INVESTIGATION OF THE KINETICS OF FERMENTATION OF PUMPKIN PULP

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Abstract

The problem of processing pumpkin pulp with the further introduction of appropriate technological solutions was studied. The influence of temperature, time, heat treatment of pumpkin pulp and the concentration of the introduced enzyme preparation on the dynamics of accumulation of pectin is investigated in the article. The directed action of Vetom 1.1 based on an enzyme produced by bacteria of the genus Bacillus subtilis was studied. It is proved that the rational conditions of the process are t=55˚C, τ=15 hours, 7,5% of the enzyme preparation to the mashed pulp of pumpkin pulp. Taking into account the obtained data, a conclusion was reached on the effectiveness of using fermented mashed pumpkin pulp in food technology.

Key words:

pumpkin pulp, temperature, time fermentation, microbial origin enzyme, pectin

Introduction

Pumpkin is considered one of the oldest melon cultures. The genus Cucurbita includes five cultivated and sixteen wild-types of pumpkins. Almost cultural species in Ukraine, the most common are three species: large-frblited pumpkin or Greek - Cucurbita Duch Tahiti., Pumpkin hard-boiled (ordinary or table-top) - Cucurbita retro L., Muscat pumpkin - CucurbitamoschataDuch. Each of these species has its own peculiarities.

The areas of pumpkin cultivation in the industrial sector of vegetable growing (agricultural organizations and farms, excluding farm households) in Ukraine over the past 15 years have grown more than 3 times and make to 744,4 thousand tons for a total area of 25 thousand hectares. Pumpkin grows in Kherson, Zaporozhye, Donetsk, Mykolayiv, Odessa regions. Here are formed the most favorable soil and climatic conditions for their cultivation [1].

The cultivation of pumpkins in Ukraine is carried out in order to their further industrial processing for the production of oil and shredded pumpkin seeds. Pulp, after takingseeds, is used for livestock feed and for silage. In general, only 28% of the total amount of pulp pumpkin is sent for further processing [2]. While fetal pulp of this melon culture contains sugars, pectin, potassium salts, calcium, magnesium, iron, vitamins C, B_1, B_2, B_6, B_9, PP and provitamin A. A small amount of fiber (0,7%) and organic acids can include pumpkin in a diet with diseases of the gastrointestinal tract, and a large amount of

pectin has a particularly positive effect on inflammation of the large intestine. Since pectin promotes excretion of cholesterol, the pumpkin is very useful in atherosclerosis. Fresh pumpkin pulp improves bowel function. Pumpkin also has a diuretic effect that can be used in dietary nutrition with edema associated with cardiovascular disease, and some diseases of the kidneys and bladder. There is an ability of pectin substances to remove toxic substances and radioactive metals from the body [3].

Thus, taking into account the above nientioned, and in accordance with the "Declaration on Low-and and Non-Waste Technologies", it is necessary tostudy of the problem of processing pumpkin pulp with the further introduction of appropriate technological solutions [4]. S.O. Belinskaya, N.Ya. Orlov, AM Odarchenko, E.V. Bayludova, V.M. Golubev, V.Yu. Michalov, AV Matora, O.G. Shkodina, V.E. Korshunova, V.F. Vinnitsa, MM Tipzyna, GK Seleznev and others were engaged in food processing of pumpkin .

Among the now known methods for processing pulp of pumpkin is a method of complex processing, which involves its preparation, cutting, seed removal, blanching of pulp, its wiping and homogenization with the receipt of juice. Pumpkin juice obtained from the described technology is not in high demand due to the specific smell of boiled pumpkin.

Among the industrial methods of processing pulp of pumpkin Odarnenko O.M. patented method of producing pasta based on pumpkin and carrots, which involves the preparation of reciped components, purification and grinding of vegetables, cooking containing a spicy aromatic herbs and citric acid, wiping, mixing with reciped components, homogenizing, evaporating, followed by xanthan, re-homogenization, packing and canning. MalyukL.P. and Fetysova G.V. offer a method of making vegetable pasta from pumpkin and aronia for the processing of significant volumes of pumpkin pulp. Patented methods of production are characterized by a complex multi-stage technological process, which make the technology inadequate for implementation.

