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Development of thick celery-based paste recipe

G V Ivanova, O Ja Kolman, T N Yamskikh, A N Ivanova and E O Nikulina

Siberian Federal University, Svobodny prospect, 79, Krasnoyarsk, 660041, Russia

E-mail: kolmanolya@mail.ru

Abstract. This paper is devoted to solving the problem related to increasing the nutritional value of sugar confectionery products, since they are highly consumed among the population. At the same time, they have some disadvantages related to high energy value and lack of vitamins, minerals and food fibres. It is possible to solve this problem by mixing different raw materials. One of the promising raw materials for the food industry is celery, which can become a source of vitamins, minerals and dietary fibres which are needed by human body. The recipe and manufacturing process for cooking thick fruity paste with the use of celery have been developed. Structural and mechanical properties (elasticity, firmness) of thick fruity pastes were studied in order to obtain a product with the desired properties and having the increased nutrition value. Then, regression analysis of the experimental data was performed using Microsoft Office Excel 2007. On the basis of the results thus obtained optimal ratio of ingredients in a thick fruity paste recipe was determined. This food product has high organoleptic, structural-mechanical properties and is a source of food nutrients essential for the body.

1. Introduction

The number of territories in Russia where a real ecological catastrophe is provoked increases from year to year. Environmental problems cause spread of ecology-dependent diseases threatening health of people living in large industrial cities [1-3].

In this regard functional foods can be considered to be those fortified foods that provide health benefits, when they are consumed as part of a varied diet on a regular basis. Such foods can be obtained by enriching food products with vitamins, minerals and biologically active additives, which will provide the body with the necessary nutrients and increase its resistance to adverse environmental factors. In recent years, due to the unfavourable environmental situation, there is a tendency to enrich food products with dietary fibres, minerals, vitamins, which ensures their functional properties [1-3]. Therefore, the development of new and improvement of the existing recipes (especially confectionery products) seem to be relevant.

Currently, the market for sugar confectionery products comprises array of food products such as chocolates, raw pastes, and various sugar-based products. Thick fruity pastes are produced from fruit and berry purees. They have high energy value and practically do not contain dietary fibres [1-4].

As is known, thick fruity pastes produced according to the traditional recipes are mainly a source of easily assimilable carbohydrates, but they lack dietary fibres, vitamins, mineral nutrients mostly found in vegetables and berries. Celery can be a promising source of dietary fibres. Celery (lat. *Apium*) is a plant genus of 30 species of the Umbrella family. In the kitchen and in medicine in particular, the Real celery (*Apium graveolens*) is used.



Celery leaves contain vitamins C, A, E, eight B-group vitamins, phytohormones, glycosides, minerals, essential oils, amino acids. Celery leaves contain 5 times more vitamin E and carotene than roots [5, 6].

Celery is an effective therapeutic agent. Celery has anti-inflammatory, antacidic, diuretic effects. It is recommended to increase appetite, improve digestion. It works well on peptic ulcers, helps relieve constipation. Celery is a versatile vegetable with many health benefits for the elderly. It is recommended for patients with neuroses and obesity [7, 8].

Celery was used as an anti-cancer agent in ancient medicine of India, Egypt, Tibet, China [7, 8].

Celery can help protect kidney health and prevent kidney disease (nephritis, nephromyiasis), inflammation of the prostate, uratic arthritis, urticaria fever, dermatitis. It is used to improve digestion and sexual function, prevent obesity, peptic ulcers, ulcerative colitis, constipation. It helps regulate sleep-wake cycle, prevents neurosis, asthenic syndrome, atherosclerosis, upper respiratory tract infections. It is considered as an agent capable of elevating metabolism and increasing overall health, physical and mental abilities [7, 8].

It is widely used to prevent uric acid deposits in joints, and, as a result, relieve chronic pain for people suffering from rheumatism, arthritis and gout [7, 8].

