The Use Of Phyto-Enrichment Agents In The Production Of Functional Bakery Products

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Abstract: An anthropogenic pollution, a sedentary lifestyle, a sharp jump in the growth of cardiovascular diseases and oncological diseases led to the need to develop functional products of a new generation that reduce the effects of the harmful factors listed above.

1. Introduction
Currently, factors affecting the ability to work, life expectancy, contributing to the preservation of the gene pool of the nation in the countries of the European Community and the Russian Federation, are elevated to the rank of state policy. “Fundamentals of state policy in the field of healthy nutrition of the population of the Russian Federation for the period until 2020” - the priority task of increasing the production of nutrient-enriched foodstuffs of mass consumption, and especially bakery products [1,2].

Excessive intake of high-density lipoproteins (HDL), low levels of soluble and insoluble dietary fibres (DF) - led to a sharp increase in the number of diseases of the cardiovascular system and endocrine system, cancer. The development of functional products of a selective orientation using non-traditional plant materials containing biologically active compounds, micro and macro elements is in demand.

Plant raw materials and plant cells are the basis of food phytobiotechnology [3]. Bakery products make up a significant share of the consumer basket of the population of the Russian Federation and up to 25% of the total mass of food consumed with daily consumption by men - 200-300 g, women - 180-250 g, in this regard, enrichment with physiologically functional ingredients based on phytobiotechnology is an actual for Foodnet direction of the Russian Federation [3].

According to research by Russian and foreign scientists, “... the bulk of bakery products has low biological and physiological value, but high calorie content ...” [3].

2. Main part
The main goal of the production of bread and bakery products is to increase the biological value and lower calorie content.

The technical regulation of the Customs Union TR TS 021/2011 "On food safety" shows, "...that the food (food) raw materials used in the production of food products must comply with the requirements established by this technical regulation and (or) technical regulations of the Customs Union on certain types of food products, and be traceable ...” [4].

Modern conditions dictate the need to expand the assortment of bakery products and introduce new types of medical-prophylactic and functional products into production [5].

According to the research of V.A. Tutelian’s functional bakery products account for approximately 5% of the total output of Fig. 1.

Phyto-enrichment agents of plant origin improve the physicochemical and organoleptic characteristics of bakery products, contribute to the intensification of the technological process and the expansion of the range of products of a functional orientation [7].
The use of aromatic and medicinal raw materials: high elecampane, dioica nettle, medicinal melissa, pharmacy chamomile, etc. improves the quality of bakery products, increasing the biological and nutritional value [8,9].

![Figure 1.](image)

**Figure 1.** The structure of the production of dietary bakery products by classification groups [6].

For example, the introduction of nettle meal in an amount of 3% by weight of flour improves the colouring of the surface of bakery products, the elasticity of the crumb, due to the formation of oxymethifurfural, the taste and aroma of bread improves; the staling process slows down; increases the content of the group of vitamins C, P and K, β-carotene and minerals [10].

Indian scientists Hooda S. and Jood S. enriched wheat bread with flour from hay fenugreek seeds, enriched with protein (25%), and an essential amino acid - lysine (5.7 g / 16 g), soluble (20%) and insoluble (28%) dietary fibre, as well as calcium, iron and β-carotene [11].

The use of fruit and berry powders leads to an increase in the volume and porosity of products, to obtain products of the correct form with a brightly coloured crust and elastic crumb [12,12].

Pumpkin puree helps to reduce the duration of the fermentation process due to the content of vitamin C and mineral elements, helps to increase the viscosity of the dough, reduces the acidity of bread, extends the shelf life of finished products [14].

The culture of a new generation - mackerel - a hybrid of spinach sorrel is a valuable plant phyto-enrichment agent, the application of which enriches bakery products with protein, increases the water absorption capacity of the dough, reduces the ability to dilute and spread the dough pieces during fermentation [15].

Hydrobionts of plant origin, for example, brown algae. enrich the target product with nutrients: iodine, polyunsaturated and food acids.

