UDC 340.50-050.90)
DOI https://doi.org/10.37734/2518-7171-2022-3-6

DEPENDENCE OF LACTOBACILLI ACTIVITY ON THE CONCENTRATION OF SUGAR IN THE SUBSTRATE

N. V. ROHOVA, Candidate of Technical Sciences, Associate Professor;
O. V. VOLODKO, Candidate of Technical Sciences, Associate Professor;
Ya. M. BYCHKOV, Candidate of Technical Sciences, Associate Professor
(Poltava University of Economics and Trade)

Abstract. *The purpose of the article was to extend the shelf life of birch sap and the time of its processing by pre-fermentation of birch sap with pure crops Lactobacillus casei ssp. alactosus.*

The disadvantage of the existing method of production of birch sap is that the newly collected birch sap must be immediately sent for processing, because short-term storage for no more than 24 hours is allowed only in chilled rooms at a temperature of 0 to 5 0C and a relative humidity of not more than 75 %.

In case of violation of these conditions, turbidity of the juice appears, acidity increases and spontaneous fermentation of the juice begins, which has significant flaws.

The sugar content in birch sap is relatively low. Since the fluctuations in the sugar content of fresh juice are quite significant, it was necessary to identify the activity of its costs during the fermentation process.

Research methodology. *The activity of lactobacilli was determined by measuring the loss of dry soluble substances in the juice during fermentation and the accumulation of titrated acids in terms of lactic acid.*

Results. *Fluctuations in sugars depending on weather conditions and place of cultivation range from 0.5 to 0.9 %. The final product of sugar fermentation with lactobacilli, as already noted, is mainly lactic acid and other substances (acetic acid, ethyl alcohol, carbon dioxide, dextrin, mannitol) in small quantities.*

The term fermentation of birch sap to the desired lactic acid content can be adjusted by adding a certain amount of sugar to it. According to the derived regression equations, it is possible to predict on which day and at what concentration in the juice the desired acidity will be.

The concentration of titrated acids in terms of lactic acid changed during the entire fermentation period, which occurred in rectilinear dependence, which is confirmed by the correlation coefficients

Conclusions. *To activate lactic fermentation with a small amount of sugar, it should be added to freshly harvested birch sap.*

Key words: *Juices, natural juices, raw material processing technology, canning, concentrated (condensed), dried vegetable juices, pigmented juices, blended juices, fermentation.*

Formulation of the problem in general and connection with the most important scientific or practical tasks. The activity of lactobacilli was determined by measuring the loss of dry soluble substances in the juice during fermentation and the accumulation of titrated acids in terms of lactic acid.

The sugar content in birch sap is relatively low. Its fluctuations depending on weather conditions and place of cultivation range from 0.5 to 0.9 %. The final product of the fermentation of sugars with lactobacilli, as already noted, is mainly lactic acid and other substances (acetic acid, ethyl alcohol, carbon dioxide, dextrin, mannitol) in small quantities [5].

Since the fluctuations in the sugar content in fresh juice are quite significant, it was necessary to identify the activity of its costs during fermentation.

Therefore, the term fermentation of birch sap to the desired content of lactic acid can be adjusted by adding a certain amount of sugar to it. According to the derived regression equations, it is possible to predict on which day and at what concentration in the juice the desired acidity will be.

Table 1

Dynamics of lactic acid accumulation

Concentration sugar, %	Titrated acidity, %, after fermentation (days)				
	1	2	3	4	5
0,1	0,02	0,05	0,07	0,1	0,22
0,2	0,02	0,08	0,10	0,21	0,34
0,3	0,02	0,11	0,14	0,3	0,47
0,4	0,02	0,24	0,27	0,36	0,62
0,5	0,02	0,17	0,19	0,4	0,70
0,6	0,02	0,20	0,22	0,47	0,80
0,7	0,02	0,22	0,25	0,5	0,90
0,8	0,02	0,25	0,28	0,62	1,0
0,9	0,02	0,28	0,32	0,7	1,1
1,0	0,02	0,37	0,46	0,82	1,2

The concentration of titrated acids in terms of lactic acid changed during the entire fermentation period, which occurred in a rectilinear relationship, which is confirmed by correlation coefficients: R^2= 0.98 and 0.99 and dry matter losses (Fig. 1).

