Puree from apple and carrot refuse, boiled with starch syrup, in marshmallow technology

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Abstract. For modern society, diseases associated with malnutrition are increasingly common. There is an urgent task of saturating the consumer market with products for a healthy diet, which are balanced in nutritional substances and contain essential nutrients, including confectionery. The article proves that in the production of marshmallows for solving this problem, it is possible to successfully use a puree from apple and carrot refuse, boiled with starch syrup. This technological solution improves organoleptic quality indicators and increases the content of flavonoids, beta-carotene and dietary fiber in the finished product.

1. Introduction
To maintain health and reduce the risk of a number of nutritionally dependent diseases, minor components are vital to a person. This fact is reflected in many scientific works of scientists in the field of nutritional science. Minor substances include various groups of flavonoids: flavanols and their glycosides, flavones, flavonones, catechins, proanthocyanidins, etc. Their physiological effects on the human body are different and are important for the prevention of diseases [1-7].

One of the most important tasks of food manufacturers is to create products that meet modern requirements for complete and balanced nutrition, quality and safety with using deep, comprehensive and resource-saving technologies. It is important to expand the assortment line of products for various purposes, namely: children’s, functional, therapeutic and prophylactic, personalized and etc. [8-11].

Marshmallow is a confectionery product with a high sugar content. One of the directions in the production of healthy food products is to increase their nutritional value along with a decrease in calorie content [12-14]. Since marshmallow belongs to mass consumption products, the development of marshmallows for a healthy diet with a low energy value using semi-finished products from apple and carrot refuse is relevant and expedient.

2. Materials and methods
When developing the technology of new types of marshmallows, the «Vanilny» marshmallow recipe was used as a control, in which the apple puree was replaced with puree from apple and carrot refuse, boiled with starch syrup, in terms of dry matter [15].

An additive based on apple and carrot refuse was added to the test samples of marshmallows at dosages of 5, 15, 25 and 35%, partially replacing sugar in terms of dry matter and completely apple puree.
The marshmallow mass and the finished marshmallow were examined for organoleptic and physicochemical quality indicators.

3. The study of the effect of a puree from apple and carrot refuse, boiled with starch syrup, on the marshmallows quality

One of the physical and chemical indicators of the confectionery quality is density. For marshmallows, the density value should not exceed 0.6 g/cm³. The density values of the control and experimental samples of marshmallow masses are presented in figures 1 and 2.

**Figure 1.** Values of density of marshmallow masses using additive from apple refuse: 1 - control; 2 - sample 1; 3 - sample 2; 4 - sample 3; 5 - sample 4.

From figure 1 it follows that for sample 1, where the dosage of apple additive is 5%, the density of the marshmallow mass in comparison with the control is slightly reduced. In samples 2-4, with an increase in the dosage of the apple additive to 15-35%, the density of the marshmallow mass increases in comparison with the control by 16.7-52.4%, respectively.

**Figure 2.** Indicators of the density of the marshmallow mass using carrot additive: 1 - control; 2 - sample 1; 3 - sample 2; 4 - sample 3; 5 - sample 4.

The diagram shown in figure 2 shows that with an increase of the carrot additive content in the recipe of marshmallow from 5 to 35% (samples 1-4), the density of the marshmallow mass increases in comparison with the control by 2.4-61.9%, respectively.

An increase in the density of marshmallow masses in the test samples can be explained by an increase in their viscosity due to the introduction of apple or carrot additive into the recipe, which in turn complicates the whipping process.

We also studied the change in the plastic strength of the control and test samples of marshmallow masses during its storage at a temperature of 18-20 °C, which is presented in the form of graphs in
figures 3 and 4. The measurement of the plastic strength of the marshmallow masses was carried out
every 30 minutes until the index reaches its maximum value.

As can be seen from figures 3 and 4, the values of the plastic strength of the test samples under
number 1 with the addition of 5% additive from apple and carrot refuse are close to the control.

![Graph 3](image3.png)

**Figure 3.** Change in the plastic strength of the marshmallow mass at various dosages of apple
additive: 1 - control; 2 - sample 1; 3 - sample 2; 4 - sample 3; 5 - sample 4.

![Graph 4](image4.png)

**Figure 4.** Change in the plastic strength of the marshmallow mass at various dosages of carrot additive:
1 - control; 2 - sample 1; 3 - sample 2; 4 - sample 3; 5 - sample 4.

Test samples numbered 2-4 with the addition of 15-35% additive from apple or carrot refuse are
characterized by increased plastic strength, while the maximum value reaches an average of 32 kPa,
which is 33% higher compared to the control.

An increase in the plastic strength in the test samples is possible due to an increase in the content of
dietary fiber from carrot and apple additive, which have the property of absorbing water from the
solvation shells of agar substances. As a result, the time of gelation is reduced, and the gel is
characterized by greater strength.

As a result of the research, a dosage of 30% apple or carrot additive was chosen, which ensures the
enrichment of marshmallows with minor substances, and the molding method is extrusion.

In order to determine the consumer properties of the developed new types of marshmallows using
puree from apple and carrot refuse, boiled with starch syrup, in an optimal dosage of 30%, the following
indicators were determined in finished products: organoleptic and physicochemical quality indicators,
nutritional value. The results of the obtained studies of the finished marshmallow are presented in tables 1, 2.