Pastushenko GV, Stoyanova O.V., Zubkova KV, Sidorchyk A.O. offer a way of preserving bits of hot puddings from pumpkin using spicy aromatic raw materials to produce pumpkin-coconut jam. Homogenized pulp is offered to preserve with the use of organic acids as preservatives by Zheplinska MM, Sheshlyuk O.S. The disadvantage of the famous recipe is an intense smell of boiled pumpkin. Boyko MM offers a way of processing

pumpkins by making pumpkin-orange confectionery from pumpkin and apples with orange peanuts, which is distinguished by the fact that it has a pleasant citrus flavor, but has a high cost. For the same reason, Kuzmenko I.O. and Orlova Ya.A. offer a method of production of pumpkin apple quinced canned goods with improved consumer properties, which are characterized by complexity of technological processing.

There are ways of processing pumpkins to produce canned foods of other dishes with vegetable supplements that have unsatisfactory organoleptic properties, and fruit canning and vegetable raw materials by freezing or drying with the formation of pumpkin powder in accordance with TU U 15.3-05417118.024-2002 "Vegetable powder from carrots, beet-roots, potatoes, cabbage, pumpkin, zucchini, onion, garlic, spinach, rhubarb, and white roots of parsley, celery, parsnip "obtained by convection-vacuum drying (mass fraction of moisture 6 ... 8%).

Among the methods of processing pumpkin pulp at non-industrial scale plants, that is, at restaurants, preserving by freezing, the production of pastes, creams and dough semi-finished products with pulp of pumpkin are used. Dessert of pumpkin-dyed frozen was patented by Belinsky S.O. and Orlova N.Ya., pumpkin pie "Sonechko" and "Berlin miracle" with filling on the basis of pumpkin paste by Antonenko A.V., custard made from pumpkin and artichoke by Lewandowski L.V. etc. [5].

It is widely known the use of pumpkin pulp as a source of pectin, as a component of culinary and confectionery dishes. However, known technologies provide the use of temperature processing of pulp at pH=4, which is achieved by the addition of organic acids, which affects the taste of products and causes a great amount of sweeteners. In this regard, the search of optimal parameters for the processing of pulp pumpkin in order to obtain a universal semi-finished product with high content of the pectin for the use in confectionery and culinary products is relevant.

One of the effective ways to solve the problem with the preservation of biologically active substances of plant material is the use of enzyme preparations (AF), as well as the cultivation of microorganisms. Treating pumpkin with enzyme preparations increases the amount of pectin.

O.A. Markina, AV Matora, O.G. Shkodina, V.E. Korshunova were engaged in The problem of enzymatic processing of pulp of pumpkin. The application of enzymes produced

by microorganisms of the genus Bacillus. According to these scientists, can increase the yield of pectin by 30-35% while preserving the environmental quality of the process of its obtaining. A known technical solution is a method for producing pectin consisting of cultivating Bacillus species on the substrate of microorganisms, further mixing the hydrolyzate with vegetable pectin containing material, extracting the mixture and isolating the soluble pectin. At the same time, despite the high degree of environmental friendliness of the process, it is advisable to ferment the plant material without removing pectin from its composition, and subsequently using it as a product with high content of pectin [6].

Thus, the way of recycling of secondary raw materials is promising in order to obtain a product based on pumpkin with a high content of pectin.

The purpose of this article is to investigate the kinetics of enzymolysis of pectin substances under the action of the enzyme preparation Vetom 1.1 depending on the influence of technological factors.

Materials and methods

For the study was selected muscat pumpkin - Cucurbita moschata Duch. The Butternut variety, which is widely usedin the trading network and has excellent organoleptic qualities, and large-flowered or Greek pumpkin - Cucurbita Duch Tahiti. Ukrainian multibread variety, grown for the purpose of obtaining seeds and pumpkin oil.

The following temperature storage regimes have been applied to pumpkin samples: +8…+10˚C and -16…-18˚C.

The research was conducted for 10 months after the harvest of 2016.

Samples of pumpkin puree were subjected to the directed action of Vetom 1.1 based on an enzyme produced by bacteria of the genus Bacillus subtilis. The introduction of an enzyme preparation, which exists in the form of a powder, was carried out by dissolving it in a liquid fraction, separated unilaterally in the preparation of mashed pumpkin, followed by the connection of liquid and solid fractions.

The content of soluble pectin in the experimental samples was determined by the standard calcium-pectate method [7]. Statistical and mathematical methods of data processing were used to process the results of experimental studies.