Yu.V. Prikhodko showed that adding ribbed brown seaweed to the bread recipe accelerates the fermentation process; improves the quality of gluten; enriches bakery products: protein, fat, carbohydrates and mineral compounds; increases porosity, crumb with small impregnations of the powder of the fire, improves the physical and chemical and rheological properties of the finished product; reduces the intensity of staling processes during storage [16].

A composite based on mushroom protein: chanterelle mushrooms and champignon mushrooms in the form of a powder increases gas-forming ability, accelerates the fermentation and proofing process of dough; increases porosity, specific volume of bread; reduces the loss of dry matter during baking and storage; slows down the staling process [17].

The functional additive is iodine casein, a composite of iodized milk protein and kelp powder [16] allows to get enriched with protein and iodine bakery products.
Water-alcohol extracts of viburnum, Schisandra chinensis and grapes intensify the fermentation process, increase the fermentative activity of yeast, add a spicy taste and promote the formation of developed porosity, increase the volume of finished products [18].

Untraditional raw materials are used to produce diabetic products. As a promising raw material, chicory roots are used; we propose replacing the scorzonera root [19]. A significant content of fructose and organic acids, the use of puree from chicory roots leads to an increase in the gas-forming ability of flour and accelerate the fermentation activity of yeast. The interaction of amino acids and sugars of the product produces dark-colored products (melanoidins), as a result of the product acquire a more saturated color and a more pronounced taste and aroma. Products obtained using mashed chicory roots differ from bread prepared according to traditional technology with an increased volumetric yield and porosity [19].

One of the promising types of non-traditional plant materials is the powdery silybum thistle composite obtained from milk thistle fruits after squeezing them, rich in compounds such as edible fibers, vitamin flavonoids, macro- and microelements (table 1.) [7,8,9,10].

| № | Name of indicators                  | Value     |
|---|------------------------------------|-----------|
| 1 | Moisture, %                        | 6.9       |
| 2 | Protein, %                         | 22.1      |
| 3 | Fat, %                             | 13.01     |
| 4 | Fatty acids, % of the total:        |           |
|    | linoleic                            | 62.0      |
|    | oleic                               | 21.9      |
|    | arachidonic                         | 1.99      |
|    | linolenic                           | 1.49      |
| 5 | Water-soluble carbohydrates, %      | 0.79      |
| 6 | Cellulose, %                       | 27.4      |
| 7 | Ash %                               | 6.0       |
| 8 | Essential oils, %                  | 0.39      |
| 9 | Vitamins, mg /                     |           |
|    | E                                   | 47        |
|    | B1                                  | 1.39      |
|    | B2                                  | 1.33      |
|   | β - carotene                        | 0.84      |
| 10| Flavolignans (in terms of silybin) per 100 g | 74 mg     |

Content in thistle spotted phenolic compounds, incl. 2-3% are flavoigned (silibin, silikristin, silidianin, and also in small quantities - quercetin, silandrin, rosin alcohol, etc.), nitrogen-containing compounds: betaine, resins, up to 0.1% of essential oil and other substances [7,8,9,10].

A distinctive feature of milk thistle is the presence of silymarin flavonoid in its seeds. Most flavonoids are contained in the membrane (up to 7.0%) and a small part in the seed (up to 0.10%) [7,8,9,10] milk thistle substances synergistically enhance the therapeutic effects of silymarin [1,7,8,9,10].

Qualitative indicators of milk thistle powder are shown in table 2.

| №  | Name of indicators                  | Value                                         |
|----|------------------------------------|----------------------------------------------|
| 1  | Colour                             | Taupe                                        |
| 2  | Smell                              | Milk thistle seed powder characteristic, oily, without odors |
| 3  | Taste                              | Inherent to milk thistle seed powder, without extraneous flavors, |
|     |                                |       |
|-----|--------------------------------|-------|
| 4   | Moisture content, %            | 7.9   |
| 5   | Acidity, degrees               | 2.4   |
| 6   | Presence of signs of mold, ins | Are absent |

We have developed a powder composite with a water-soluble polysaccharide complex from scorzonera of the Spanish variety “Mamont” - the main component of which is inulin polysaccharide, milk thistle powder, containing antioxidant silybin and turmeric powder - the main biologically active component is curcumin.

