Some aspects of creating functional coatings on dairy products

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Abstract. This article discusses the elements of working out the technological principles for creating coatings containing functional ingredients on model substrates. As such ingredients, tree bark extracts are used, as well as those containing bioflavonoids: pines, willows, cassias. For potential leveling of the specific intense smell of the substances and their solutions used, their micro-droplet application is proposed and scientifically justified. Under certain conditions, it can contribute to the formation of microcapsules and nanocapsules with a basic film-forming substance, which in this study is agar-agar, which is a mixture of agarose and agarpectin polysaccharides obtained by extraction from red algae. A laboratory stand was created, and a series of experiments was carried out that showed the feasibility of joint nozzle spraying of a film-forming substance with a solution of a functional ingredient.

1. Introduction
One of the promising areas of research is the creation of coatings, incl. edible. This type of product protection has no alternative in terms of environmental impact. To impart certain functional properties to the coatings (barrier, mechanical, gustatory, antimicrobial, etc.), it becomes necessary to carefully select the compositions. Their composition must necessarily include (along with low molecular weight additives of organic and inorganic nature) also high molecular weight compounds, fillers, as a result of the introduction of which heterophase systems are formed that require special conditions for forming and subsequent use of films. As a rule, the main film-forming components for their production are polysaccharides, proteins, lipids, and natural resins [1].

In our opinion, promising functional ingredients are substances with a proven antioxidant effect, which can not only “restrain” the processes of free radical oxidation, but also, as a consequence, stabilize the dairy product during storage.

When creating objects of the food industry - products, packaging, coatings on products with a certain functional orientation, the use of bioflavonoids is of great interest [2, 3]. This group of substances includes polyphenolic compounds of plant origin, containing about 120 substances in their composition [4]. They owe their name to the Latin term flavus, since the first flavonoids extracted in the 19th century by man had a yellow tint. Numerous studies have shown that bioflavonoids have a wide range of positive effects on the human body, being the strongest antioxidants [5]. Bioflavonoids are found in various plant objects - flowers, fruits, berries, leaves, plant roots, and tree wood. There is confirmed information that a significant amount of them is contained in foods that a person does not eat, for example, in grape and citrus seeds, tree bark and coniferous wood [6]. The most famous substances in this group are: citrus peel; sweet red pepper (Bulgarian); various types of green tea; onions - green, onions, lettuce, etc.; dark beers; fruits and seeds of sea buckthorn; black (bitter) chocolate, with a cocoa percentage of at least
70%; Red wine; berries (plum, blueberry, cherry, black currant); fruits (peaches, mango). Plant flavonoids are found in unripe fruits, young inflorescences and other parts of medicinal plants: hawthorn; chokeberry; licorice; the highlander is cheeky; tansy; horsetail; Japanese sophora; field steel (roots); eucalyptus (leaves); blue cornflower (inflorescences); larch bark and resin; blueberries (fruits), etc. [7]. For the first time, the scientist Chevrolet (early 19th century) managed to extract plant flavonoids from oak bark. For example, blueberries contain anthocyanins, milk thistle, the bioflavonoid silymarin and, of course, tocopherols from red grape seeds. Studies of various scientists have established [8, 9] that active bioflavonoids from red grape seeds neutralize a wider range of free radicals than selenium, zinc, vitamins A, E, C, beta-carotene known for their antioxidant activity. Bioflavonoids, including resveratrol, are 50 times superior to such a powerful antioxidant as vitamin E, 20 times superior to vitamin C. Moreover, bioflavonoids protect all vitamins from the damaging effects of free radicals.

A separate group of bioflavonoids, the so-called proanthocyanidins, has the strongest antioxidant properties. They are found in: grape seed extract and red wine obtained from natural grape juice; bark of seaside pine and lemon tree; hazel leaves; cranberries; raspberries; eggplant; fruits of black elderberry [10].

Extracts of tree bark contain bioactive components, some of which have valuable industrial and technological properties (tannins from the bark of redwood); some are medicinal (oak bark is effective in healing wounds). Pine bark, for example, contains unique tannins D-galacturonic acid, powerful antioxidants - pycnogenol and resveratrol, as well as a rich complex of macro- and microelements [11].

A feature of these substances is that they have a bright color (red, yellow, brown, orange, green, etc.), a strong odor and a specific, in many cases, unpleasant taste.

We have put forward a working hypothesis that in order to level the unattractive odor of the selected functional objects of study, it is advisable to use technological methods of microdroplet coating, which leads to the formation of microencapsulated forms of the active substance in it.

There are technological methods for obtaining microencapsulated products. All of them are based on the processes of film formation in heterogeneous systems - at the interface liquid - liquid, liquid - solid, gas (vapor) – liquid, gas (vapor) – solid [12].

| No | Type of extract used       | The list of the main bioactive substances included in its composition [13]                                                                 |
|----|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Pine bark extract          | Pycnogenol, bioflavonoids, proanthocyanidins with antioxidant properties; phenolic compounds (tannins)                             |
| 2  | Willow bark extract        | Bioflavonoids; tannins and glucosides; pectin; polyphenols; iron; calcium and phosphorus; resins and tannins; quinine; vitamin C     |
| 3  | Cassia bark extract        | Essential oils that exhibit antimicrobial and antioxidant activity (cinnamic acid aldehyde 90%); coumarin; tannins; calcium and manganese; B vitamins, essential and non-essential amino acids |

2. Materials and methods

For research, a laboratory bench was created, the main element of which was a direct-flow nozzle atomizing device (figure 1).
Figure 1. Schematic diagram of direct-flow drip outflow of solution.

The spray rate was selected in such a way as to ensure the disintegration (fragmentation) of the liquid jet into individual droplets (figure 2).

Figure 2. The resulting array of droplets (spray torch).

To practice spraying, degreased glass (Petri dishes) was used as a model object of application. The film was formed in two ways:

The first. A film of agar-agar was cast in a Petri dish. Aqueous solutions of extracts in the concentration range of 0.5% - 2.5% were sprayed onto the surface of a non-solidified agar-agar layer and dried under uncontrolled conditions.

Second. Hot agar-agar was mixed with aqueous solutions of extracts, sprayed onto glass and dried under uncontrolled conditions.

3. Results
Comparative evaluation of the coatings obtained by the two methods showed the following. The drying time in both cases is almost the same and does not depend on the concentration and type of ingredient used. Visual inspection indicates that the appearance of the resulting coating in the first embodiment is unsatisfactory. Individual irregularities and bubbles are observed. As for the second option, the resulting coating turned out to be smooth and uniform. No bubbles or separate frozen drops were found.

4. Conclusion
Thus, a technological principle of joint spray spraying of a film-forming substance with a solution of a functional ingredient in the creation of coatings containing antioxidant substances of tree bark has been proposed. The worked-out stage, in our opinion, will be fundamental in the technology and provide the required set of properties of the objects obtained.
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