Results and discussion

The samples of mashed pumpkin pulp, which were subjected to enzyme treatment, were studied. The grinding of heat-treated pulp of pumpkin with the formation of mashed pumpkin having homogeneity of the consistence is due to the fact that pectin substances are localized in different parts of the fruit unevenly.

The technological process of obtaining puree from pumpkin with high content of pectin involves a number of technological steps: inspection, washing and cleaning, cutting with a cube with a rib size $(0{,}8\ldots1)\cdot10^{-2}$m, followed by thermal steam treatment at a temperature of 110±2˚C during $(20\ldots25)\cdot60$s, followed by grinding at a temperature of 80±2˚C and followed by heat treatment at a temperature of 75±5˚C for $(6\ldots7)\cdot60$c [8].

Activity of the preparation on the basis of the enzyme produced by the bacteria of the genus Bacillusubtilis, according to A. A. Matori, A. Shkodina, A. V. Korshunova. and Ptichkina N.M. is the maximum pH value of the medium approaching pH=7,5 [6]. At the same time, in her studies Yudina TI, the technology of temperature processing of pumpkin pulp which is based on our studies, recommends the introduction of citric acid for acidification of the medium in order to intensify the process of transition of protopectin to soluble pectin (RP) [8] . According to the fact that in the acidic environment the action of the enzyme preparation Vetom 1.1 is inhibited, then the citric acid was not introduced in the mashed pumpkin from the pulp of the pumpkin, maintaining a neutral or slightly alkaline pH medium.

The variability of the parameters of obtaining a product with high content of pectin determined the need to study the kinetics of fermentolysis, depending on the duration and temperature regime, the amount of enzyme preparation Vetom 1.1, from the pomological variety of pumpkin and from the temperature regimes of its storage.

Thus, in the process of storing pumpkin fruits of various sorts, the total amount of pectin substances is significantly reduced from the initial content at different storage temperatures. The undamaged fruit of the pumpkin is usually stored at +8...+10˚C, while the fruits with broken integrity of the outer shell are kept at -18...-16˚C. Thus, freezing contributes to a better preservation of food and biologically active substances and the uninterrupted supply of restaurant facilities with raw materials in comparison with traditional ways of preserving the pumpkin with whole fruits, which is economically

unprofitable due to the need to keep fruit at constant temperature in the warehouse, and in the form segments in the treezers, which is inappropriate due to relatively short storage periods [9]. That is why it is relevant to study the process of fermentolysis in samples of pumpkin, which were kept at -18...-16˚C and at +8...+10˚C.

Thus, as the dynamics of the change in the total amount of pectin substances in the pumpkin fruit of the studied pomological grades varies in different temperature regimes, the content of RP (%) was determined depending on this indicator. The results of the studies are presented in Table 1.

Table 1

Total content of pectin substances in different storage modes

Grade	Time Analysis	Storage mode	
		+8…+10˚C	-18…-16˚C
Pumpkin nutmeg Butternut	October	1,06	0,81
	March	1,29	0,79
Large-fruited pumpkin variety Ukrainian multi-breeding	October	1,07	0,79
	March	1,15	0,78

As we can see from the table, the quantitative changes in the content of pectin substances in the pumpkin fruit are characteristic of both botanical varieties. During the storage period, the amount of pectin increases at a temperature storage temperature of +8…+10˚C, which is accompanied by the transfer of protopectin into the form of soluble pectin. At the same time, at low temperature storage, pectin passed into a solution of intercellular fluid and was removed in the process of defrosting. Thus, samples of pumpkin pulp, which were to be stored at low temperatures, had a lower content of pectin substances by 40-47% than when stored at +8…+10˚C.

In addition, it can be seen from Table 1, the quantitative content of pectin substances also depends on the variety of pumpkin. In this regard, for the study the were selected, samples of the most popular varieties of pumpkin: dinnerware Batternat (Butternut) and breeding Ukrainian variety fertilizer [10].

In connection with the above mentioned, in the first stage of the study, the effect of the enzyme preparation was directed to experimental samples of pumpkin, which were stored at +8…+10˚C and -18...-16˚C (Fig. 1).