As can be seen from the Fig. 2, on the first and second day of fermentation, the activity of vital activity

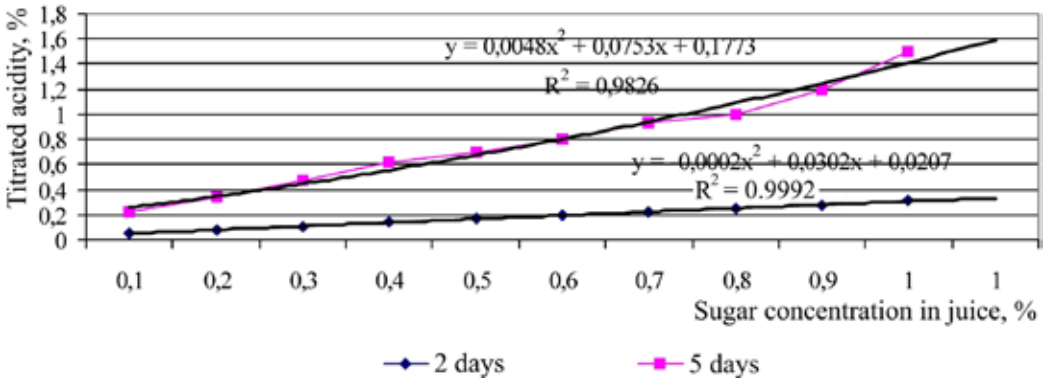

Fig. 1. Dynamics of accumulation of lactic acid (according to the content of titrated acids) depending on the concentration of sugar in the substrate

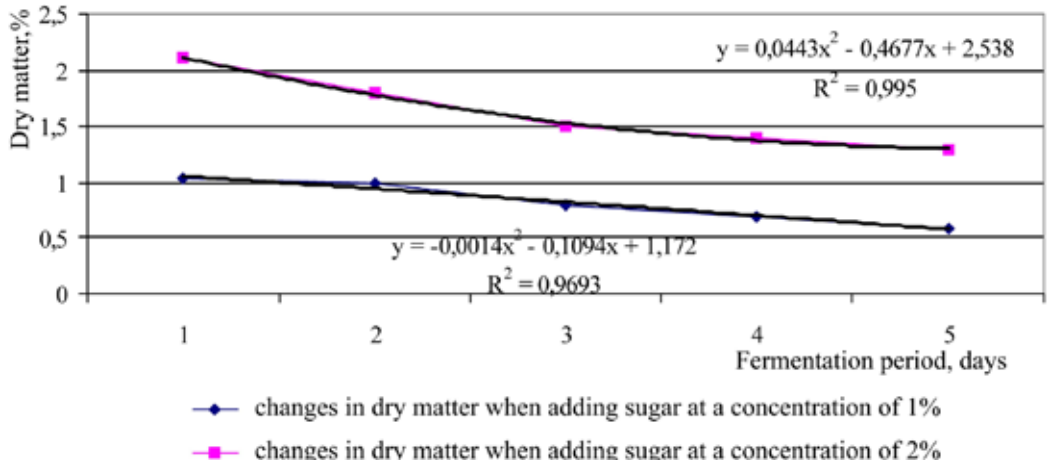

Fig. 2. Dynamics of changes in dry soluble substances during fermentation

of lactobacilli is much higher than in subsequent days, as evidenced by a decrease in the concentration of dry soluble substances due to the metabolization of sugars. They make up 70.4%, and on day 5 – only 58% of their original content. With an increase in the concentration of sugar in the substrate, the activity of vital activity of lactic acid bacteria increases. If in a substrate with a sugar concentration of 1% the loss of dry soluble substances on the fifth day is 34%, then at a concentration of 2%, they increase to 39% due to the conversion of sugar to acid.

Therefore, to activate lactic fermentation with a small amount of sugar, it should be added to freshly harvested birch sap.

Analysis of recent research and publications. The study of the issue found out that there is significant potential for domestic producers of juices and juice drinks, the use of which is limited by such factors as the low level of purchasing power of Ukrainian consumers and the growth of competition in this segment of the commodity market and modern technologies for harvesting raw materials for the production of birch sap from increased period of its preservation and justification of recommendations for the production of new types of natural blended juices based on fermented birch sap because the processing industry until recently used only freshly produced birch sap for canning. Healing product of birch is stored only 3-4 days.

Formulation of the objectives of the article (statement of the problem). It is known that both high and low temperature values affect the development of bacteria. However, low – before freezing – they carry, and elevated – after 45°C – lead to a lethal reaction [1, 2].

Some authors believe that homofermen-tative mesophilic lactobacilli reach the most active development at a temperature of about 30°C, while others consider the Tien fig.

Fig. 3 shows the direct correlation of the effect of temperature on the time of fermentation of birch sap. mperature to be 16...18°C to be optimal [3].

At a higher temperature, the fermentation period of a certain amount of substrate occurs much faster than at low temperatures. Therefore, depending on the production needs, it is possible to adjust the fermentation process by the temperature factor.

