Application of modern convergent solutions in food biotechnologies

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Abstract. The need to introduce innovative technologies in the food industry is a requirement of the time. What previously seemed completely incompatible is now becoming a close and complementary unity of knowledge due to the emergence of convergent technologies. In the course of a specific study, it was shown that the synthesis of biotechnology, which provides methods for working with living organisms (in our case, yeast) and nanotechnology, which forms the basis of the scientific and technological revolution, will radically change food technology. According to experts, about 85% of food production is somehow related to the use of microbiological processes. Modern food biotechnology is associated with increasing requirements for the intensification of technological processes. Acceleration of food production processes without deterioration of their quality characteristics is an extremely relevant area of research. The use of biotechnology to develop a new method of intensifying the fermentation process will provide a solution to one of the key social problems — accelerating the progress of the food industry. The relevance of research conducted in this direction is also confirmed by the fact that the use of new technologies based on innovations in various fields of knowledge and being their synthesis leads to an increase in economic and, as a consequence, social welfare. As a result of the study, it was found that the use of colloidal silver for water treatment during a series of experiments resulted in an increase in the lifting force of yeast.

1. Introduction

Modern food industry is a dynamically developing sector of the national economy, which, as a result of the scientific and technological revolution that has taken place in the last century and still continues to this day, is a complex system that includes machinery, technologies, nano- and biotechnologies. Further development of this industry is unthinkable without the introduction of convergent technologies.

Convergent technologies today include information and communication technologies, biotechnologies, nanotechnologies and cognitive technologies. ISDN is, in fact, new technologies that cannot be clearly divided into specific areas of knowledge in the old fashion, clearly isolated technologies with features and methodology inherent only to them.

The implementation of innovative technological improvement projects in the food industry implies the merger of different technologies and the emergence of new types of technologies as a result of such a convergence. The main task of introducing convergent technologies in the food industry is the development of new technologies that ensure the production of food products of high nutritional value, satisfying the needs of the population for the usual, traditional food, while having a high economic effect.
The result of the merger of the technologies described above both in the modern food industry and in our specific study is seen as the following: nanotechnology – the use of atomic engineering in technological processes; biotechnology – implementing into the obtained nano-models of living objects, studying the effect of their interaction; cognitive technologies in this case are based on knowledge of the process of thinking, cognition, human search for ways to implement research results.

The need to develop convergent technologies in the food industry is a requirement of the time. The transformation of the modern food biotechnology is associated with ever-increasing requirements for the intensification of technological processes. Acceleration of food production processes without deterioration of their quality characteristics is an extremely relevant area of research.

The development of convergent solutions in the food industry is already starting to lead to significant changes in this industry. Our studies aimed to determine the effect of a colloidal solution of silver ions on the duration of the technological cycle of production of bakery products by studying the effect of silver ions on the technological properties of baker's yeast of the Saccharomyces cerevisiae species. Currently, increased demands are placed on the yeast, characterizing their activity. In this case, the function of ISDN was to ensure the formation of the concept of “breakthrough” technology that could change the role of traditional processes in global technologies.

There are a number of studies in this area. So, the European Food Safety Authority (EFSA, Italy) has already approved the use of yeast processed with ultraviolet and enriched with vitamin D2 [2]. A known method of activation of pressed baking yeast, which involves preparation of flour suspension, putting the yeast in and ultrasonic treatment of flour suspension [4]. There are studies aimed at studying the activation of yeast by microwaves, providing for an increase in the level of their fermentation energy and intensification of the fermentation process [3]. Concerning the interaction of atomic-molecular models and biological objects, there are studies aimed at studying the mechanism of incorporation of copper ions into the T2/T3 centers of a recombinant copper-containing oxidase – two-domain laccase Streptomyces griseoflavus Ac-993 [1].

The intensification of the studied fermentation process is due to the quality of yeast cells and their physiological activity [5]. It is the increase in activity that is the tool that will allow for obtaining a visible technological effect from the implementation of the developed technology. Using convergent technologies to develop a new method of intensifying the fermentation process will provide a solution to one of the key social problems – accelerating the progress of new technologies.

2. Research objects and research methods

The object of the study was baker's yeast Saccharomyces cerevisiae pressed, race 262.

Evaluation of the lifting force of yeast was carried out in accordance with GOST R 54731-2011 “Pressed baker's yeast. Technical conditions”.

3. Results and discussion

Studies to determine the effect of an ionic solution of colloidal silver ions on the technological properties of yeast were carried out at the Department of Agricultural Technology of Production and Processing of Agricultural Products of Yaroslav-the-Wise Novgorod State University with the use of two brands of equipment allowing to obtain a solution of a certain concentration (500 μg/l).

At the first stage, to conduct a study of the lifting force of yeast, water treatment for preparation of yeast milk was carried out using the “George” colloidal silver ion generator in regime 1 (500 μg/l). Saccharomyces cerevisiae pressed yeast, race 262, and water from a centralized water supply were used. As a result of the research of the yeast lifting force by the accelerated method, it was found that water treatment with colloidal silver ions increased the yeast lifting force by 27% (figure 1).

