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Novik G. V.,
anna.novik.82@ukr.net, ORCID: 0000-0003-4045-4878,
ResearcherID: G-8283-2019,
Ph.D., Associate Professor Department of food technology,
Oles Honchar Dnipro National University, Dnipro

Prymenko V. G.,
primenkovlad@gmail.com, ORCID: 0000-0001-7856-6678, ResearcherID:ADO-8769-2022,
Ph.D., Associate Professor, Associate Professor of the Department of Management and Administrating,
Autonomous subdivision "Dnipro Faculty of Management and
Business of Kyiv University of Culture", Dnipro

Savchenko A. M.,
savkalka3@gmail.com, ORCID: 0000-0002-2649-8412,
ResearcherID: ADT-972-2022,
Assistant Department of food technology,
Oles Honchar Dnipro National University, Dnipro

Artemenko Y. E.,
juliachevuk10081996@gmail.com, ORCID: 0000-0002-8900-5945,
ResearcherID: HCI-1087-2022,
Teacher,
Specialized College of Economics and Business of Dnipro National University
named after Oles Honchar, Dnipro

DEVELOPMENT OF TECHNOLOGY OF FROZEN SEMI-FINISHED PRODUCTS FROM YEAST DOUGH WITH STUFFING

Abstract. *Today, food science knows many technologies for obtaining semi-finished products and ready-to-go culinary products from yeast dough, along with comprehensive studies of their quality indicators. However, the vast majority of such developments concern dough products without stuffing. Also, for the most part, there is no review of ways to improve the quality of frozen ready-to-go products, especially aspects of the technology of re-freezing, thawing and cooking (warming) of ready-to-go products, in particular with stuffing, without changing the organoleptic properties of the finished products. Therefore, the technology of frozen semi-finished products from yeast dough with stuffing and the study of their quality indicators proposed in the work are appropriate, relevant and will be of scientific interest among specialists in the food industry. The purpose of the study is to develop the technology of frozen semi-finished products with stuffing and to study the influence of re-freezing, thawing and reheating on the quality indicators of finished products. The main results of the study. The influence of the introduction of dry wheat gluten on the quality of fibrin in the tested dough samples was determined experimentally, and its influence on the deliquescence of the fibrin ball was investigated. The recipe composition of the frozen semi-finished product from yeast dough with stuffing is presented, taking into account the mass fraction of added dry wheat gluten, as well as the technological scheme for the production of frozen semi-finished product from yeast dough with stuffing is developed. The optimal amount of adding gluten to the basic dough was found: it is advisable to replace no more than 4% of the mass of flour with fibrin. An analysis of the organoleptic quality indicators of the developed products with different contents of seaweed in the stuffing was carried out, which proved the relevance of adding algae as moisture-retaining agents. Prospects for further research in this direction. The analysis of the obtained data shows that the addition of kelp for no more than 3% and fucus for 5% of the weight of the stuffing is appropriate, improves and naturally enhances the taste properties of the products. Therefore, studies of the influence of kelp and fucus algae on quality indicators and storage of other flour and flour pastry products with stuffing will be promising.*

Key words: *technology, semi-finished product, freezing, yeast dough, gluten, fibrin, stuffing, kelp, fucus.*

Новік Г. В.,
anna.novik.82@ukr.net, ORCID: 0000-0003-4045-4878,
ResearcherID: G-8283-2019,
к. т. н., доцент кафедри харчових технологій,
Дніпровський національний університет імені Олеся Гончара, м. Дніпро

Применко В. Г.,
primenkovlad@gmail.com , ORCID: 0000-0001-7856-6678
ResearcherID: – ADO-8769-2022,
к. т. н., доцент кафедри менеджменту та адміністрування,
Відокремлений підрозділ «Дніпровський факультет менеджменту
і бізнесу Київського університету культури», м. Дніпро

