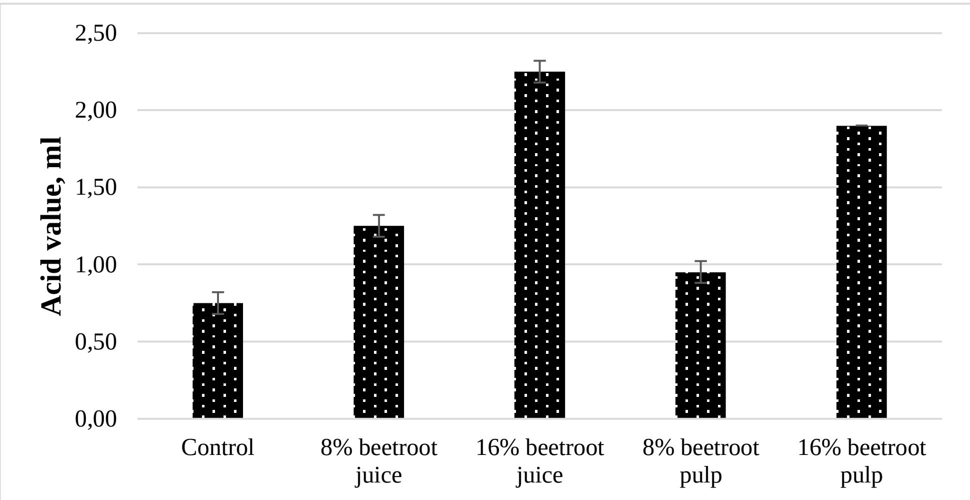

Fig. 1. Acid values of pasta made with beetroot juice and pulp addition

The drying losses were also influenced by the composition. As Table 1 shows 8% beetroot addition did not lead to changes in water loss, 27 and 28% values were experienced and therefore almost all the added water was removed during the natural drying. In contrast, the 16% beetroot juice addition increased the water loss by 3% and the same amount of beetroot pulp addition decreased it by 2% in comparison to the control pasta. The composition also influenced the amount of absorbed water during cooking; the control and the 8 and 16% beetroot juice enriched pasta had 222 to 226% water absorption, but the absorption of beetroot pulp enriched the resulted values around 260%, probably due to the higher fibre content. The presence of beetroot had also effect on the required cooking time. The beetroot

juice addition resulted in a moderate increase in the cooking time, while the addition of the beetroot pulp resulted in two time higher cooking times.
The concentrations of total phenolic components (TPC) were also measured from the raw materials and the pasta products. The beetroot juice had 185 mg GAE/100 g TPC and the beetroot juice and the beetroot pulp had 128 mg GAE/100 g. The TPC of the control dry pasta was 28.4 mg GAE/100 g and both the pulp and juice addition doubled it. Much less difference can be seen amongst the concentrations but we can state that the higher additions resulted in slightly higher concentrations and the use of pulp resulted in a little bit higher TPC. These advantages in nutrient value had been lost by cooking: the TPC varied from 7 to 17 mg GAE/100 g, therefore we can state that the TPC content of pasta products cannot be increased by beetroot addition, although the colour of the additive results significant change in the colour of the dry and cooked pasta (Fig. 2). The total flavonoid content (TFC) was also measured for the raw materials and the products, but while the beetroot juice and pulp had significant concentrations (185 and 128 mg CE/100 g, respectively), the TFC were under the detection limit for both the dry and cooked pasta products.