When conducting the study using the standard method for determining the lifting force of yeast, at the first stage of the study it was found that in the test samples which were not treated with colloidal silver ions, the lifting force was 63.3±5.8 minutes, and in the treated samples it was 53.3±5.8 minutes. Thus, the dough, which was saturated with silver ions, increased in volume by 50% 10 minutes faster than the
unprocessed dough, therefore, due to the treatment, the rise time of the dough was reduced by 16% (figure 2).

At the second stage of the study, in order to test the results of the first stage, similar experiments were carried out using other equipment (silver ion generator “Serebrin”), which allows for obtaining a colloidal solution of silver ions of a given concentration (500 μg/l).

The results of a study of the lifting force of yeast using the accelerated method (GOST R 54731-2011) are presented in figure 3.

According to the obtained experimental data, the average lifting force of yeast in water samples not treated with colloidal silver ions amounted to 44.62±4.57, and in the processed samples to 38.36±0.89. Thus, the use of colloidal silver increased this indicator by 14.0%.

The results of the study are supplemented by analysis of variance (table 1).

**Table 1.** The results of a one-way analysis of variance of the lifting force of the yeast by the accelerated method.

| Source of variation | Sum of squared deviations | Variability | Dispersion | F        | F critical |
|---------------------|---------------------------|-------------|------------|----------|------------|
| Between groups      | 23.9077                   | 2           | 11.95385   | 0.458856 | 9.552094   |
| Inside groups       | 78.1543                   | 3           | 26.05143   |          |            |
| Total               | 102.062                   | 5           | 38.00528   |          |            |
Since the actual value of the Fisher ratio (0.46) is less than the critical (9.55), with a probability of 95% we reject the null hypothesis of equality of means. And the ratio of intergroup and total dispersion (11.95 / 38 = 0.315) showed that the lifting force of yeast by 31.5% depends on the method of water treatment.

Then, at the second stage of the study, an experiment was carried out to determine the lifting force of yeast, carried out by the standard method. To prepare the dough pieces, wheat flour, pressed baking yeast Saccharomyces cerevisiae, race 262, food salt, as well as water from a centralized water supply were used. At the stage of preparation of yeast milk, water was treated using the “Serebrin” generator to a concentration of silver ions of ~ 500 μg/l. The results of the study are presented in table 2.

Table 2. Test results for yeast lift by standard method.

| Criteria | Water not treated with colloidal silver ions | Water treated with colloidal silver ions |
|----------|---------------------------------------------|----------------------------------------|
| Time, h. | 1 h. 30 min.                                |                                        |
| Dough volume \( V_{av, \text{start}}, \text{ml} \) | 116.7±5.8 | 106.7±5.8 |
| Dough volume \( V_{av, \text{fin}}, \text{ml} \) | 186.7±5.8 | 203.3±5.8 |
| Growth V, % | 59.98 | 90.53 |

From the data of table 2 it can be concluded that the volume of the dough prepared using the water treated with colloidal silver ions is 30.55 percentage points larger than the sample not subjected to treatment.

4. Conclusion

As a result of the study, it was found that the use of colloidal silver for water treatment during a series of experiments resulted in an increase in the lifting force of yeast.

At the first stage of the study, when evaluating the lifting force of yeast using the accelerated method, it was found that the treatment of water with colloidal silver ions increased the lifting force of yeast by 27%. When conducting a study using the standard method for evaluating the lifting force of yeast, it was found that the dough prepared using the water saturated with silver ions increased in volume by 50% 10 minutes faster than the unprocessed dough, and the lifting time of the dough was reduced by 16%.

During the second stage of research in an experiment conducted by the accelerated method, it was found that the use of colloidal silver increased the lifting force of yeast by 14.0%, this indicator by 31.5% depends on the method of water treatment. With the standard method for determining the indicator, it turned out that the volume of the dough prepared using water treated with colloidal silver ions is 30.55 percentage points more than the sample not subjected to processing.

Thus, in the course of this study, the need for the development and application of modern convergent solutions in food biotechnology was established. The use of a colloidal solution of metallic silver with a particle size of 1 nm to several microns combines two innovative technologies – biotechnology, which provides methods for working with living organisms (in our case, yeast) and nanotechnology, which forms the basis of the scientific and technological revolution, which allows one to radically change food technology.

References

[1] Gabdulhakov A G, Kostareva O S, Kolyadenko I A, Mihajlina A O, Trubicina L I and Tishchenko S V 2018 Embedding of copper ions in the t2 / t3 centers of two-domain laccases. Molecular biology (Moscow: RAS) Vol. 52 1

[2] Kodencova V M, Risnik D V and Mazo V K 2019 UV irradiation as a way to increase the content of vitamin D in food products Agricultural Biology Vol. 54 4 693–704
[3] Kosovan A P 1999 Problems of planning bakery production in a market (Moscow: Publishing. Complex MGUPP) p 290

[4] A method of activating baker's yeast in the production of dough copyright certificate 522229 USSR. L P Pashchenko (patent holder Voronezh Institute of Technology) declared 06/19/87, publ. 05.15.90 18

[5] Splelenko L A and Tyurina O E 2014 Features of the development of technologies for specialized bakery products. Bakery products 8 p 50