Curcumin, the most active ingredient in Long Curcuma (“Zardchoubeh”), is from the Zingiberaceae family and is widely used as a medicinal plant in India and other Asian countries. Rhizomes C. longa are widely used as spices and dyes in the production of dietary food.

C. longa powder is a mixture of 3 different compounds known as curcuminoids (C3 curcumin complex).

The clinical use of curcumin is justified by several pharmacological effects, such as antioxidant, anti-inflammatory, antiparasitic, antimutagenic, chemoprotective, antiviral and antitumor.

Current research on the pharmacological properties of curcumin has proven the activity of this biologically active compound in cancer of the liver and pancreas. Oral curcumin is well tolerated, despite its limited absorption in the gastrointestinal tract and has a pronounced biological activity in some patients with pancreatic and liver cancer.

Pancreatic adenocarcinoma is one of the deadliest types of cancer, most patients die within 1 year. The only compounds that currently have a positive effect are gemcitabine and erlotinib, their effect on patient survival is measured only for weeks [20].

![Figure 2](image)

**Figure 2.** Computed tomography of the abdominal cavity with liver damage in a patient with pancreatic and liver adenocarcinoma. A computed tomographic scan on the left was performed before therapy, and a scan on the right 2 months after the administration of curcumin [20].

There was a general decrease in the size of liver lesions by 73% according to the criteria for evaluating the response in solid tumors.

Studies by Japanese scientists [21,22] showed that C. longa rhizome extracts have antimicrobial activity against Mycobacterium tuberculosis H37Rv tubercle bacillus in experiments in vitro Fig. 3.
The pharmacological effects exhibited by this plant material have made it possible to develop and study the possibility of enriching bakery products with a phytocomposite based on milk thistle, scorzonera and turmeric. The technological parameters affecting the raw materials and the finished product are studied. Experimental studies were carried out in no less than two agility. Deviations did not exceed 3%.

In the work, methods of statistical analysis of the obtained data were used.

**Table 3.** Options for adding composite

| Experience Options                                      | Amount of flour, % | Amount of powder composite, % | NaCl (salt), % | Pressed baker's yeast, % |
|--------------------------------------------------------|--------------------|-------------------------------|----------------|-------------------------|
| Premium wheat flour (100%) - control (sample No. 1)    | 100.0              | -                             | 1.50           | 3.0                     |
| Flour 100.0% + powder 1.0 % (sample No. 2)              | 100.0              | 1.0                           | 1.50           | 3.0                     |
| Flour 100.0% + powder 3.0 % (sampl eNo. 3)              | 100.0              | 3.0                           | 1.50           | 3.0                     |
| Flour 100.0% + powder 5.0 % (sample No. 4)              | 100.0              | 5.0                           | 1.50           | 3.0                     |
| Flour 100.0% + powder 7.0 % (sampl eNo. 5)              | 100.0              | 7.0                           | 1.50           | 3.0                     |
| Flour 100.0% + powder 10.0 % (sample No. 6)             | 100.0              | 10.0                          | 1.50           | 3.0                     |

An analysis of the experimental data showed that when phyto-enrichment agents from non-traditional plant materials are introduced, the organoleptic characteristics of flour change. The most acceptable according to experts were samples No. 1 and No. 4. The results are shown in table No. 4.

**Table 4.** Organoleptic characteristics of flour with non-traditional vegetable phyto-enrichment agents

| Sample Name | Ash content, % | Organoleptic indicators | Point grade |
|-------------|----------------|-------------------------|-------------|
|             |                | Smell | Taste, crunch | Colour |
The acidity of flour shows the ability of protein compounds of flour to bind a certain amount of alkali. With the breakdown of compounds: phytin, lipids, etc., rancidity of flour occurs and an increased content of organic acids occurs in it. The results of the influence of phyto-enrichment agents on acidity are presented in Table 5.

