

# New types of flour confectionery products for preventive nutrition using *Laminaria saccharina*

*Galina Ivanova, Olga Kolman\**, Marina Glotova, Ekaterina Nikulina, and Olga Evtukhova

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

**Abstract.** Over the years, more and more attention has been paid in the food industry to the development and production of functional products, which include biological value-enhancing components, one of which is laminaria powder. Flour confectionery is a widely used mass consumption product that has been in growing demand in recent years, but has a low nutritional value, and is an excellent basis for creating functional products. Research objects: *Laminaria saccharina* powder, flour confectionery with the addition of *Laminaria saccharina* powder. A technology for the production of flour confectionery products was developed - the «Black Pearl» cupcake (with the addition of *Laminaria saccharina* powder). The indicators of quality and safety of the developed flour confectionery products were investigated; normative and technical documentation for new flour confectionery products was developed. An analysis of the economic efficiency of introducing a new product into production was carried out.

## 1 Introduction

From data of statistical studies, at present, Sosnovoborsk, Lesosibirsk, Norilsk, Minusinsk, Kansk, as well as Berezovsky, Bogotolsky, Boguchansky, Shushensky districts have become areas of risk (with an excess of 2-3 times the newly detected incidence of the population) in the Krasnoyarsk Territory. One of the causes of thyroid dysfunction is natural iodine deficiency, or iodine deficiency. Recently, this is the most common non-infectious human disease [1].

According to the latest epidemiological studies, it became clear that Krasnoyarsk is a region with moderately mild iodine deficiency. Iodine is the basis for the formation of thyroid hormones. In conditions of its deficiency, a change in the synthesis of these hormones occurs. Iodine is one of the most important trace elements needed to maintain the health of our body. First of all, it is necessary for the normal functioning of the thyroid gland, the hormones have a direct effect on the functioning of the brain and the immune status of the body [1].

Diseases associated with iodine deficiency are primarily affected by those who work a lot and have little rest, are often under stress, eat improperly and irregularly. In addition to residents of unfavorable regions and inveterate workaholics, pregnant women fall into the risk group. The body's need for iodine during pregnancy increases by almost 2 times. According to statistics, women are more prone to iodine deficiency than men [1, 2].

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\* Corresponding author: [2057061@mail.ru](mailto:2057061@mail.ru)

Many factors can affect the functioning of the thyroid gland, primarily age. People over 50 are more susceptible to thyroid disease and those who have experienced nervous stress or suffer from constant depression [1].

As it is explained in Rospotrebnadzor, the very geographical position of the Krasnoyarsk Territory - sharply continental - is the reason that its inhabitants are chronically lacking in iodine, which is contained in excess, for example, in coastal regions.

In addition, the experts of the department note the decrease in the quality of products in chemical processing which reduces the content of this microelement in food [3].

It is impossible completely to compensate for iodine deficiency from food, but it is necessary to include foods containing iodine in your diet. A person can receive half of the required amount of iodine for the body with food.

In 2020, 21,858.8 tons of micronutrient-enriched food products were produced on the Krasnoyarsk Territory, which exceeds the same indicator in 2019 by more than 4 tons. These are mainly bread and bakery products: this group of products accounts for more than 75 % enriched with iodine. For confectionery – 12.4 %, for dairy products – 12.2 %. In this regard, the introduction of an enriching additive in bakery products, namely in flour confectionery (cookies, crackers, etc.) is advisable [4].

Meanwhile, doctors say, it is vitally important to fill the iodine deficiency in the body in our conditions.

According to literary sources, at present the most popular food additives with technological and functional properties are brown seaweeds (in particular, *Laminaria saccharina*). This is due to the multifactorial properties of these additives. In addition to the source of iodine, kelp is most effectively used as a gelling agent in confectionery [5], in the production of sauces [4], as well as a regulator of the structural and mechanical properties of food products [5, 6], in the production of bakery products and confectionery products.

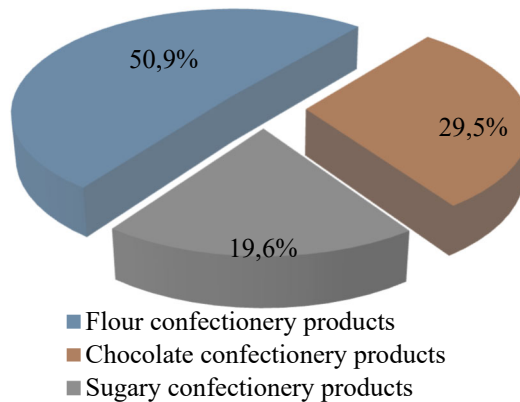
Confectionery products are a large group of high-calorie food products that are in increasing demand in Russia. The main disadvantage of confectionery in general is the low physiological value of these products. Their excessive consumption disrupts the balance of the diet both in terms of nutrients and energy value, which is explained by the high content of some components (fats, carbohydrates) and quite low, and in some cases the complete absence of others, for example, vitamins, dietary fiber [7].