Experiments to determine the effect of temperature on the period of fermentation of birch sap confirmed

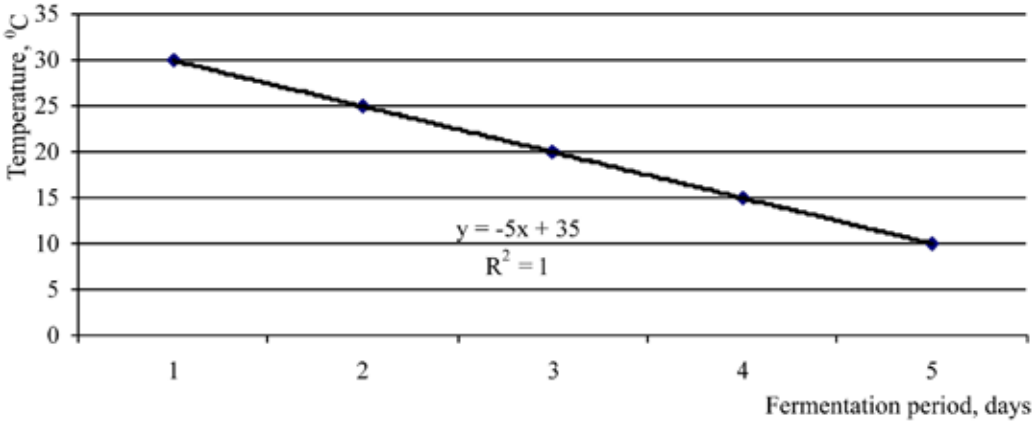

Fig. 3. The effect of temperature on the period of fermentation of birch sap

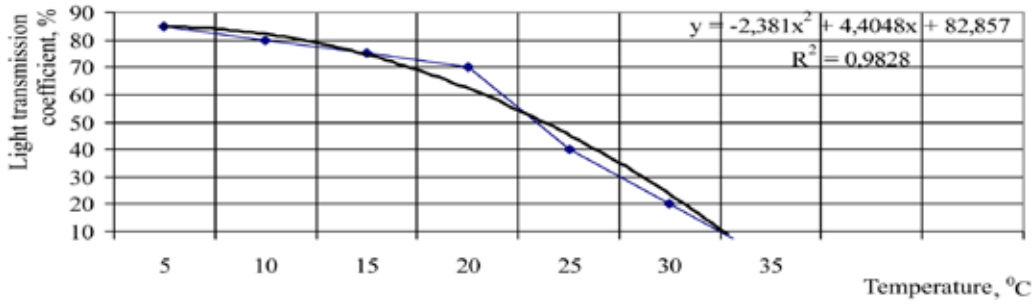

Fig. 4. The effect of fermentation temperature on the transparency of fermented birch sap

the conclusions of those researchers who recommend lower temperatures. Yes, in fig. 3. It can be seen that the fermentation period increases by one day with a decrease in temperature by 5°C. At the same time, the accumulation of lactic acid (by titrated acidity) increases to 0.35 – 0.45 %. In addition, the appearance of the juice, fermented at temperatures of 30^0C and 25^0C, was less attractive than at lower temperatures due to turbidity. This can be explained by the fact that with more active (rapid) fermentation, the amount of lactobacilli increases and enzymatic reactions do not end.

The advantages of rapid lactic fermentation include only a reduction in its term, the disadvantages – and, as noted in the literature, deterioration of aroma, turbidity, formation of mucous substances [4].

The effect of fermentation temperature on the transparency of fermented birch sap is reflected in (Fig. 4).

From the regression equation it can be seen that there is an inverse relationship between the fermentation temperature and transparency with a correlation coefficient of 0.98.

Consequently, the quality of fermented products, as a rule, at high fermentation temperatures is much worse than at low. This fact is explained by the fact that under the influence of lactic acid, more rapid changes in the pH of the medium occur.

Results. The aim of scientific research was to extend the shelf life of birch sap and the time of its processing by carrying out the preliminary fermentation of birch sap with pure cultures Lactobacillus casei ssp. alactosus. Therefore, according to our research, the technology of fermented birch sap has the following stages [5].

Natural birch sap is delivered to enterprises in containers into which it is drained during collection. Birch juice is collected in glass jars with a capacity of not more than 10 dm^3 or juicers made of polymeric materials authorized by the Ministry of Health for contact with food. Then the juice is poured into wooden barrels with a capacity of 50dm^3, 100dm^3, 150$dm^{3.}$, 200dm^3, metal flasks for milk and dairy products, tankers for food. Juice is drained through filters in two layers of gauze or filter synthetic fabrics.