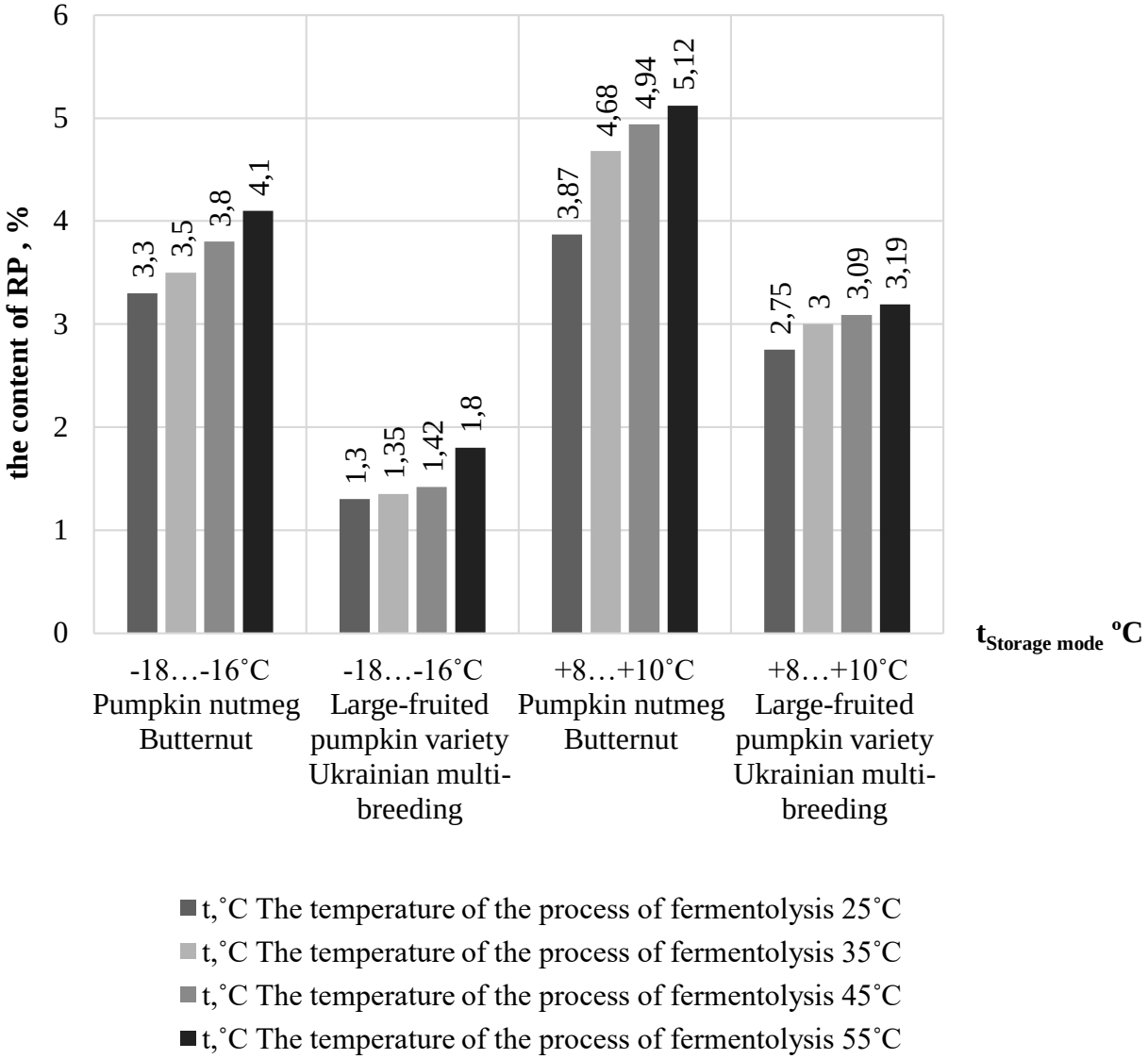

Fig.1The kinetics of formation of RP (%) depending on storage (ºC)

According to the results of the conducted researches (fig.1) it was proved, that the content of soluble pectin (RP) is increased unevenly in the same samples of pumpkin at different temperature storage parameters. This phenomenon is typical for both the table variety of pumpkin and forage. So, for a pumpkin variety, the Ukrainian large-fruit plant has an increase in the content of RP by 70% when stored at temperatures +8…+10˚C compared with the results obtained for long-term storage at -18...-16˚C. Similarly, an increase in the content of RP by 25% in samples of pumpkin of the Batternat variety was observed at temperatures +8...+10˚C in comparison with the temperature regime -

18...-16˚C. The resulting content of soluble pectin in the experimental samples varies depending on the variety in 1,3-2,5 times.