Савченко А. М.,
savkalka3@gmail.com, ORCID: 0000-0002-2649-8412,
ResearcherID: ADT-972-2022,
асистент кафедри харчових технологій,
Дніпровський національний університет імені Олеся Гончара, м. Дніпро

Артеменко Ю. Є.,
juliachevuk10081996@gmail.com, ORCID: 0000-0002-8900-5945,
ResearcherID: HCI-1087-2022,
Викладач,
Фаховий коледж економіки та бізнесу Дніпровського національного університету
імені Олеся Гончара

РОЗРОБКА ТЕХНОЛОГІЇ ЗАМОРОЖЕНИХ НАПІВФАБРИКАТІВ ІЗ ДРІЖДЖОВОГО ТІСТА З НАЧИНКОЮ

Анотація. *На сьогодні харчовій науці відома безліч технологій одержання напівфабрикатів та готових кулінарних виробів із дріжджового тіста поряд із всеосяжними дослідженнями показників їхньої якості. Але, переважна більшість таких розробок стосуються саме виробів із тіста без начинки. Також, здебільшого відсутній огляд способів підвищення якості заморожених готових виробів, особливо аспекти технології повторного заморожування, розморожування та приготування (розігрівання) готових виробів, зокрема із начинками, без зміни органолептичних властивостей готових виробів. Тому, запропоновані у роботі технології заморожених напівфабрикатів із дріжджового тіста з начинкою та дослідження показників їх якості є доцільними, актуальними та представлятимуть науковий інтерес серед фахівців галузі харчової промисловості. Мета дослідження полягає в розробці технології заморожених напівфабрикатів із начинками та дослідження впливу повторного заморожування, розморожування та розігрівання на показники якості готових виробів. Основні результати дослідження. Експериментальним шляхом встановлено вплив внесення сухого пшеничного глютену на якість клейковини у досліджуваних зразках тіста, досліджено його вплив на розпливання кульки клейковини. Наведено рецептурний склад замороженого напівфабрикату із дріжджового тіста із начинкою з урахуванням масової частки доданого сухого пшеничного глютену, а також розроблена технологічна схема виробництва замороженого напівфабрикату із дріжджового тіста із начинкою. Виявлено оптимальну кількість внесення глютену до базового тіста: доцільно замінювати не більше 4% маси борошна на клейковину. Визначений оптимальний компонентний склад начинки заморожених напівфабрикатів із дріжджового тіста. Проведений аналіз органолептичних показників якості розроблених виробів із різним вмістом морських водоростей у складі начинки, який довів доречність внесення водоростей як вологоутримуючих агентів. Перспективи подальших досліджень у даному напрямі. Аналіз отриманих даних свідчить про те, що додавання ламінарії в кількості не більше 3% та фукусу в кількості 5% від маси начинки є доцільним, покращує і природньо підсилює смакові властивості виробів. Тому, перспективними будуть дослідження*

впливу водоростей ламінарії та фукусу на показники якості та зберігання інших борошняних та борошняних кондитерських виробів із начинками.

Ключові слова: *технологія, напівфабрикат, заморожування, дріжджове тісто, глютен, клейковина, начинка, ламінарія, фукус.*

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Formulation of the problem. Recently, the storage of food products at low temperatures has become widespread all over the world. Freezing of perishable food products is the main widely used and reliable preservation method, which ensures maximum preservation of high quality food products due to minimal changes in organoleptic properties and nutritional value. The high stability of frozen products during storage is due to the suppression of the vital activity of microorganisms, the slowing down of enzymatic and oxidizing processes [1-3].

On the other hand, there is an increasing demand for semi-finished products with a high degree of readiness, or ready-to-go dishes or products that only need to be heated. At the same time, a long shelf life of products is an important requirement of modern consumers, as well as the absence of preservatives, flavorings and other artificial food additives.