Processing of juicers, containers and auxiliary materials is carried out in accordance with the standards.

Juice submitted for processing is sent for pasteurization at a temperature of (80 ± 2)°C, for (10 ± 1) minutes in heat exchangers or cooking boilers.

Fermentation is carried out in containers filled under the lid with, juice to prevent the development of mold fungi and membranous yeast. days at a temperature of (25±1)°C. Sowing material is

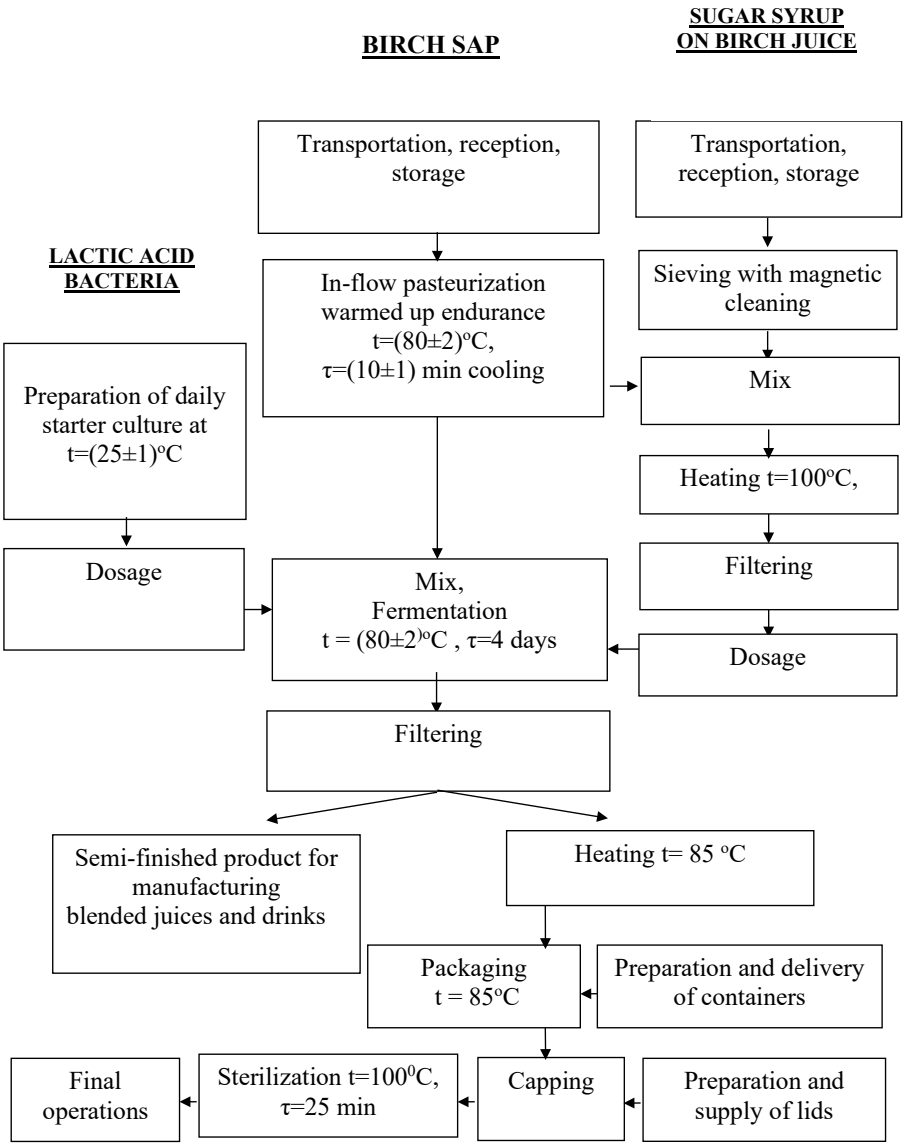

Fig. 5. Technological scheme of production of fermented birch sap

introduced in the amount of 0.3% of the volume of juice. Juice is stored at room temperature in hermetically sealed containers, protecting against the ingress of foreign microorganisms and relative humidity of 75% [4].

When the total acidity of 0.3 - 0.6% is reached in the juice, it can be transferred for processing within three months.

Before serving, the juice is filtered through two layers of gauze or filter cloth and fed to the centrifugation in separators or filtered through filter presses.

Filtering on filter presses is carried out at a pressure of 40...160 kPa through filter cardboard brand T. The first portion of juice, which is turbid, is collected separately and filtered a second time after settling [3].

The technological scheme for the manufacture of fermented birch sap is shown in Fig. 5.