## **2 Results and discussions**

The domestic confectionery market is considered one of the largest in the world - it is in the TOP-5 of the world's largest markets. According to the Association of Confectionery Industry Enterprises (ASKOND), the market share of flour confectionery is approaching 50 % in terms of sales and almost 30 % in terms of revenue (Figure 1).

Flour confectionery products, including cupcakes, along with bread and bakery products, occupy a significant place in the diet of a modern person, have special taste characteristics and are in stable demand. However, their main disadvantage is an unbalanced chemical composition caused by an excess of fats and easily digestible carbohydrates with a small amount of micro- and macronutrients. This category is perfect for creating prophylactic products [8].

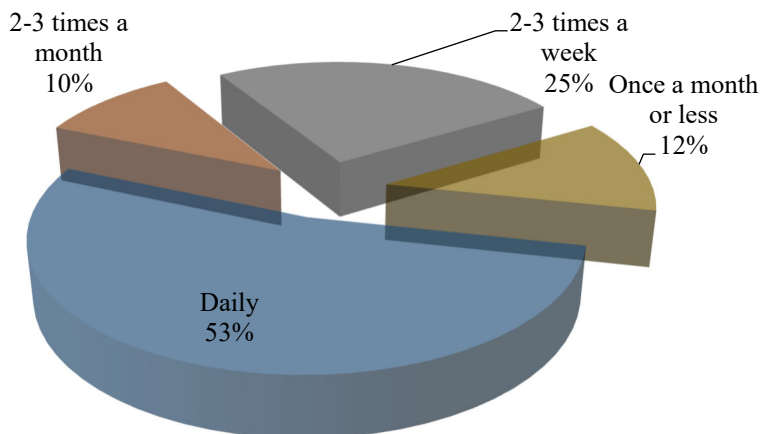
From a large assortment of flour confectionery products, we have chosen those types, the production technology of which does not undergo changes when using functional additives, as well as those that are in high demand among the mass consumer.



**Fig. 1.** Sales of confectionery products in Russia by type in 2020.

Transformations in the confectionery market have significantly changed the traditional approaches to this group of products. Confectionery products from high-calorie desserts are gradually turning into important and favorite components of all age groups diet of the population. They are increasingly used in the assortment list of school breakfasts. The demand for confectionery for dietary purposes is increasing.

Analyzing the research data of the flour confectionery market, we can conclude that flour confectionery products are popular among the population (Figure 2).

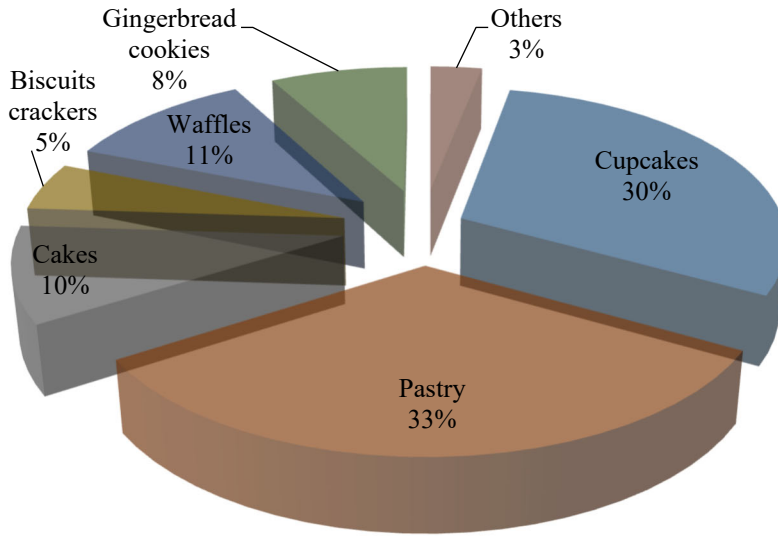


**Fig. 2.** The frequency of consumption of flour confectionery by the population of the Russian Federation.

More than 53 % of respondents include flour confectionery in their daily diet, and 25 % buy such products 2-3 times a week.