Bread and bakery products, including those made from yeast dough, are quite well amenable to freezing and low-temperature storage, as is known from literary sources. In addition, this category of food products occupies a significant share in the population's diet. A wide range of products, including frozen products, represents the bakery market. Products containing stuffing can be optimized in terms of nutrient composition. In addition, bakery products with stuffing can be positioned as one of the dishes of daily food consumption or as a quick hunger relief. Therefore, a convenient form of storage of the proposed food products, namely in the form of already ready frozen products, is an important requirement.

Food products that can be re-frozen by the consumer after defrosting with full preservation of organoleptic properties have a special value and convenience during consumption. Therefore, food industry specialists face the task of developing such technologies for the production of dough and fillings, so that the products can withstand several cycles of defrosting, reheating and re-freezing without negative changes.

Using low temperatures to store products, in particular bakery products made from yeast dough has some disadvantages, although it extends the shelf life of products. The main drawback of this method is the effect on some components that are part of the yeast dough. Freezing significantly affects the gluten contained in flour, in particular wheat, even if ready-baked or otherwise prepared products (in an atmosphere of hot steam) are meant.

During the freezing of dough blanks, denaturation of proteins occurs in them, because of which the product loses its organoleptic and physicochemical properties. Protein denaturation is based on the process of their aggregation with the formation of ionic, hydrogen, hydrophobic and disulfide bonds. To prevent this, cryoprotectors are added to bakery products to protect the protein fraction [4, 5].

A cryoprotector is a substance that protects the frozen product from hypothermia. Cryoprotectors are used in the practice of cryogenic technology due to their ability to stabilize the properties of food products or semi-finished products during storage [6-8].

Analysis of recent research and publications.

Currently, a large number of studies have been carried out on the use of cryoprotectors of various nature in the bakery products technology.

The analysis of literary sources showed that sucrose, fructose, sorbitol can act as cryoprotectors, but their characteristic sweet taste may be undesirable. In addition, pectin containing compounds, xanthan, the use of which will help prevent the gradual loss of dough strength, reduced yeast activity and deterioration of the texture of the final product [9].

Chinese scientists [10] suggested using trehalose and maltodextrin to improve the quality of frozen yeast dough products. It was established that the addition of trehalose for 0.1% of the dough mass reduced the effect of low-temperature storage on yeast activity, and the use of 2% maltodextrin ensured the preservation of the rheological properties of the dough.

The use of collagen obtained from pigskin as a cryoprotector will help preserve up to 98% of moisture during several cycles of freezing and re-thawing the dough [11].

Another group of scientists suggests using extracted barley protein, the addition of which, for

0.5% of the mass of flour, improves the properties of yeast dough after freeze-thaw cycles [12]. It is worth noting that they established the following fact: the addition of extracted barley protein to the dough helps the yeast dough to rise more quickly after repeated freezing and thawing. In addition, the preservation of gluten strength was observed compared to the control sample. Also, yeast dough products with the addition of extracted barley protein after baking retained their volume and shape much better than the control samples.

Scientists have suggested using soy protein as an additive that accelerates the metabolism of yeast in yeast dough that is subjected to several cycles of freezing and thawing, and contributes to the preservation of yeast cells during the period of storage in a frozen state of thirty days [13].

Homeland scientists suggest using vegetable oil and milk serum as cryoprotectors [14]. The most optimal amount of vegetable oil is 2%. This amount of added oil contributed to an increase in the volume of finished products compared to the control sample, both of which were frozen and thawed, and then the bread was made using traditional technology. The introduction of whey as a liquid base for the dough led to a decrease in the percentage of bread mass loss during baking, a decrease in the drying of the dough during storage of the finished product, as well as an increase in the volume of the finished products and the porosity of the crumb. The addition of vegetable oil for 5% together with the use of whey instead of water in the dough showed a better result of the porosity of the finished products.