**Table 1. Indicators of the quality of marshmallow with using additive from apple and carrot refuse**

| Indicators | Marshmallow characteristic | «Nezhnost» (with apple additive) | «Legkost» (with carrot additive) |
|------------|-----------------------------|----------------------------------|----------------------------------|
| Taste and smell | Organoleptic quality indicators | Apple flavor and aroma, without foreign taste and smell | Carrot flavor and aroma, without foreign taste and smell |
| Colour | White | Light orange |
| Structure | Characteristic of marshmallows, foamy, uniform | Various, no deformation |
| Form | Physical and chemical quality indicators | Moisture content, % 24.2 23.5 | Reducing substance, % 18.76 13.37 |
|       | Total acidity, deg. | 2.4 2.3 |
|       | Density of marshmallow mass, kg / m³, no more | 530 550 |

From table 1 it can be seen that new types of marshmallows, prepared using puree from apple and carrot refuse, boiled with starch syrup, in terms of organoleptic and physicochemical quality indicators, meet the requirements of the current regulatory and technical documentation. The taste, smell and color of the marshmallow depends on the type of additive used in the recipe.

A study of the nutritional value of marshmallows using additive from apple or carrot refuse showed that the developed products in terms of the content of such essential nutrients as dietary fiber and antioxidants can be recommended for a healthy diet (table 2).

The developed new types of marshmallows «Nezhnost» and «Legkost» are characterized by a reduced energy value (respectively, 93.7 kJ (22.4 kcal) and 78.6 kJ (18.8 kcal) lower than that of the marshmallow «Vanilny» 1303, 7 kJ (311.6 kcal).

From table 2 it follows that 100 g of marshmallow using additive from apple or carrot refuse contains dietary fiber in an amount of 2.2 and 2.0 g, respectively, which makes it possible to replenish the average daily human need for this functional ingredient by 11 and 10%.

The antioxidant value of marshmallows depends on the type of additive used in its recipe. It has been established that marshmallows using additive from apple refuse are a source of water-soluble antioxidants, such as flavonoids, which are contained in an amount of 12.6% of the daily intake, while marshmallows using additive from carrot refuse is a source of fat-soluble antioxidant beta-carotene, the content of which replenishes the daily intake of this antioxidant by 28%. The mineral composition of new types of marshmallows slightly differs from the control.
Table 2. Chemical composition of 100 g of marshmallow with using additive from apple and carrot refuse

| Indicators              | Average daily requirement | Nutrient content       | The share of meeting the average daily need for nutrients, % |
|-------------------------|---------------------------|------------------------|-------------------------------------------------------------|
|                         |                           | «Vanilny» (control sample) | «Nezhnost» | «Legkost» | «Vanilny» (control sample) | «Nezhnost» | «Legkost» |
| Proteins, g             | 80                        | 0.8                    | 1.0        | 1.1       | 1.0                      | 1.3        | 1.4        |
| Fats, g                 | 70                        | 0.1                    | 0.1        | 0.1       | 0.1                      | 0.1        | 0.1        |
| Carbohydrates, g        | 400                       | 76.9                   | 71.1       | 71.9      | 19.2                     | 17.8       | 18.0       |
| Dietary fiber, g        | 20                        | 1.0                    | 2.2        | 2.0       | 6.0                      | 11.0       | 10.0       |
| Organic acids, g        | 2                         | 0.9                    | 1.0        | 0.9       | 45.0                     | 50.0       | 45.0       |
| Vitamins, mg:           |                           |                        |            |            |                          |            |            |
| beta-carotene           | 5                         | -                      | -          | 1.4       | -                        | -          | 28.0       |
| ascorbic acid           | 90                        | -                      | 6.5        | -         | 7.2                      | -          |            |
| flavonoids              | 250                       | 3.4                    | 31.6       | 7.5       | 1.4                      | 12.6       | 3.0        |
| Ash, g                  | -                         | 0.3                    | 0.4        | 0.5       | -                        | -          |            |
| Mineral substances, mg: |                           |                        |            |            |                          |            |            |
| K                       | 2500                      | 55.4                   | 37.6       | 50.0      | 2.2                      | 1.5        | 2.0        |
| Ca                      | 1000                      | 12.6                   | 29.1       | 37.9      | 1.3                      | 2.9        | 3.8        |
| Mg                      | 400                       | 9.9                    | 17.8       | 27.6      | 2.5                      | 4.5        | 6.9        |
| P                       | 800                       | 11.4                   | 25.1       | 46.4      | 1.4                      | 3.1        | 5.8        |
| Fe                      | 10/18                     | 0.60                   | 1.20       | 0.9       | 6.0/3.3                  | 12.0/6.7   | 9.0/5.0    |
| Zn                      | 12                        | 0.07                   | 0.08       | 0.09      | 0.6                      | 0.7        | 0.8        |
| Cu                      | 1                         | 0.02                   | 0.03       | 0.02      | 2.0                      | 3.0        | 2.0        |
| Mn                      | 2                         | 0.04                   | 0.05       | 0.06      | 2.0                      | 2.5        | 3.0        |
| Energy value, kJ (kcal) | 11704 (2795)              | 1303.7 (311.6)         | 1210.0 (289.2) | 1225.1 (292.8) | 11.1                      | 10.3       | 10.5       |

4. Conclusion
The developed new types of marshmallows with using of puree from apple and carrot refuse, boiled with starch syrup, in contrast to the traditional ones, are characterized by improved organoleptic properties, reduced energy value, increased content of dietary fiber and antioxidants such as flavonoids and beta-carotene. A technological feature of the marshmallow production technology is the use of the molding method is extrusion.

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