Table 5 - Indicators titratable acidity of flour with non-traditional phytochemicals

| Sample name | The amount of 0.1 n alkali, went to the titration, ml | Acidity, degrees | Conclusion |
|-------------|--------------------------------------------------|-----------------|------------|
| Control    | 1.45                                             | 3.0             | Meets the standard requirements for flour quality |
| Sample No. 1 | 1.58                                               | 3.2             | With the introduction of milk thistle powder, a slight increase in acidity occurs |
| Sample No. 2 | 1.67                                               | 3.4             | With the introduction of milk thistle powder, a slight increase in acidity occurs |
| Sample No. 3 | 1.88                                               | 3.8             | With the introduction of milk thistle powder, an increase in acidity occurs due to the presence of organic acids in the feed |
With the introduction of powder from scorzonera, a significant increase in acidity occurs.

When powder is added from scorzonera, a significant increase in acidity occurs.

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The analysis of experimental data showed that in sample No. 1 there is a slight increase in the acidity of flour, in samples No. 3-4 the acidity is higher, which must be taken into account in the production of bakery products.

The "strength" of flour affects the quality of bakery products. The results of the analysis are presented in table 6.

**Table 6 - “Strength” of flour, depending on the size of sedimentation sediment in experimental samples**

| Sample Name | V (sediment volume), cm³ | Analysis results, cm³ | Flour class by "strength" |
|-------------|--------------------------|-----------------------|--------------------------|
| Control     | More than 60             | 50.9                  | High-protein, excellent gluten, strong |
| Sample No. 1| 40-59                    | 46.8                  | High protein, good quality gluten, strong |
| Sample No. 2| 40                       | 43.4                  | With medium protein and low gluten quality |
| Sample No. 3| 31-39                    | 387.1                 | With medium protein and low gluten quality |
| Sample No. 4| 31-39                    | 49.6                  | With medium protein and low gluten quality |
| Sample No. 5| 31-39                    | 38.0                  | High protein, good quality gluten, strong |
| Sample No. 6| Less than 30             | 30.4                  | With medium protein and low gluten quality |

Thus, the most acceptable for the production of bakery products are sample No. 1, No. 2, No. 4.

The effect of phyto-additives from unconventional raw materials on the lifting force of baker's yeast

The presence of macro-and micronutrients (Na, K, Ca, Mg, P) in the raw materials of phytobacteria has a special effect on yeast. Na ions activate the synthesis of intracellular substances, stimulating the growth of yeast, Mg stimulates the production of enzymes in yeast cells, and phosphorus is one of the main factors in the activity of yeast cells. Ca - activator of energy processes.
Figure 4. Changes in the lifting force of yeast when making a thistle powder composite

The lifting force of baker's yeast with milk thistle and turmeric is 2 minutes for a sample with a dosage of powdered composite 5%, 3 min - 7% and 1 min with a dosage of powdered composite 10%. Phyto-enricher – is a powdered composite based on milk thistle stimulates the process of alcohol fermentation and the growth of yeast cells due to the microelement composition and vitamin complex.

Figure 5. The effect of scorzonera powder with lingonberry leaf on the lifting force of yeast

Bakery yeast with scorzonera and lingonberry leaf (5%) - 3 min, 2 min - 7%, 1 min - 10%.
Thus, with the introduction of 5% milk thistle (sample No. 1, No. 2) and 5% scorzonera (sample No. 4), the lifting force of the yeast increases and the maturation process of the dough is accelerated.