Thus, the vast majority of research and proposed technologies relate to dough products without stuffing. The technologies listed above only provide for the prevention of the negative impact of freezing and storage on the dough semi-finished product, but do not consider ways to prevent the loss of organoleptic and physicochemical properties of stuffing in products containing them. Also, the sources and references given in the analytical review in the vast majority do not consider methods of improving the quality of frozen ready-to-go products, especially aspects of the technology of re-freezing, thawing and cooking (warming) of ready-to-go products, in particular with stuffing, without changing the organoleptic properties of finished products. Some authors offer only technological approaches for repeated freezing and thawing of yeast semi-finished products in the form of «raw» dough. Therefore, the research and proposed technologies in the work are expedient, relevant and will be of scientific interest among specialists in the food industry.

Task statement.

The choice of a frozen semi-finished product from yeast dough with stuffing as a subject of research is due to the fact that such products are a fairly traditional product in the diet of the population, have an affordable price and have a high nutritional value.

The purpose of the work is to develop the technology of frozen semi-finished products with stuffing and to study the effect of re-freezing, thawing and reheating on the quality indicators of finished products.

The object of research is the production technology of a frozen yeast semi-finished product with a stuffing.

Presentation of the main research material.

In order to preserve the integrity of the yeast dough, it was proposed to use dry wheat gluten as a recipe component. Scientists have proven that during freezing, the moisture-retaining capacity of its own gluten contained in flour decreases, and this, in turn, leads to its possible destruction during the process of storage in a frozen state, thawing and heating. Therefore, increasing the gluten content, which will be contained in the frozen semi-finished yeast dough with stuffing, will allow to preserve the integrity of the dough structure.

Since this work deals with a frozen yeast semi-finished product with stuffing, attention should be paid to preserving the organoleptic parameters and integrity of the filling during the processes of defrosting, heating and subsequent freezing of the products.

To ensure this condition, it was suggested to add crushed seaweed - kelp and fucus in the form of powder. From literary sources, it is known about the ability of dried seaweed to actively absorb moisture [15]. Therefore, the addition of this component can solve the problem of moisture loss in the filling during subsequent defrosting, reheating and freezing cycles. It should be noted that this supplement is of natural origin, and therefore is safe for the human body. Moreover, it is known about the high nutritional value of the products in question, since seaweed, in particular kelp and fucus, is a source of macro- and microelements, especially iodine. As a filling, they used a semi-finished product containing: minced pork, cabbage, onion, salt, spices.

Dry kelp and fucus powder were added to the stuffing for 3%, 5%, and 8%, respectively.

As a prototype of a semi-finished dough, a yeast dough recipe was chosen, which contains: wheat flour, water, salt, sugar, dry yeast [16]. Modifica-

tion of the dough involves the introduction of dry wheat gluten and baking powder in amounts of 1-2% of the weight of the semi-finished dough.

Preparation of yeast dough was carried out according to traditional technology. Three types of dough samples were chosen for the research: a control sample, a dough with the addition of dry wheat gluten and baking powder in amounts of 1% and 2% of the weight of the semi-finished dough.

The influence of the addition of dry wheat gluten on the properties of wheat flour was studied by the amount and quality of fibrin, its extensibility, elasticity, ability to absorb moisture, degree of blurring over time. The flexible-elastic and viscous-plastic characteristics of dough with dry wheat gluten were determined by laboratory methods.

The results of studies of the introduction of dry wheat gluten (DWG) on the quality of fibrin in the tested dough samples are shown in table 1.

As can be seen from the obtained data, the addition of dry wheat gluten has a positive effect on the structural and mechanical properties of wheat flour dough. In particular, one can see the pattern that with the increase in the content of DWG, as predicted by the theory, the percentage of raw and dry gluten increases. Also, the addition of DWG significantly increases the elasticity index and hydration capacity of the dough. However, the limit value of 5% added DWG is no longer satisfactory for the extensibility index.

Because in the production of dough, an important indicator is its stretchability, which in the future will add difficulties when rolling out the dough on the appropriate equipment during production. The introduction of DWG for 3% of the flour mass is a well-founded decision. This will ensure the future maintaining the structural properties of the dough in the ready-to-go form during frozen storage and subsequent reheating of finished products or their re-freezing.