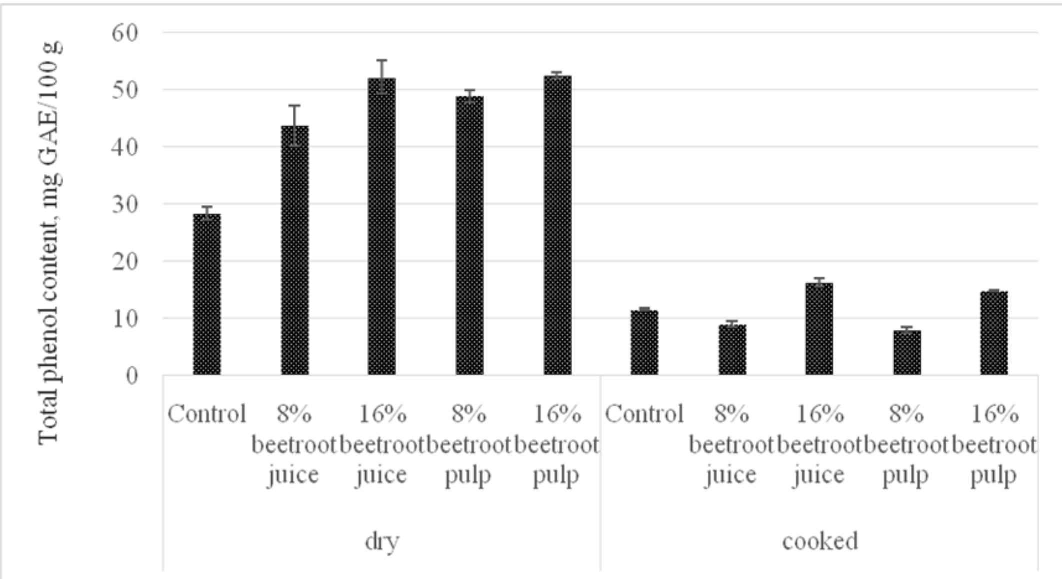

Fig. 2. Total phenol contents of pastas made with beetroot juice and pulp addition

The sensory analyses were made to determine how the consumers accept the products (Table 2). On average the products got 4.8 points from the maximum 5.5 for the appearance, 2.94 from 3.5 for the odour, 3.82 from 4.5 for the taste and 5.62 from 6.5 for the texture, what shows that the overall acceptance is good for the products. The average score for the sensory analysis is 17.2; this means second class products by classification. One product got higher values that 18 what is required for first class quality; the one made with 8% beetroot pulp. This was due its high values for appearance, odour and taste, but its texture score registered also the highest values. The pasta made with 16% beetroot pulp addition scored 15.84% and was classified under the second class, because of its low scores for appearance. It is interesting to see that the control pasta got the lowest scores for taste and odour, therefore we concluded that the addition has advantageous effects on the main sensory values. When the testers were asked to make a preference order for the products, the highest position was achieved by the pasta made with beetroot pulp addition independently from the concentration (18 scores for both the 8 and 16% addition), the third was the one made with 16% juice addition (17 score) and the forth is the one made with 8% addition (15 score). The control pasta got only 7 score that meant that almost all the testers would prefer the least. The tasters found the pasta products made with beetroot addition have intensive taste what makes them enjoyable.

Table 2.

Results of sensory evaluation of pastas made with beetroot juice and pulp addition

	Appearance	Odour	Taste	Texture	Sensory value
Control	4.84	2.8	3.42	5.72	**16.78**
8% beetroot juice	4.84	2.8	3.78	5.98	**17.4**
16% beetroot juice	4.18	2.94	3.78	4.94	**15.84**
8% beetroot pulp	5.28	3.08	4.14	5.98	**18.49**
16% beetroot pulp	4.84	3.08	3.96	5.46	**17.34**
Average	**4.8**	**2.94**	**3.82**	**5.62**	**17.17**

4. Conclusions

The results show that while the beetroot pulp and juice addition in 8 and 16% concentrations significantly influences the colour of products the other physical properties are only slightly modified. The addition has only moderate effect or no effect on the moisture content and the drying loss (and not even on the acidity value) while the water absorption during cooking is increased by the fibre parts of the beetroot pulp. The expected nutritional effect that this antioxidant rich component would increase the nutritional value of pasta was not proved; although the dry enriched pasta had significant total phenol concentration thanks to the gentle natural drying, cooking resulted in decrease probably due to leaching. In the case of the total flavonoid content the enrichment had no effect on the flavonoid content of dry or cooked products. In addition to all of these apsects we concluded that the production of this kind of enriched products can be advantageous, because the consumers found them attractive and the sensory analysis proved that they can be competitors of traditional pasta products both in texture, taste and odour. They could consume it willingly and it can be an opportunity for the expansion of assortment.

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