Development of a recipe and technology of pumpkin soup puree with the addition of functional polysaccharides

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Abstract. The effect of polysaccharides (PS) – xanthan and guaran – on the quality of our “Pumpkin milk soup puree” was studied, and a recipe and technology for this culinary product were developed. A positive effect of the studied PS on the quality of the pumpkin soup puree was revealed, namely: the dry matter content decreased (by 4% on average), the acidity increased (by 25% on average), the palatability improved, and the shelf life of the pumpkin soup puree increased up to 48 h. Adding PS did not significantly affect the cost of the samples under study; a decrease in cost by an average of 0.6% took place. As a result of sensory analysis, physicochemical and microbiological studies, our developed dish “Pumpkin soup puree” with the addition of 0.25% guaran can be recommended for introduction into the food industry (catering) as a functional and dietary product.

1. Introduction

The formula “Health is a function of nutrition” is the basis for modern food science. Over the past two hundred years, our nutrition has undergone significant changes. First, human consumption of refined foods, deprived of many vitamins, dietary fiber and other essential food components, has sharply increased. Second, the composition and ratio of the components used in food that are involved in providing the body with plastic and regulatory compounds have changed. Our ancestors’ food contained a smaller amount of protein, and its composition had more various mineral salts, dietary fiber and antioxidants 2, 4–10 and 10 times, respectively. Third, the intake of lactic acid bacteria into the modern human body has sharply decreased [1-3].

There is evidence that currently the food consumed by Russians does not meet the physiological needs of humans, resulting in an increase in overall nutritional incidence, a decrease in performance, and a significant reduction in life expectancy and population of the Russian Federation [4]. At the same time, there is a tendency to improve the quality of life, including through healthy nutrition, namely, in the development of the new Foodnet market of the national technological initiative, whose goal is to create “smart” services and products that will become leaders by 2035 in world markets due to the best technological solutions for human food security [5].

Therefore, based on the foregoing, the development of a recipe and technology of pumpkin soup puree for functional purposes is an urgent task.

The aim of our study was to develop a recipe and technology of pumpkin soup puree with the addition of functional polysaccharides.

To achieve this goal, the following tasks were set:

- to theoretically substantiate and experimentally confirm the feasibility of using polysaccharides
(PS) (xanthan and guaran) in the recipe and technology of our pumpkin soup puree;

• to estimate the physicochemical characteristics of the pumpkin soup puree;
• to estimate the nutritional and energy values of the pumpkin soup puree;
• to estimate the biological value of the pumpkin soup puree;
• to explore the structural and mechanical properties of the pumpkin soup puree;
• to evaluate the microbiological parameters of the pumpkin soup puree; and
• to calculate the cost of our pumpkin soup puree.

2. Objects and research methods

The object of our study was “Pumpkin milk soup” taken from the collection of recipes for the diet food production for catering enterprises [6].

Two polysaccharides were used in the work, namely: xanthan (xanthan gum, Deosen, China) and guaran (guar gum, Guarsar, India), which are related to dietary fiber.

Sampling for organoleptic analysis was carried out in accordance with GOST No. 31986-2012 “Catering services. The method of organoleptic assessment of the quality of catering products” on a five-point scale [7].

The mass fraction of solids was measured in a Chizhov apparatus at a temperature of 150 ± 5°C during seven min according to GOST R 54607.2-2012 [8–10].

Total acidity was estimated by titration according to the guidelines for laboratory quality control of catering products [9, 10].

The number of mesophilic aerobic and facultative anaerobic microorganisms (NMAFAM) was estimated in accordance with GOST 10444.15-94 “Food products. Methods for measuring the number of mesophilic aerobic and facultative anaerobic microorganisms” [11].

The presence of Escherichia coli bacteria (ECB) was detected according to GOST 31747-2012 “Food products. Methods for detecting and determining the number of Escherichia coli bacteria (coliform bacteria)” [12].

The research was conducted at the chairs of “Food Technology” and “Microbiology, Biotechnology and Chemistry.”

The research results were statistically processed using the Windows applications Microsoft Office Excel 2007 and MathCad 14 [13].

3. Results and discussion

When developing a recipe and technology of the pumpkin soup puree, semolina was replaced with polysaccharides. The selected PS have a number of technological advantages, namely, a wide range of viscosity, high thermal stability, no syneresis (the stability of product quality during storage), an antioxidant effect, economic efficiency, and the possibility of using in gluten-free and dietary nutrition [14].