The next stage of the study was to establish an optimal temperature regime for the process of fermentolysis. During the study, the samples were thermoformed in cabinets with a constant temperature of 25˚C, 35˚C, 45˚C and 55˚C. These temperature regimes are selected taking into account the recommended values of the activity temperature of the enzyme produced by bacteria of the genus Bacillus tubilum [6].

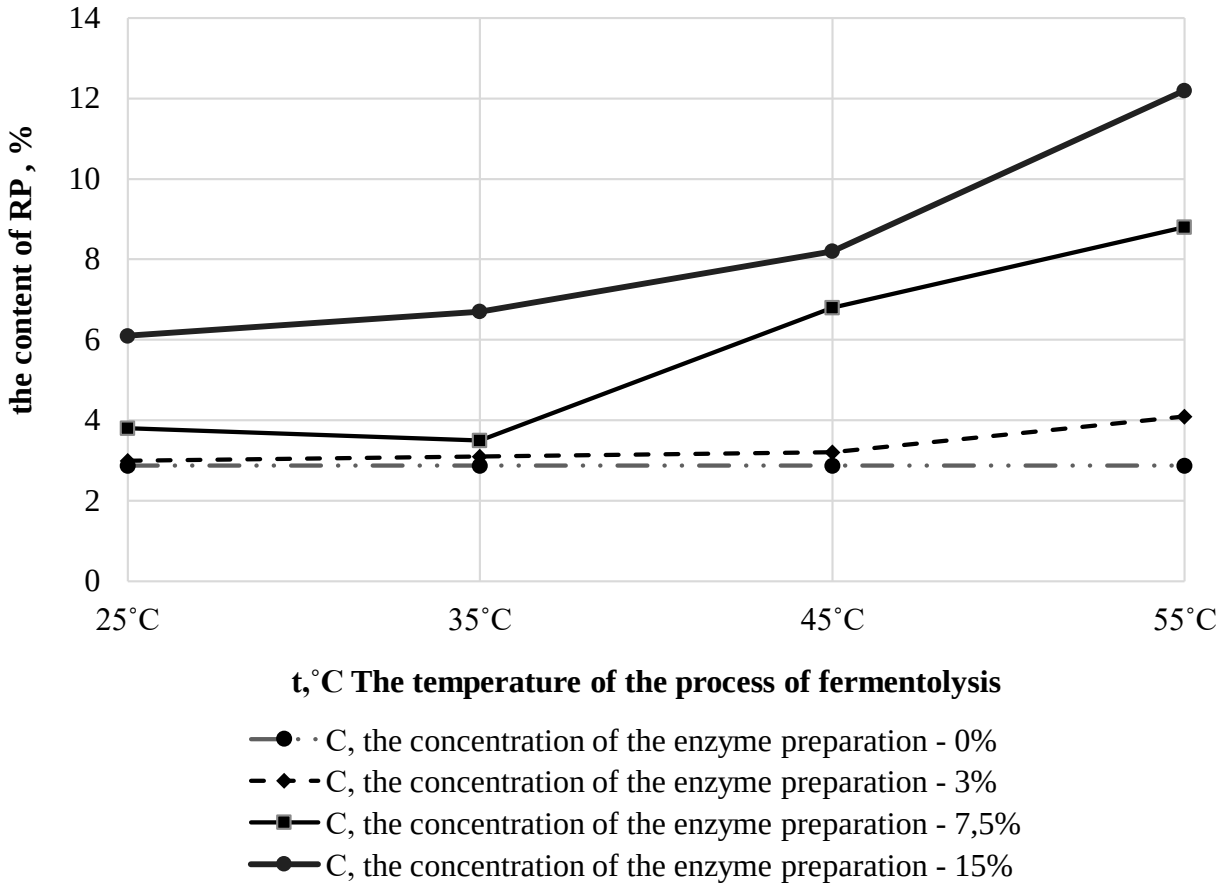

Fig.2 The kinetics of formation of RP (%) depending on the temperature of the process of fermentolysis (t, ºC)

From Fig. 2 it is evident that the temperature indices directly influence the process of fermentolysis. Thus, at a temperature of 55°C, the initial product contains the highest amount of RP (%) for all concentrations of the prepared Vetom 1.1. Since the growth of the concentration of soluble pectin is characteristic for all samples of both varieties of pumpkin and all concentrations of the enzyme used, for a greater clarity, the results of the study are taken from one type of process in the dynamics of temperature changes.