The nature of the effect of added DWG on the total flour fibrin in wheat yeast dough can also be evaluated during the study of the rheological properties of the samples (table 2).

As we can see from the obtained data, the addition of DWG reduces the deliquescence rate of the gluten ball. As the amount of added DWG increases, the total ball diameter decreases after the end of the experiment, i.e. after 180 minutes.

The 1% DWG sample had a 3% smaller deliquescence diameter, the 3% DWG sample had a 16% smaller deliquescence diameter and the 5% DWG sample had a 27% one. These data also support the feasibility of adding DWG to wheat flour dough, which will ultimately help preserve the appearance of finished products during frozen storage, reheating, and re-freezing.

The obtained data also confirm the expediency of adding DWG, which will contribute to the formation of a fibrin frame in the dough, obtaining products with high porosity and dry crumb. However, according to the literature, the optimal downfall number is an indicator within 240...270 seconds. Therefore, we stopped at 3% of DWG application instead of the appropriate amount of flour to obtain products with the best properties.

Based on the complex of experimental studies, the optimal component composition of the ingredients of the frozen semi-finished product from yeast dough with stuffing was chosen as the developing basis for the appropriate recipe.

The recipe composition for semi-finished yeast dough with stuffing is given in table 3.

The technology of manufacturing frozen semi-finished products from yeast dough with filling involves the preparation of semi-finished products «Yeast dough» and semi-finished products «Stuffing».

The technological scheme for the production of a frozen semi-finished product from yeast dough with stuffing is shown in fig. 1.

The conducted research made it possible to develop several recipes and work out the technologies

Table 1

The influence of the addition of DWG on the quality of fibrin in the studied dough samples

Fibrin quality indicators	The value of the index in the samples			
	Without DWG addition (control)	With 1% DWG addition instead of flour	With 3% DWG addition instead of flour	With 5% DWG addition instead of flour
Raw gluten,%	28,3±1,3	30,5±1	32±0,9	35,5±0,3
Dry fibrin, %	9,9±0,3	10,9±1	12,6±0,4	15±0,5
Extensibility, cm	15±0,6	17±0,5	19±1	15±1
Hydrating ability, %	185±7	199±3	209±2	220±4

Table 2

Effect of DWG on the fibrin balls deliquescence

Fibrin sample	The value of the index of the fibrin ball deliquescence (mm) during laying, min					
	0	**30**	**60**	**90**	**120**	**180**
Without additive (control)	20	26	31	33	36	38
With 1% DWG instead of flour	20	24	28	31	34	37
With 3% DWG instead of flour	20	22	25	27	30	32
With 5% DWG instead of flour	20	21	23	25	27	28

Table 3

Recipe composition of a frozen semi-finished product from yeast dough with stuffing

Recipe components	Addition aim	Technological purpose	Raw material consumption per 1 kg of ready-to-go products, g	
			gross weight	**net weight**
Semi-finished product «Yeast dough»				
Wheat flour	The main component that forms the dough	Forms the structure of the dough due to the swelling of fibrin proteins during dough kneading	374	374
DWG	Dough structure improver	Improves the structural-mechanical and rheological properties of the dough	13	13
White sugar	Flavor regulator	Gives a sweet taste	8	8
Baking powder	Affects the dough structure	Loosens the dough, increasing the porosity of the crumb of the finished products	13	13
Dried yeast	The main leavening agent of the dough	Provides volume and porosity of dough blanks and finished products	13	13
Kitchen salt	Flavor regulator	Gives a salty taste	4	4
Drinking water			188	188
Raw material weight				613
Output				600
Semi-finished product «Stuffing»				
Chopped meat	The main component of the stuffing	The component has a high nutritional value	18	180
White cabbage	Stuffing component	The component gives texture to the stuffing	150	120
Onion	Stuffing component	The component creates a balanced taste	120	100
Vegetable oil	Temperature conductor during heat treatment (frying)	Effective temperature transfer during heat treatment	40	40
Kitchen salt	Flavor regulator	Gives a salty taste	2	2
Drinking water			70	70
Dried seaweed (fucus, kelp)	Moisture binding agent	Binds moisture in the stuffing, ensures the integrity of the dough shell of the semi-finished product	20	20
Raw material weight				532
Output				400
Semi-finished product «Frozen semi-finished product from yeast dough with stuffing»				
Output				1000