Samples 1.1–1.5 of the pumpkin soup puree were studied with the addition of xanthan at several pre-selected concentrations: 0.1, 0.15, 0.2, 0.3 and 0.4% and that of guaran 2.1–2.5 at concentrations of 0.1, 0.2, 0.25, 0.3 and 0.4%.

The optimal concentrations for these PS were selected using sensory analysis [7,15], on whose basis, organoleptic profiles were plotted (see figures 1 and 2).
Figure 1. Organoleptic profile of the developed pumpkin soup puree with the addition of xanthan

Figure 1 shows that the best concentrations were 0.15% (29.3 points) and 0.2% (29.5 points) for the group 1 samples, since these samples had a more pronounced milk-pumpkin taste and their consistency was homogeneous. In addition, an advantage of these pilot samples was the absence of a film on the soup surface which is usually formed during storage.

Figure 2. Organoleptic profile of the developed pumpkin soup puree with the addition of guaran

For the group 2 samples, as can be seen from Figure 2, the best concentrations were 0.25% (28.7 points) and 0.3% (28.9 points), since pumpkin taste and aroma were more pronounced in these samples as compared to the control. In addition, we noted that the use of guaran led to the formation of a “mucous” consistency, which allows these soups to be recommended for diet nutrition.

As a result of organoleptic evaluation, samples 1.2, 1.3 and 2.3, 2.4 with the best organoleptic properties were selected for further physicochemical studies (see table 1).

From Table 1 it is seen that the solids content in the pilot samples (with the addition of polysaccharides) decreased as compared with the control sample by an average of 4%. This decrease is associated with the replacement of wheat flour with a polysaccharide. In addition, it can be seen from Table 1 that the pilot sample acidity increased by an average of 25%, this increase being presumably due to the property of PS to affect the pH level of the product [16-18].
Table 1. Physicochemical indicators of the selected samples of the pumpkin soup puree

| Indicator          | Control         | Pilot samples |                  |                  |                  |                  |
|--------------------|-----------------|---------------|-----------------|-----------------|-----------------|-----------------|
|                    |                 | group 1.2     | group 1.3       | group 2.3       | group 2.4       |                  |
|                    |                 | 0.15 % xanthan| 0.20 % xanthan  | 0.25 % guaran   | 0.30 % guaran   |                  |
| Solids content, %  | 15.900±0.010    | 15.200±0.050  | 15.500±0.050    | 14.600±0.020    | 14.700±0.010    |                  |
| Acidity, deg       | 2.800±0.010     | 3.400±0.020   | 3.600±0.050     | 3.070±0.050     | 3.500±0.010     |                  |

It can be concluded from our physicochemical studies that the selected polysaccharides are able to change the physicochemical properties of the final product.

Using data given in the reference book “Chemical composition and calorie content of Russian food products” [19], we calculated the nutritional and energy values of the studied products, which are presented in Table 2.

Table 2. Nutritional and energy values of the pumpkin soup puree

| Indicator        | Control   | Pilot samples |                  |                  |                  |                  |
|------------------|-----------|---------------|-----------------|-----------------|-----------------|-----------------|
|                   |           | group 1.2     | group 1.3       | group 2.3       | group 2.4       |                  |
|                   |           | 0.15 % xanthan| 0.20 % xanthan  | 0.25 % guaran   | 0.30 % guaran   |                  |
| Protein, g        | 2.296     | 2.090         | 2.090           | 2.090           | 2.090           | 2.090           |
| Fat, g            | 1.975     | 1.955         | 1.955           | 1.955           | 1.955           | 1.955           |
| Carbohydrates, g  | 6.770     | 5.358         | 5.358           | 5.358           | 5.358           | 5.358           |
| Dietary fiber, g  | **0.772** | **0.850**     | **0.900**       | **0.950**       | **1.000**       |                  |
| Retinol, µg       | 12.000    | 12.000        | 12.000          | 12.000          | 12.000          | 12.000          |
| Thiamine, mg      | 0.044     | 0.042         | 0.042           | 0.042           | 0.042           | 0.042           |
| Riboflavin mg     | 0.112     | 0.111         | 0.111           | 0.111           | 0.111           | 0.111           |
| Niacin, mg        | 0.259     | 0.235         | 0.235           | 0.235           | 0.235           | 0.235           |
| Ascorbic acid, mg | 3.580     | 3.580         | 3.580           | 3.580           | 3.580           | 3.580           |
| Na, mg            | 31.470    | 31.410        | 31.410          | 31.410          | 31.410          | 31.410          |
| K, mg             | 161.630   | 159.030       | 159.030         | 159.030         | 159.030         | 159.030         |
| Ca, mg            | 81.180    | 80.780        | 80.780          | 80.780          | 80.780          | 80.780          |
| Mg, mg            | 13.660    | 13.300        | 13.300          | 13.300          | 13.300          | 13.300          |
| P, mg             | 64.450    | 62.750        | 62.750          | 62.750          | 62.750          | 62.750          |
| Fe, mg            | 0.223     | 0.203         | 0.203           | 0.203           | 0.203           | 0.203           |
| EV, kcal          | 54.350    | 47.690        | 47.690          | 47.690          | 47.690          | 47.690          |