In addition, the samples with fermentation process was at a temperature of 55°C, were characterized by excellent organoleptic characteristics, in particular, the color and homogeneity of the consistency (Table 2).

Table 2

Organoleptic characteristics

<table>
<tr><th rowspan="2">Sort</th><th colspan="4">Temperature mode</th></tr>
<tr><th>25 ºC</th><th>35 ºC</th><th>45 ºC</th><th>55 ºC</th></tr>
<tr><td>pumpkin Muscat Butternut (Butternut)</td><td rowspan="2">The consistency is not homogeneous, with pronounced separation of dispersed phases, the pronounced aroma of pumpkin</td><td rowspan="2">Consistency is not homogeneous, with pronounced separation of dispersed phases, bright orange color, pronounced aroma of pumpkin</td><td rowspan="2">Consistency is homogeneous, bright orange, light pumpkin aroma.</td><td rowspan="2">Consistency is homogeneous, tender, bright orange, light pumpkin aroma.</td></tr>
<tr><td>Ukrainian pumpkin large-fruited variety</td></tr>
</table>

The homogeneity of the purée consistency is explained by the high emulsifying capacity of pectin substances belonging to the group of low and medium-eutrophy. The stability of the formed emulsions is due to the mechanical strength of the interphase adsorption layer, which does not collapse as a result of heat treatment. Therefore, it is projected that organoleptic parameters will improve with increasing content of soluble pectin as a result of enzymatic treatment of mashed pumpkin. Therefore, it is necessary to follow the dependence of an increase in the percentage of content of pectin substances depending on the introduced concentration of the enzyme preparation (Fig. 3).