In terms of production of flour confectionery, the Siberian Federal District is in 3rd place (19 % of the total production in Russia).

When choosing the enriched product, the structure of consumption of flour confectionery products by the population of the Russian Federation was analyzed (Figure 3). Among the selected groups, the most popular is the group of cupcakes (30 %), the second place is occupied by waffles (11 %), the third is cakes and pastries (10 %) [8].



**Fig. 3.** The structure of consumption of flour confectionery products by the population of the Russian Federation.

Based on this, a cupcake was chosen as the base product for further development. Cupcakes have high organoleptic characteristics, are in demand among the population, and also have a longer shelf life compared to cakes.

The production of enriched, functional products is a priority trend in the development of the flour confectionery market in accordance with the state policy in the field of healthy nutrition of the population of the Russian Federation and the strategy of scientific and technological development of the Russian Federation.

A study on the assortment of plain cakes sold in retail chains in Krasnoyarsk: «Svetofor», «25 Hours», «Krasny Yar», «Komandor», «Lenta», «O-Kay » led to the conclusion that the market is represented by a wide assortment of different types, which include exclusively flavoring additives: dried fruits, candied fruits, peanuts, sunflower kernels, flax seeds, sesame seeds, fruit and berry fillings, glazes, caramel. Products with vitamins, premixes, minerals and dietary fiber are not on sale. Formed product offers in the consumer market of Krasnoyarsk by types of cupcakes do not allow satisfying the growing consumer demand for «useful» products enriched with functional ingredients.

The analysis of statistical data shows that such flour confectionery products as cupcakes are a worthy basis for the development of functional products.

One of the foods rich in iodine content is kelp (*Laminaria saccharina*). Most of the inhabitants of our country are very fond of sea kale and add it to salads, eat it dried or canned. Today there are a large number of products that have a low-calorie content, but have great benefits for our body. These products include seaweed.

*Laminaria* grows at a depth of 10-12 meters and belongs to the class of brown algae. Seaweed grows in the Japanese, Okhotsk, Kara, White Seas, in the Atlantic and the Pacific Ocean.

For the first time, they learned about seaweed in Japan. Today this country is the leader in the production of kelp. In Russia, sea kale appeared in the 18th century. It began to be used not only in cooking, but also in medicine. It began to be used not only in cooking, but also in medicine. Kelp on the territory of our country was discovered by the participants of the Bering expedition and began to be called «whale whiskers».

Since ancient times, seaweeds have been used for livestock feed and as medicines. Today, medicines based on kelp are already being produced in Russia. Extensive studies on the use of biologically active substances derived from seaweed are being conducted in the USA, Japan, France, Yugoslavia, New Zealand, Canada, and China [6]. Researchers in a number of scientific organizations of the CIS are engaged in similar developments. Biologically active substances from seaweed have antitumor, oncoprophylactic, antimutagenic, antiviral, radioprotective, anticoagulant, antimicrobial, antibacterial, antifungal, anti-inflammatory, immunomodulatory and other useful properties. Seaweeds are a promising raw material for the creation of therapeutic and prophylactic agents [6].

Nowadays, out of the known 30 types of sea kale, only 5 types are used in cosmetology, medicine and cooking.

The need for iodine increases in the growing body of children, in people with active mental and physical activity, pregnant women and during lactation and also in patients with impaired thyroid function - hypothyroidism. Organic iodine from kelp is better absorbed than synthetic iodine-containing preparations.

Laminaria is consumed fresh or dried.

The composition of kelp includes the following nutrients:

- Minerals - phosphorus, iodine, sodium, magnesium, iron.
- Vitamins - C, A, E, D, B-groups.
- Alginates - remove toxins and radionuclides from the body.
- Sterols - prevent thrombosis by thinning the blood and removing excess cholesterol.
- Dietary fiber - normalizes the work of the gastrointestinal tract.
- Fatty acids - prevent atherosclerosis.
- Proteins and amino acids.
- Polysaccharides - normalize metabolism and cholesterol levels

Seaweed is often eaten fresh, and the dried product is also added to drinks, sauces, soups, and even jellies and desserts. Laminaria has an original taste and gives the dishes a marine flavor. Japanese dishes often use kelp, prepare sushi, rolls, bake bread and make jam. Seaweed goes well with vegetable salad, fried potatoes, cereals, rice, mushrooms, cheese and pasta.