Lemon fruits were chosen as the natural flavor and source of organic acids due to the fact that fruit flesh can contain as much as 8% citric acid. Lemon flesh also contains malic acid, but not much. Sugars are glucose (up to 0.80%), sucrose (up to 0.75%) and fructose (up to 0.60%). There are also pectin substances (0.5%), and fiber that positively affects the muscular tone of intestinal walls in constipation patients. Vitamins include carotene, vitamins B1, B2, C, D, E, P. Some researchers have reported new data on the content of vitamins B6, B15, PP. As for minerals, lemon fruits contain potassium salts. Phosphorus, iron, magnesium, sodium, sulfur, cobalt, manganese and other minerals have also been identified. Various glycosides and phytoncides have been found. Peels contain significant amount of ascorbic acid and flavonoids. Yellow color is due to hesperidin, a dyeing substance. A very fresh scent is caused by essential lemon oil (0.4-0.6%), which is based on limonene, geraniol and citral [5].

The purpose of this study is to develop new type of functional food product - thick fruity paste with specified structural and mechanical properties for various segments of the population, including people living in adverse environmental conditions.

The research study is guided by the following specific objectives:

- Designing a new confectionery product with higher content of dietary fibre;
- Studying structural and mechanical properties of the designed thick fruity paste;
- Identifying the optimal ratio of ingredients in the thick fruity paste recipe;
- Conducting a taste test and determine if the developed food product satisfies daily need in essential food nutrients.

2. Objects and methods of research

The object of study is thick celery (*Apium graveolens*) - based fruity paste.

Research methods. Structural and mechanical indicators (elasticity, firmness) are determined using a texture analyzer.

The main distinctive feature of the proposed thick fruity paste is that it contains homogenized celery and lemon mass, as opposed to traditional thick fruity pastes, which are based on pure fruit or berry juice.

3. Results

Taking into account modern trends in designing functional sugar confectionery products, the manufacturing process for cooking thick celery-lemon paste was developed.

The manufacturing process for cooking thick celery-lemon paste. Dry pectin is mixed with double amount of sugar in an agitated vat and poured with cold water (ratio 1: 25). Left for 1 h. After pectin is

dissolved, it is brought to boiling and boiled for 1-1.5 min in a dissutor. Celery stems and lemons with peels are mixed into a homogeneous mass. The obtained celery-lemon puree is thoroughly blended. Then the acidity of the mixture is measured. Sugar is added and the mixture is stirred until sugar is dissolved. Pectin is added before cooking. The mass is boiled down to moisture content of 26-32%. Then it is mixed and fed to the sizing conveyor, where the gelation time takes about 20 – 30 minutes.

The study of chemical composition showed that the recipe thus designed and the manufacturing process for cooking thick celery-lemon paste, is characterized by higher content of dietary fibres and vitamins - E, β -carotene, PP, minerals K, Ca, Mn, Na, Mg, organic acids when compared to traditional recipes. Despite high vitamin C content in the raw materials, a small amount of vitamin C is found in the ready-to-eat thick fruity paste due to thermal processing. Therefore, this food product cannot be considered as a source of vitamin C.

We have studied the structural and mechanical properties of thick celery-lemon paste.

Using Microsoft Office Excel 2007, a regression analysis of the structural and mechanical indicators of thick celery-lemon paste was performed and the optimal ratio of ingredients was determined.

The following indicators were selected as response functions: y_1 - elasticity, %; y_2 - elasticity, %. Concentration of celery - x_1 , %; and concentration of lemon - x_2 , % were considered as independent or variable factors.

The obtained experimental data were processed using Microsoft Office Excel 2007.

The results of regression analysis are presented in table 1.

Table 1. The results of regression analysis.

Structural and mechanical properties	Correlation Coefficient (R)	Determination Coefficient (R^2)	Fisher Criterion (F)
Elasticity, %	0,96	0,93	87,57*
Firmness, %	0,94	0,88	48,1*

* The critical value of $F_{\text{tabl.}}$ is found using the table (F - distribution: critical values of F with degrees of freedom ν_1 and ν_2 ; significance level of 5%): $F_{\text{tabl.}} = 3.89$ [3].