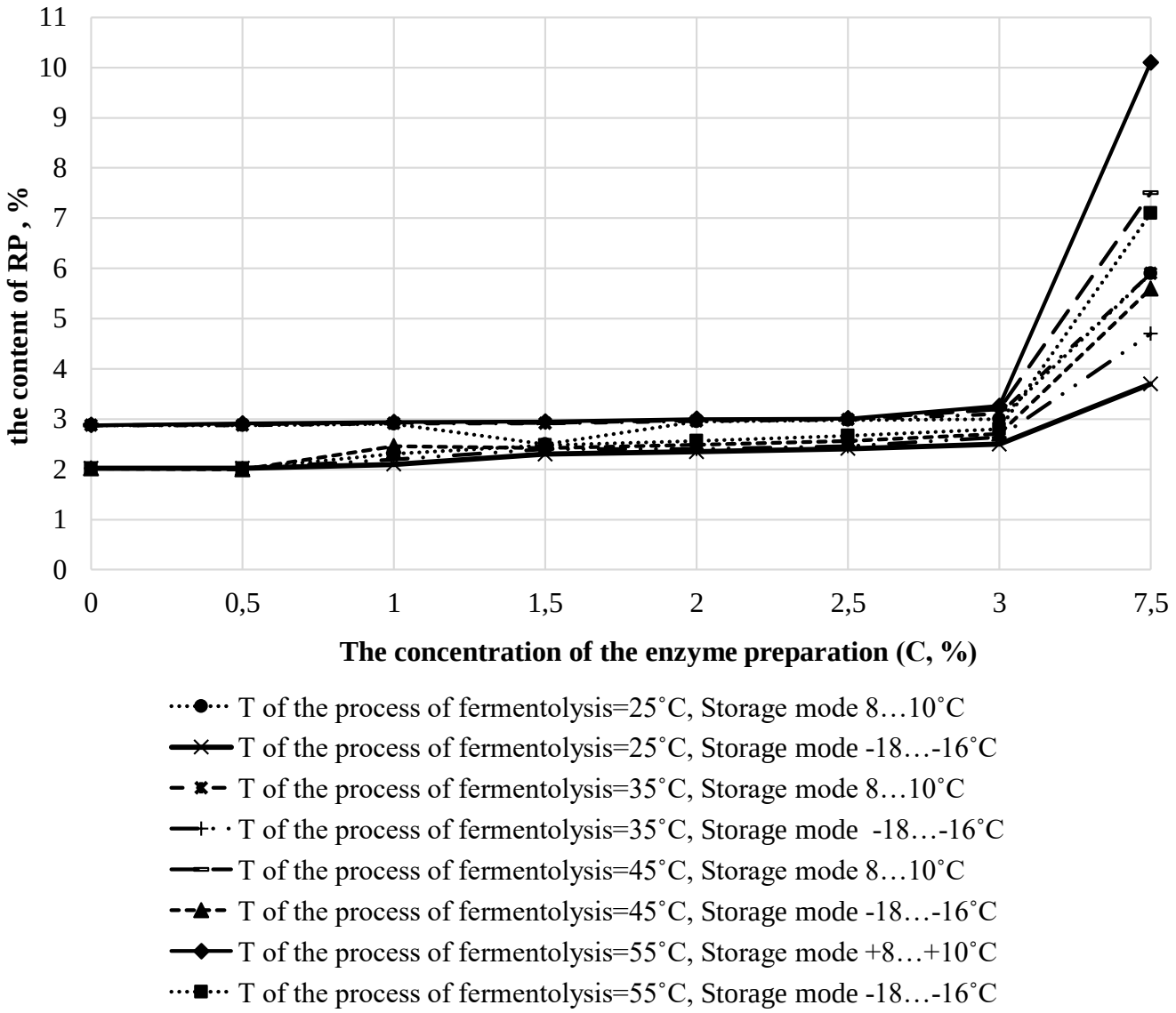

Fig. 3 The kinetics of formation of RP (%) depending on the concentration of enzyme preparation (C,%)

As can be seen from Fig. 3, a significant increase in the content of soluble pectin is observed when the concentration of the enzyme preparation is more than 3%. The use of an enzyme preparation in an amount less than 3% is inappropriate, in connection with the equalization of the benefits of reducing the cost of purchasing an enzyme preparation due to a significant increase in labor intensity, duration, energy efficiency of the process. On the other hand, taking into account the economic index, it is inappropriate to use the enzyme preparation in the amount of 15%, which leads to a significant increase in the cost of the original product with a slight increase in the content of soluble pectin compared with samples with a concentration of 7,5% of the enzyme preparation.

In order to determine the optimal duration of the process of fermentolysis, the change in the content of soluble pectin from the time process of fermentation was in vestigated (Fig. 4). So, Matora AV, Shkodina O.G., Korshunova V.E. and Ptichkina NM, the development of which is concerned with increasing the completeness of the yield of purified pectin from plant material in mild conditions, has established that the maximum amount of soluble pectin is observed during 15 hours. Therefore, it is advisable to investigate the effect of the formation of soluble pectinous pulp from pumpkin pulp as a result of treatment with a preparation based on microorganisms of the species BacillusSubtilis during the recommended 15 hours. To determine the activity limits of the enzyme preparation, the duration of the study is chosen in the range of 1 hour and 24 hours.