Seaweed stimulates the motility of the gastrointestinal tract. It can be used as a natural laxative with a mild effect. The property is explained by the presence of polysaccharides in the composition, which are capable of swelling greatly and increasing in volume, provoking irritation of receptors in the intestine. The enveloping effect of algin helps to delay the absorption of fluid in the intestine, which helps to normalize defecation. The benefits of kelp are also explained by its ability to cleanse the body of radionuclides and heavy metals and the high concentration of iodine in its composition [2, 6].

Laminaria is rich in nutrients that exhibit pronounced antioxidant activity. It consists in neutralizing free radicals and preventing oxidative stress [3, 6].

The use of kelp in dietetics is due to the fact that dry fresh kelp contains 6–8 kcal, and in pickled form – 47 kcal. Low calorie content combined with a rich mineral and vitamin composition makes sea kale a valuable food for people who are trying to lose weight. Thanks to the use of seaweed, it is possible to get rid of the feeling of hunger quickly, as well as to fill the body's need for dietary fiber. The inclusion of seaweed in the menu allows you to normalize metabolic processes quickly.

Thus, we concluded that the use of kelp in the food industry will allow:

- expand the range of public catering products by including biologically active additives in some products;
- get other types of thickeners, food mass stabilizers, which can be substitutes for starch and gelatin;
- produce products with therapeutic and prophylactic properties;

- improve people's health, increase the average life expectancy, as well as increase the adaptive capacity of a person to the difficult environmental conditions of the existence of the majority of the world's population.

The most promising use of kelp as food additives in the production of flour confectionery products (such as cookies, cupcakes, crackers, etc.), which allows you to expand the circle of consumers and more clearly control the process of dosing biologically active additives at the stage of the technological process. This product has a longer shelf life than confectionery products with fillings, and can be sold as mass demand products not only in catering establishments, but also in various retail outlets [5, 6].

Despite the widespread use of kelp in the food industry, there is practically no scientifically based technology for using them in the production of such flour confectionery products as cupcakes.

Due to the fact that cupcakes are quite popular flour confectionery products in our country (which is confirmed by the data of statistical studies), it seems relevant to use kelp as an ingredient in cupcakes. In addition to expanding the range of flour confectionery products, it is expected that these products will have a therapeutic and prophylactic effect.

The study of literature data allows us to conclude that the use of *Laminaria saccharina* as an ingredient in functional food products (bearing a therapeutic and prophylactic effect) is little covered. Thus, the problem of studying the methods of using kelp in culinary products, including the production of flour confectionery products, such as cupcakes, in order to obtain therapeutic and prophylactic food products, is an urgent task.

The research was carried out on the basis of Catering Technology Department the Institute of Trade and Services SFU in accordance with the tasks set. The entire research cycle consists of four stages.

At the first stage, scientific and literary sources were studied and analyzed, as well as educational literature and statistical data on the research problem using the collections of scientific libraries and the Internet.

The second stage was devoted to the study of a number of methods for studying the physicochemical, rheological and technological characteristics of the test dough and baked flour confectionery.

Taking into account the results of the study of patent sources, at the third stage, new functional flour confectionery products were developed – the «Black Pearl» cake (with the addition of kelp powder). This stage includes research on the optimization of recipes and technology for new functional flour confectionery products. During this stage, a technology for the preparation of new flour confectionery products was developed, and the influence of various factors on the quality of the dough and the vitamin composition of the cupcakes was studied. Also at the third stage, technical documentation was developed for a new type of flour confectionery with kelp.

At the fourth stage, an analysis of production risks of a new type of flour confectionery products was carried out, as well as calculations of the economic efficiency of introducing it into production were carried out.

The object of the study was dried kelp powder, as well as flour confectionery products, which are prepared according to the developed recipe. The recipes of cupcakes made from dough with the addition of chemical leavening agents were considered.

When conducting research with flour confectionery products with the addition of kelp powder, the following were used:

- premium wheat flour GOST R 52189-03;
- kelp powder produced by JSC Arkhangelsk Experimental Seaweed Plant (Specifications 03.11.63-805-41669896-2019);
- granulated sugar GOST 33222-2015;
- butter GOST 32261-2013;

- raisins GOST 6882-88;
- chicken eggs GOST 31654-2012;
- edible salt GOST R 51574-2018;
- baking powder for dough GOST 32802-2014.

In the course of technological studies, the following results were obtained:

1. When studying the effect of powder from dried kelp on the baking properties of wheat flour and dough, we found that the introduction of this additive into wheat flour leads to the strengthening of gluten, while increasing the dosage increases its strength characteristics. The introduction of kelp powder into the dough significantly increases the acidity of the dough. It was also found that with an increase in the percentage of the introduced substance, the percentage of dough moisture increases. Summing up, we can say that the revealed effect of kelp powder on the baking properties of flour makes it possible to increase the nutritional value of flour products without violating the quality of baked products.