As can be seen from Table 2, our change in the recipe composition of the pumpkin soup puree has affected the content of its main nutrients. The amount of protein, fat and carbohydrates decreased by 8.97%, 1.01% and 20.86%, respectively, as compared with the control. As a result, the calorie content decreased by 12.25%.

Moreover, there was a slight decrease in the level of vitamins and minerals in the pilot samples of our soup (by 2.6% on average), except for retinol and ascorbic acid.

At the same time, the content of dietary fiber in the selected samples with PS added, as compared with the control, increased by an average of 12.7% per 100 g of product.

From literature data [20] it is known that, according to physiological norms, the need for dietary fiber for an adult is 20 g/day, and 10–20 g/day for children over 3 years old. Based on this, our developed product can be attributed to the functional ones, the recommended portion size being 300–400 g.

In order to characterize microbiological safety and to estimate shelf life, we conducted
microbiological studies, whose results are presented in Table 3.

**Table 3. Microbiological indicators of the pumpkin soup puree**

| Sample | NMAFAM, CFU/g | Weight of the product (g/cm$^3$) in which not allowed are | NMAFAM, CFU/g | Weight of the product (g/cm$^3$) in which not allowed are |
|--------|---------------|----------------------------------------------------------|---------------|----------------------------------------------------------|
| SanPin 2.3.2.1078-01 | no more than $1 \cdot 10^3$ | 1.0 | – | – |
| Control | Not detected | Not detected | 0.014·$10^3 \pm 0.010$ | 0.007·$10^3 \pm 0.020$ |
| 1.2 (xanthan) | Not detected | Not detected | 0.003·$10^3 \pm 0.020$ | 0.002·$10^3 \pm 0.050$ |
| 1.3 (xanthan) | $0.020 \cdot 10^3 \pm 0.050$ | Not detected | Not detected | Not detected |
| 2.3 (guaran) | Not detected | Not detected | 0.004·$10^3 \pm 0.010$ | Not detected |
| 2.4 (guaran) | Not detected | Not detected | 0.003·$10^3 \pm 0.050$ | 0.002·$10^3 \pm 0.010$ |

Note: – according to SanPin 2.3.2.1078-01, microflora is analyzed only within 24 h.

From Table 3 it is seen that a small amount of mesophilic aerobic and facultative anaerobic bacteria was found only in sample 1.3 in the pumpkin soup puree with xanthan added after 24 h, not exceeding the SanPin limit. No Escherichia coli bacteria were detected in samples 1.2 and 1.3. After 48 h, a slight increase in these microorganisms was observed only in sample 1.2, in significantly smaller quantities than in the control one. At the same time, no microorganisms were detected in sample 1.3.

In the pumpkin soup puree with guaran added, no mesophilic aerobic and facultative anaerobic bacteria as well as Escherichia coli bacteria were found in samples 2.3 and 2.4 after 24 h. After 48 h, a small NMAFAM was detected in samples 2.3 and 2.4, but significantly less than in the control sample. Escherichia coli bacteria were detected in sample 2.4 in very small quantities only (Table 3).

As a result of the foregoing, it can be concluded that the introduction of the polysaccharides into the pumpkin soup puree helps to prolong the shelf life of the finished product.

As a result of our preliminary economic calculations, the cost of the finished product (both control and pilot samples) was calculated, which is presented in Figure 3.

**Figure 3.** Cost of finished products of the control and pilot samples of the pumpkin soup puree (pricing as of 01.01.2020)
4. Conclusion

Figure 3 shows that our change in the component composition of pumpkin soup puree led to a decrease in the cost of pilot samples by an average of 0.6%. This is due to the replacement of semolina, which was in the recipe of the control sample.

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