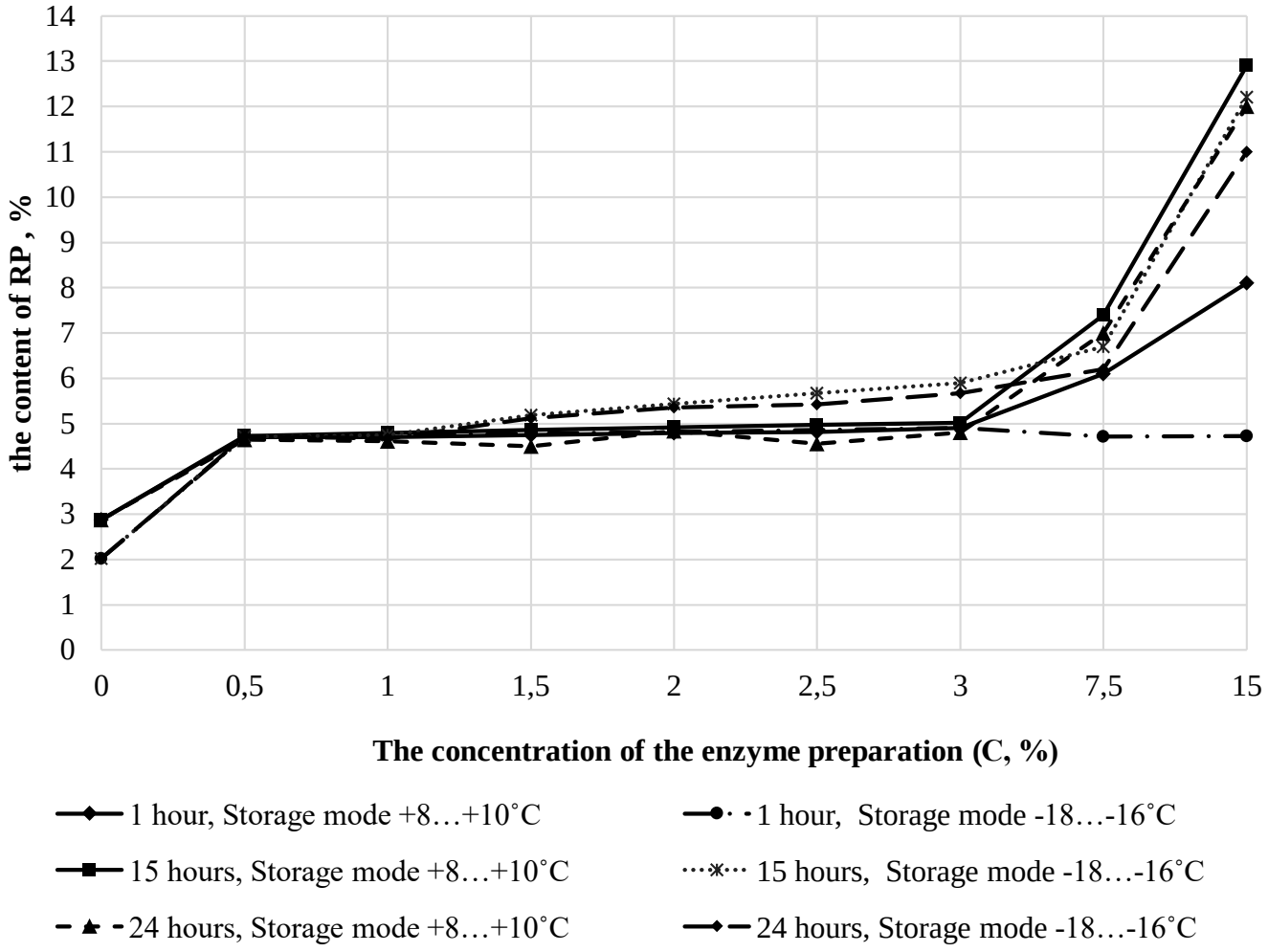

Fig. 4 The kinetics of formation of RP (%) depending on τ (h)

As can be seen from the diagram of increasing the duration of the enzymatic process, there is a decrease in the content of RP in the product under study. This is due to the rapid degeneration of microorganisms and the ability to use pectin, which reduces the yield of the ready product. In addition, 24 hours research is characterized by a high level of labor

intensity and has a higher cost than conducting studies lasting 15 hours and 1 hour. Results obtained after contact of the product with the enzyme preparation for 1 hour indicate a short-term effect of inefficiency.

Conclusion

Thus, the optimal parameters of the process are: 55°C, 15 hours, 7,5%. The trends confirmed that the increase in the duration of fermentolysis, even in the presence of unfavorable starting characteristics of the product, shows a significant increase in the content of RP (%) in the studied samples of pumpkin puree . The duration of fermentolysis should be within 15 hours, since during the 24-hour process the pectin content in the samples decreased. In addition, the resultant content of RP (%) in the source product is influenced by the storage mode and the quality of the pumpkin. Because low-temperature storage significantly slows down the formation of the RP (%) and negatively affects its resulting output. That is why, in this case, the enzymatic processing of pulp of the pumpkin is most appropriate, because after picking the seeds from the fruit of the pumpkin, its outer shell is damaged, which makes it impossible to store the fruit of the pumpkin at another. temperature modes differ from low temperature. At the same time, considering the effectiveness of the enzyme preparation on samples of pumpkin stored at +8...+10ºC and excellent organoleptic parameters, it is possible and appropriate to use the drug to the fruits immediately after harvesting. The conducted studies have shown the possibility of obtaining pectin substances from pumpkin pulp and the ability to predict its further use in the food industry.

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