Influence of phyto-fortifiers from non-traditional plant materials on the physicochemical parameters of bakery products.
The results of the effect on the porosity, volume and acidity of finished products are presented in table 7.

| Sample Name     | The porosity of the crumb, % | Volume of bread, cm³ | Acidity, degrees |
|-----------------|------------------------------|-----------------------|-----------------|
| Control         | 60.6                         | 115                   | 5.0             |
| Sample No. 1    | 63.4                         | 125                   | 5.6             |
| Sample No. 2    | 61.9                         | 116                   | 5.8             |
| Sample No. 3    | 61.8                         | 110                   | 4.4             |
| Sample No. 4    | 63.9                         | 130                   | 5.1             |
Bakery products with the addition of milk thistle powder and scorzonera in an amount of 5% by weight are distinguished by better organoleptic and physicochemical properties compared to the control sample, which is due to

The biologically active compounds contained in the composites form complexes with protein compounds, improving the quality of gluten, increasing the lifting force of yeast. Products turn out to be of greater volume and porosity.

The effect of vegetable dressing from non-traditional raw materials on the organoleptic characteristics of bakery products.

In the study, a total assessment system (integrated) quality assessment of bakery products, i.e. tastes were determined (on a five-point scale) and appearance.

![Universal quality assessment system 5-point scale](image)

**Figure 6.** Total quality assessment of bakery products

Bakery products are evaluated according to 6 indicators (the color of the crust, the surface of its condition). The results are presented in table 8, 9.

| Sample name     | Appearance | Taste | Condition of crumb | Condition of crust | Aroma | Freshness | Total significance coefficient |
|-----------------|------------|-------|--------------------|--------------------|-------|-----------|-------------------------------|
| Control         | 4.0        | 4.0   | 3.3                | 3.3                | 3.3   | 2.1       | 19.6                          |
| Sample No. 1    | 3.9        | 4.0   | 3.3                | 3.2                | 3.3   | 2.0       | 19.7                          |
| Sample No. 2    | 3.7        | 3.5   | 3.0                | 3.0                | 3.3   | 1.7       | 18.2                          |
| Sample No. 3    | 2.0        | 3.2   | 2.1                | 2.8                | 3.0   | 1.3       | 14.41                         |
| Sample No. 4    | 3.9        | 4.0   | 3.3                | 3.2                | 3.3   | 2.0       | 19.7                          |
The highest significance value in sample No. 1 and sample No. 4, and in the control sample approaches the optimal coefficient of significance for bakery products. Each indicator is evaluated using a five-point system (the total score is 100 points): excellent (100-90 points), very good (89-80 points), good (79-70 points), average (69-55 points), satisfactory (54-40), unsatisfactory (less than 40 points).

Table 9 - Indicators characterizing the quality of the crumb and the appearance of the bread.

| Grade, points | Appearance | Crumb | Taste |
|---------------|------------|-------|-------|
| 5             | Intense brown with a ruddy tint | Light brown with a golden brown | Yellow gold | Taupe | Pal | Colour |
| 4             | Rounded, convex | Medium convex | Weakly convex | Flat | Concave | The form |
| 3             | Smooth | Flat | Grungy | With small bumps and cracks | Torn edges | Surface |
| 2             | White with a grayish tint | Intense yellow | Gray yellow or dirty yellow | Grayish Golden | Dark grey | Colour |
| 1             | Small, uniform, thin-walled | Small, uneven, thin-walled | Large, uniform | Dense, uneven | Very large, ragged | Porosity |
|               | Easy to restore when pressed, gentle | Delicate, soft structure | With difficulty restores the original form | Crumbles | Haze dup | Elasticity |
|               | Normal bread | Unleavened | Sharply sweet or salty | Yeast | Not peculiar to bread | Normal bread |

According to the results, the highest indicator in samples No. 1 and No. 4.

3. Conclusions

To sum up, a study with a focus on mechanisms of acquired resistance in plants to harmful biotical Bakery products with the addition of milk thistle powder and scorzonera in an amount of 5% by weight are distinguished by better organoleptic and physico-chemical properties compared to the control sample, which is associated with biologically active compounds contained in the composites form complexes with protein compounds, improving the quality of gluten, increasing the leverage of yeast. Products are obtained with a larger volume and porosity and enrich the functional product with biologically active substances.

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