Systematic analysis of the succulent extraction process to improve bakery technology

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Abstract. To improve the technology and extend the assortment of bakery products of preventive and functional orientation by introducing extracts of succulent plants, in particular aloe and kalanchoe, the authors have analyzed the process of extraction of vegetable materials and selected optimal conditions: process temperature - 100 °C, duration - 24 hours, the nature of the extractant - water, both for the aloe and kalanchoe extract. The study revealed that by adding the extracts to the semi-finished buns the quality of the products in organoleptic and physico-chemical parameters is not inferior to the control (without adding the plant extracts), and in some cases it becomes better, the optimum dosage is 8% of plant extracts of the amount of water in the dough. Based on the microstructure of the buns' crumb it was found that the crumb with the addition of 8 % of plant extract in place of the amount of water in the recipe has a uniform structure, which was expressed in an increase in the pore diameter compared to other samples and a stable structure of micro-bridges between them. Such a micro pattern characterises the finished product, which has excellent quality parameters.

1. Introduction
Recently, there has been a sharp increase in attention to nutritional problems from various branches of science and industry, due to changes in the environmental situation, improper nutrition, and a sharp decrease in the protective functions of the body. In this regard, products of functional and preventive orientation in the diet of the population are of particular relevance today, which leads to the development of the market of these products [1–5].

Everyone knows that bakery products are a unique foodstuff containing almost all the components necessary for human life and health: proteins, complex carbohydrates, calcium, iron, phosphorus, B vitamins, with a small amount of fat. In addition, they are easy to fortify, technologically speaking, and are a product of daily consumption [1, 2, 4]. However, to date, the volume of production of dietary products is still insignificant, the need for them is satisfied only by 10-20%. The level of production of prophylactic products is low.

A solution to the problem of balanced nutrition of the population, which is of national importance, is only possible if technologies are developed and introduced into production that will ensure the safety of agricultural and food raw materials and food products, reduce the incidence of disease among children due
to malnutrition and produce a new generation of environmentally friendly mass and dietary foods [1, 2, 4, 6].

Currently, the food industry pays much attention to the development of new types of food, including bakery products using non-traditional plant raw materials rich in vitamins, macro and micronutrients, as well as dietary fibers. The Department of Service and Restaurant Business of Voronezh State University of Engineering Technologies conducts research towards the application of herbal extracts in the technology of bread and bakery products, in order to increase their nutritional value and expand the range of products of preventive and functional orientation [1, 2, 4, 6].

2. Purpose and objects of the study
The aim of the research was to improve the technology and expand the range of prophylactic and functional baked goods by introducing extracts from succulent plants, in particular aloe and kalanchoe. The research focused on samples of extracts from these plants and bakery products with their addition.

3. Materials and methods
3.1 Investigation of the optical density of succulent plant extracts
The completeness of the process and the selection of extraction conditions for succulent plants (aloë and kalanchoe) were determined according to GOST R 52769-2007.

3.2 Investigating the quality of baked goods
The quality of the bakery products in 14 hours after baking was estimated by organoleptic (appearance, crumb condition, taste and smell) and physico-chemical indices (humidity, acidity, porosity, microstructure of the crumb) according to GOST 5667-65, GOST 21094-75, GOST 5670-96, GOST 5669-96.

4. Results and Discussion
The extract based on the selected raw materials was obtained by extraction in the system: aloe and kalanchoe juice - water, alcohol and vegetable oil.

To investigate the interaction of factors influencing the choice of extractant, we analysed the change in optical density on a photoelectrocolorimeter at 22 °C in the wavelength range of 400-750 nm (Table 1). Based on the data obtained, it can be concluded that the most complete extraction occurs when water is selected as an extractant, at a wavelength of 400 nm, as evidenced by the highest optical density values.

The extraction temperature was selected on a spectrophotometer at different temperatures of 40, 60, 80 and 100 °C for the aqueous extract of aloe and kalanchoe. The results are presented in Table 2.

After selecting the nature of the extractant and the extraction temperature, as well as the wavelength in order to determine the completeness of the process, the optimum extraction time should be selected. Since the process takes place at a temperature of 100 °C, which requires additional energy costs, the precise selection of the extraction time will affect not only the completeness of the process, but also the cost of semi-finished product (plant extract) and the final product (bakery products). The results of the study are presented in Table 3.

Based on the organoleptic and physico-chemical quality assessment of the finished products, with the addition of water extracts of aloe and kalanchoe in amounts of 6%, 8%, 10% respectively, the quality indicators of the products were analysed (Table 4).
Table 1. Variation of the optical density of herbal extracts depending on the nature of the extractant (at 50 °C)

| The nature of the extractant | Wavelength, nm / Optical density | Aloe | Kalanchoe |
|-----------------------------|---------------------------------|------|-----------|
|                            | 400                             | 440  | 490 | 540 | 590 | 670 | 750 |
| alcoholic extract           | 0.115                           | 0.086| 0.084| 0.076| 0.063| 0.050| 0.042|
| water extract               | 0.508                           | 0.500| 0.496| 0.475| 0.460| 0.454| 0.434|
| oil extract                 | 0.217                           | 0.197| 0.107| 0.096| 0.060| 0.057| 0.010|
| alcoholic extract           | 0.038                           | 0.033| 0.031| 0.022| 0.017| 0.010| 0.001|
| water extract               | 0.490                           | 0.460| 0.421| 0.392| 0.389| 0.360| 0.338|
| oil extract                 | 0.311                           | 0.211| 0.119| 0.116| 0.178| 0.053| 0.012|