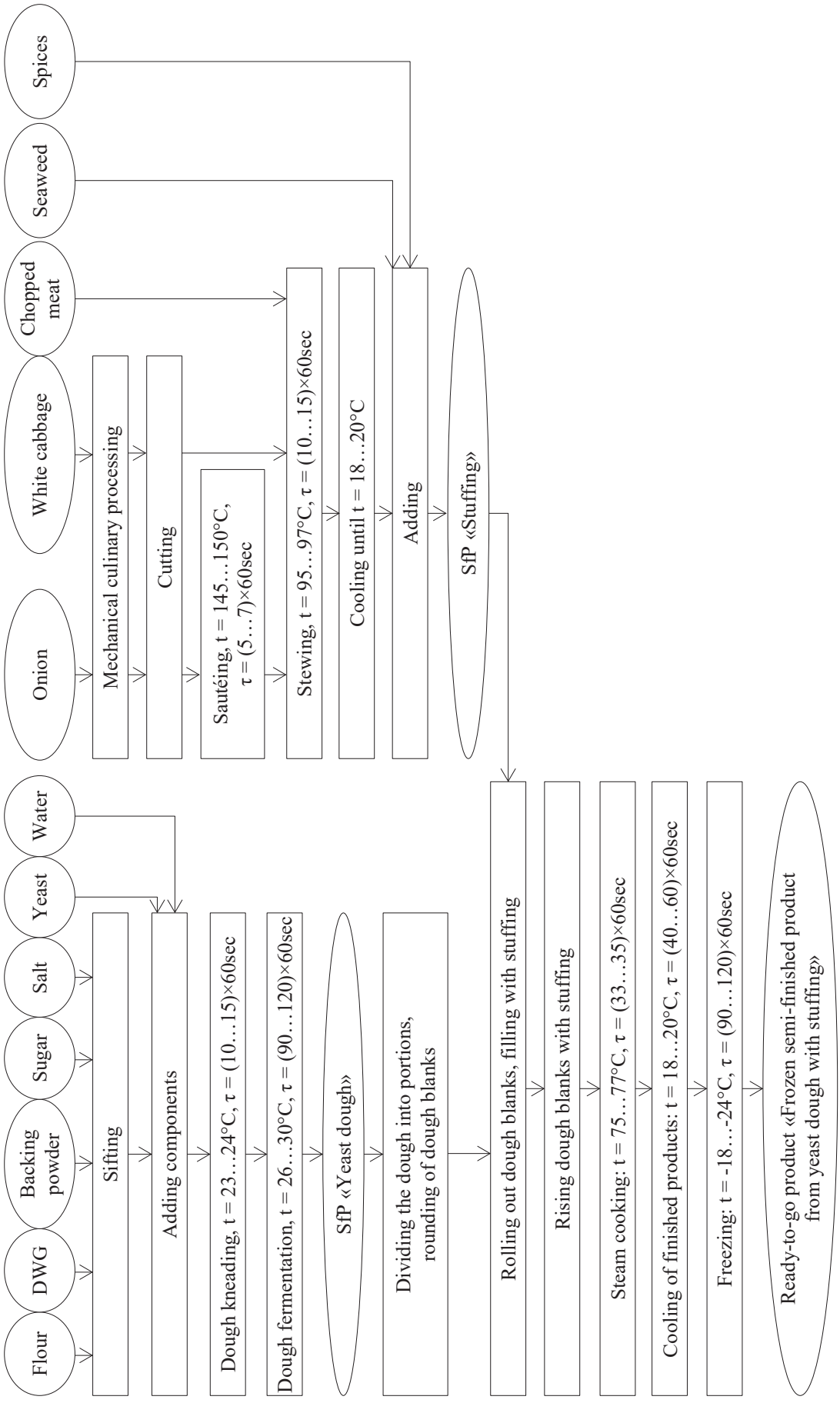

Fig. 1. Technological scheme for the production of a frozen semi-finished product from yeast dough with stuffing