Since the research has shown that $F_{\text{fact.}} > F_{\text{tabl.}}$, the equations which are presented below adequately describe the experimental data:

$$y_1 = 19,96 - 0,17 \cdot x_1 + 0,73 \cdot x_2. \quad (1)$$

$$y_2 = 1,85 + 1,75 \cdot x_1 + 2,32 \cdot x_2. \quad (2)$$

Thus, the optimal ratio “celery: lemon” is 1:0.25.

A comparative taste test was conducted to estimate the quality of the food product developed in this research.

Two samples of thick fruity paste were subjected to tasting: the thick fruity paste prepared according to standard technology [4], and the one cooked using the recipe developed in this research. The tasting evaluation was carried out using a specially designed scoring scale. Based on the results of tasting evaluation of the developed sugar confectionery product, we can conclude that the average values of quality indicators “odor” and “taste” are not lower than those of traditional thick fruity paste. Slight deviation is observed for the indicator “odor.” This is due to pronounced celery flavor (figure 1).

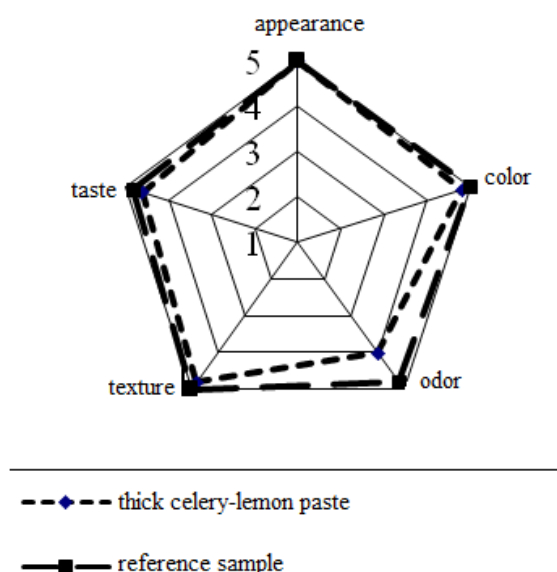


Figure 1. Comparative sensory evaluation of celery-lemon and traditional thick fruity pastes.

We consider that light celery flavor and taste do not belittle the advantages of the designed product. In general, the quality of the developed product by organoleptic indices was estimated high enough.

4. Discussion

The experimental results revealed the prospects for creating an alternative functional product using non-traditional raw materials with optimal structural-mechanical properties, organoleptic characteristics and nutritional value [1-3].

Sugar confectionery products, in particular, thick fruity pastes, have high energy value and practically do not contain dietary fibres [1-4]. They are highly consumed among the population. Therefore, the solution to problem related to the development of food products of high nutritional value by mixing different raw materials is being searched for [1-4]. Celery is of practical interest to the food industry as a source of vitamins and minerals. Its high nutrition value and functional properties are reported and discussed in a number of research works: Malhotra S.K. [5], Tutelyan V. A. [6], Mezeyová, I., Hegedúsová, A., Mezey, J., Šlosár, M., Farkaš, J. [7], Sarshar, S.S., Sendker, J., Qin, X., Goycoolea, F.M., Asadi, K.M.R., Habibi, M., Bouzari, S., Dobrindt, U., Hensel, A. [8]. Production of thick celery-based paste will reduce the nutritional value of this food product and enrich it with vitamins and minerals necessary for the body's growth and maintenance.

5. Discussion

Based on the results of our studies, we developed the manufacturing process for cooking thick celery-lemon paste with high structural-mechanical and organoleptic properties. The designed food product satisfies 40% of the daily need for dietary fibres, 52% - for potassium, 24% - for phosphorus, 40% - for β -carotene, 15% - for vitamin C, 11% - for vitamin E, 16 % of protein requirements, 5% of fat requirements. The quality characteristics of the designed food product were substantiated with a taste test.

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