Table 2. Changes in the optical density of herbal extracts depending on extraction temperature (wavelength of 400 nm, extractant water)

| Extraction process temperature, °C | Value of optical density of aqueous extracts |
|-----------------------------------|---------------------------------------------|
|                                   | aloe extract | kalanchoe extract |
| 40                                 | 0.14         | 0.08              |
| 60                                 | 0.20         | 0.07              |
| 80                                 | 0.23         | 0.09              |
| 100                                | 0.27         | 0.16              |

Table 3. Changes in the optical density of herbal extracts depending on the duration of extraction (extraction temperature of 100 °C, extractant water)

| Extraction time, h | Wavelength/Optic density | Aloe | Kalanchoe |
|-------------------|--------------------------|------|-----------|
|                   | 400 | 440 | 490 | 540 | 590 | 670 | 750 |
| 6                 | 0.338| 0.319| 0.302| 0.286| 0.251| 0.231| 0.216|
| 12                | 0.431| 0.423| 0.415| 0.405| 0.385| 0.350| 0.318|
| 24                | 0.508| 0.500| 0.496| 0.475| 0.460| 0.454| 0.434|
| 48                | 0.441| 0.425| 0.395| 0.361| 0.345| 0.317| 0.305|
|                   | 400 | 440 | 490 | 540 | 590 | 670 | 750 |
| 6                 | 0.287| 0.271| 0.253| 0.245| 0.231| 0.224| 0.210|
| 12                | 0.327| 0.321| 0.315| 0.308| 0.300| 0.293| 0.289|
| 24                | 0.490| 0.460| 0.421| 0.392| 0.389| 0.360| 0.338|
| 48                | 0.470| 0.440| 0.400| 0.374| 0.365| 0.318| 0.308|
Table 4. Quality indicators for baked goods with the addition of herbal extracts

| Name of indicators   | Control (0 %) | Aloe extract | Kalanchoe extract |
|----------------------|---------------|--------------|-------------------|
|                      |               | 6%           | 8%                | 10%              | 6%  | 8%  | 10%  |
| Organoleptic         |               |              |                   |                   |     |     |      |
| Appearance, point    | 4             | 4            | 5                 | 5                 | 4   | 5   | 4    |
| Form, score          | 4             | 4            | 5                 | 5                 | 4   | 5   | 4    |
| Crust colour, score  | 4             | 5            | 5                 | 5                 | 5   | 5   | 4    |
| Baked, point         | 5             | 5            | 5                 | 5                 | 5   | 5   | 5    |
| Promess, score       | 5             | 5            | 5                 | 5                 | 5   | 5   | 5    |
| Taste, score         | 4             | 4            | 5                 | 5                 | 5   | 5   | 4    |
| Odor, score          | 4             | 4            | 5                 | 4                 | 5   | 5   | 5    |
| Physico-chemical     |               |              |                   |                   |     |     |      |
| Humidity, %          | 42.0          | 45.0         | 42.0              | 44.0              | 42.2| 41.0| 43.0 |
| Acidity, deg.        | 2.8           | 2.6          | 3.0               | 2.6               | 3.0 | 3.0 | 2.8  |
| Porosity, %          | 73.0          | 74.0         | 78.0              | 76.0              | 76.0| 79.0| 74.0 |
| Specific volume, cm³/100g | 320.0      | 340.0        | 348.0             | 342.0             | 338.0| 340.0| 328.0|

A - control sample (without the addition of plant extracts),
B - 6 % aloe extract, C - 8 % aloe extract, D - 10 % aloe extract.

Figure 1. Microstructure of bakery crumb with aloe extract

A - control sample (without the addition of plant extracts),
B - 6 % of kalanchoe extract, C - 8 % of kalanchoe extract, D - 10 % of kalanchoe extract.

Figure 2. Microstructure of bakery crumb with the addition of kalanchoe extract

In order to study the effect of aloe and kalanchoe extracts on the basic properties and structure of the bakery products, the microstructure of the crumb with different dosages of extracts and the control sample
were examined. The results of the buns' crumb microstructure are shown in Figures 1 and 2, which clearly show the difference between the test and control samples.

5. Conclusion
Based on a systematic analysis of the extraction process of succulents, particularly aloe and kalanchoe, it has been established that the optimum conditions of extraction determined by optical density: process temperature - 100 °C, duration - 24 hours, the nature of the extractant - water, both for aloe and kalanchoe extract. When adding extracts to semi-finished bakery products, the quality of products according to organoleptic and physico-chemical parameters is not inferior to the control (without adding plant extracts), and in certain cases it becomes better, the optimal dosage is the addition of 8% of plant extracts of the amount of water in the dough.

It was found that the crumb of the bakery products without additives was characterised by a loosened structure. In figure A, it can be seen that the micro-fibers have many tears and thickening, which leads to excessive crumbliness, reduced storability and a deterioration in the properties of the finished product. Figure B shows changes in the crumb structure of a bakery product containing 6% aloe extract. The crumb was characterised by a more compacted structure, it can be noted that the micro partitions between the pores have thickened considerably, which leads to a harder structure and a thicker crumb. The crumb in figure B with the addition of 8% aloe extract showed an even structure in the finished product, with an increased pore diameter compared to the rest of the samples, and a stable structure of micro-webs between the pores. Such a microcosm characterises the final product, which has an excellent quality index. The structure of the crumb in figure D is very similar to the loosened structure of the control sample.

References
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