of other frozen semi-finished products from yeast dough with stuffing. Thus, in order to expand the range of products of this type and increase the biological value of finished products, it is suggested to add seaweed for 3 to 8% of the weight of the stuffing, as well as to use both kelp and fucus as algae additives.

The component composition of the stuffing of frozen semi-finished products with stuffing is given in table 4.

An organoleptic evaluation of the finished products was carried out in order to justify the feasibility of adding gluten to the dough and algae to the stuffing. The results of the organoleptic analysis of the developed products depending on the content of seaweed in the stuffing are shown in table 5.

The results of the general organoleptic analysis proved that new products with the addition of DWG to the dough and dry seaweed to the filling improve the organoleptic characteristics of the finished products. In particular, the shape of the products is preserved, there was no cracks on the surface, or traces of leakage of the stuffing.

The analysis of the obtained data shows that the addition of kelp for 3% and fucus for 5% of the mass of the filling is appropriate. The introduction of algae does not add a swampy taste to the filling, but only improves its taste properties, giving the filling and the finished products in general an umami taste, which naturally enhances the taste of the products. However, in the case of applying these principles and technologies in the production of products for national cuisine establishments, where the presence of seaweed in dishes is a constant and important taste element, the content of fucus and kelp can be increased to 8%. Increasing the algal component should be carried out by adjusting the moisture content of the filling and its recipe composition, as well as the products as a whole.

Conclusions and prospects for further research in this direction.

During structural and mechanical properties research of the yeast dough of the experimental samples, the optimal amount of adding gluten to the base dough was found, namely, it is advisable to replace no more than 4% of the mass of flour with fibrin. The introduction of gluten contributes to the preservation of the integrity of the dough during the preparation of products, which was confirmed by the organoleptic analysis of the condition of the finished products.

Table 4

The component composition of the stuffing of frozen semi-finished products with yeast dough

Components	Sample stuffing		
	1	2	3
Semi-finished product «Stuffing»	97	95	92
Dried seaweed (kelp or fucus)	3	5	8

Table 5

Organoleptic indicators of the developed products with different contents of seaweed in the stuffing

Indicator name	**The name of the sample according to the seaweed content**					
	3% of kelp & 97% of stuffing	**5% of kelp & 95% of stuffing**	**8% of kelp & 92% of stuffing**	**3% of fucus & 97% of stuffing**	**5% of fucus & 95% of stuffing**	**8% of fucus & 92% of stuffing**
Product shape	Correct with a convex crust, without undermining and lateral outflows					
Surface	Smooth, without cracks or undermining					
Crumb state	Elastic with developed porosity, without traces of unprocessed					
Stuffing appearance	With a greenish shade	With a greenish shade	With a noticeable greenish tint	With dark fucus spots	With a dark shade	With a dark shade
Stuffing consistency	A bit damp	Tight	Very tight	A bit damp	Tight	Very tight
Stuffing flavor	Seaweed is not noticeable, with an umami taste	Seaweed taste is moderate	Seaweed taste is felt strongly	Seaweed is not noticeable, with an umami taste	Seaweed is not noticeable, with an umami taste	Seaweed taste is moderate

The analysis of the obtained data shows that the addition of kelp for no more than 3% and fucus for 5% of the weight of the stuffing is appropriate, improves and naturally enhances the taste properties of the products. It should be noted that the stuffing had a denser structure, and the finished products retained their integrity and no loss of moisture was detected by the stuffing. Therefore, studies of the influence of kelp and fucus algae on quality indicators and storage of other flour and flour pastry products with stuffing will be promising.

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