2. The effect of kelp powder on the baking properties of wheat flour and the rheological properties of the dough was studied, as a result of the study, a decrease in the concentration of gluten with an increase in the concentration of the applied kelp powder, and an increase in the rheological properties (elasticity) of the dough were proved. The improvement of the rheological properties of the dough, as well as the strengthening of gluten, can be explained by the highwater absorption capacity of pectin substances in kelp.

3. Optimal modes of production of new flour confectionery products with improved organoleptic and consumer characteristics have been established. The amount of kelp powder added to the recipe is 5% instead of the added flour mass.

4. A technology has been developed for the production of a new type of flour confectionery - the «Black Pearl» cupcake with the addition of kelp powder. The organoleptic, physical-chemical and consumer quality indicators of the developed flour confectionery products have been studied. The content of vitamin A and B<sub>2</sub>, minerals (potassium, calcium, magnesium), trace elements of iodine and iron has been increased in new flour confectionery products. A project of technical conditions and technological instructions has been developed for new flour confectionery products.

5. It was revealed that the introduction of kelp powder into the composition of flour confectionery products (cupcakes) allows positioning them as products with increased nutritional value.

6. A selection of suppliers of kelp powder was made, and based on the results of the assessment, the supplier of JSC Arkhangelsk Experimental Seaweed Plant was selected, which scored the highest total number of points.

7. According to the calculation of economic indicators of the effectiveness of the introduction of new types of products (the «Black Pearl» cupcake), the payback period for an enterprise engaged in the production of a new type of flour confectionery using kelp powder will be a little more than two years. Currently, projects that provide a return on investment within 2-3 years are effective. It follows that the new flour confectionery product, the «Black Pearl» cupcake, developed in the course of the dissertation research, can be included in the production program of both a separate workshop and a public catering enterprise with a specialized workshop that produces products both for sale within the institution and for retail sale.

### 3 Conclusions

The Krasnoyarsk Territory belongs to the territories of Russia with severe iodine deficiency. This is justified by the distance of the region from the seas, and the insufficient distribution of products rich in iodine in this territory. In this regard, in the territory of the region, the high risk of developing iodine deficiency pathology is wide and extends from reproductive

disorders to specific thyroid diseases, including functional autonomy and iodine-induced thyrotoxicosis as one of the most severe manifestations of iodine deficiency diseases associated with iodine deficiency. The spectrum of iodine deficiency pathology is wide and extends from reproductive disorders to specific thyroid diseases, including functional autonomy and iodine-induced thyrotoxicosis as one of the most severe manifestations of iodine deficiency diseases. Therefore, the most reasonable way to prevent and eliminate iodine deficiency is to enrich the daily diet with iodine-containing foods or complex dietary supplements, as well as additional enrichment of mass consumption products with them.

Analysis of existing developments in the field of enrichment of flour confectionery recipes showed that this direction is quite promising, and allows enriching these types of products with various functional additives. Laminaria, as an enriching supplement, is quite common. However, there are practically no works studying the introduction of dried kelp additives into the recipes of flour confectionery products among scientific developments. This testifies to the novelty and relevance of the forthcoming research.

Analysis of statistical data shows that the most popular flour confectionery products among consumers in Russia are cookies and cupcakes. In turn, cupcakes are a worthy basis for the development of functional products, they have high organoleptic characteristics, are in demand among the population, and also have a longer shelf life compared to cakes.

We chose kelp as an enriching product. The use of kelp as an ingredient in functional flour confectionery products has been little studied and covered in scientific papers. In this regard, the development of a new type of cupcakes with kelp will, firstly, expand the range of flour confectionery products, and, secondly, improve the health of the population, in particular by increasing the iodine content in the diet.

The effect of kelp powder on the baking properties of wheat flour and the rheological properties of the dough was studied.

The optimal modes of production of new flour confectionery products with kelp with improved organoleptic and consumer indicators have been established.

A technology has been developed for the production of a new type of flour confectionery - cake with the addition of powder from Laminaria saccharina. The indicators of quality and safety of the developed flour confectionery products have been studied. Normative and technical documentation for new flour confectionery products has been developed.

The calculation of the economic efficiency of production was made, which showed these products can be included in the production program of both a separate workshop and a public catering enterprise with a specialized workshop that produces products both for sale within the institution and for retail sale.

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