Conclusions. The selected technological methods and substantiated parameters of the processes, investigated the regularities of the kinetics of lactic acid accumulation by the selected strains of ICD.

The technology of production of birch sap fermented by lactic acid bacteria has been developed. Pasteurized at a temperature of (80±2)°C for (10±1) minutes. and cooled to room temperature birch sap made 0.3% seeding material and stored at room temperature (20±1)°C in hermetically sealed containers, protecting it from the ingress of aerobe microorganisms – membranous yeast and mold fungi.

BIBLIOGRAPHY

1. Rogova N.V. Manufacture technology of fermented birch sap and new combined products based. Actual problemsof the world today : materials of collective monograph. London, 2019. P. 252–267.

2. Рогова Н. В., Кущ Л. І. Раціональні параметри процесу ферментування натуральних соків. *Науковий вісник Полтавського університету економіки і торгівлі. Серія «Технічні науки».* 2020. № 1(96). С. 30–38.

3. Rogova N.V. Manufacture technology of fermented birch sap and new combined products based. Actual problems of the world today: Materials of collective monograph / Rogova N.V., Volodko O.V. London, 2019. P. 252–267.

4. Дослідження біологічної активності ферментованого березового соку / Н. В. Рогова, В. В. Кожухар, Л. М. Пилипенко, Я. Б. Паулина. *Вісник ХНТУСГ ім. П. Василенка «Сучасні напрями технології та механізації процесів переробних і харчових виробництв».* 2006. Вип. 45. С. 371–376.

5. Рогова Н. В. Вплив температури на термін ферментування і прозорість березового соку. Нові технології і обладнання харчових виробництв : міжвуз. наук.-практ. семінар. (19 квіт. 2018 року). Полтава : ПУЕТ, 2018. С. 21–23.

REFERENCES

1. Rogova N.V. (2019). Manufacture technology of fermented birch sap and new combined products based. Actual problems of the world today : Materials of collective monograph. London, 2019. P. 252–267 [in English].

2. Rohova N. V., Kushch L. I. (2020). Ratsionalni parametry protsesu fermentuvannia naturalnykh sokiv [Rational parameters of the fermentation process of natural juices]. Naukovyi visnyk Poltavskoho universytetu ekonomiky i torhivli. Seriia «Tekhnichni nauky». 2020. № 1(96). S. 30–38. [in Ukrainian].

3. Rogova N.V. (2019). Manufacture technology of fermented birch sap and new combined products based. Actual problems of the world today : Materials of collective monograph / Rogova N.V., Volodko O.V. London, 2019. P. 252–267.

4. Doslidzhennia biolohichnoi aktyvnosti fermentovanoho berezovoho soku [Study of the biological activity of fermented birch sap]. N. V. Rohova, V. V. Kozhukhar, L. M. Pylypenko, Ya. B. Paulyna. (2006). Visnyk KhNTUSH im. P. Vasylenka «Suchasni napriamy tekhnolohii ta mekhanizatsii protsesiv pererobnykh i kharchovykh vyrobnytstv», 45. 371–376.

5. Rogova N.V. (2018). Vpliv temperaturi na termin fermentuvannja i prozorist' berezovogo soku [The effect of temperature on the fermentation period and the transparency of birch sap]. Novi tehnologiї i obladnannja harchovih virobnictv : mizhvuz. nauk.-prakt. semin. (Poltava, 19 kvitnja 2018 roku). PUET, 21–23.

Н. В. Рогова, *кандидат технічних наук, доцент;* ***О. В. Володько,*** *кандидат технічних наук, доцент;* ***Я. М. Бичков,*** *кандидат технічних наук, доцент (Полтавський університет економіки і торгівлі).*

Залежність активності лактобацил від концентрації цукру в субстраті

Анотація. *Мета статті. Подовжити термін зберігання березового соку і час його переробки, провівши попереднє ферментування березового соку чистими культурами Lactobacillus casei ssp. alactosus.*

Недоліком існуючого способу виробництва березового соку є те, що щойно зібраний березовий сік необхідно одразу направляти на переробку, тому що короткочасне зберігання на протязі не більше 24 годин дозволяється тільки в охолоджених приміщеннях при температурі від 0 до 5°С і відносній вологості повітря не більше 75 %.

При порушенні даних умов з'являється помутніння соку, підвищується кислотність і розпочинається спонтанне бродіння соку, яке має відмічені суттєві вади.

Вміст цукрів у березовому соку відносно невисокий. Оскільки коливання вмісту цукру у свіжому соку досить значні, було необхідно виявити активність його витрат в процесі бродіння.

Методика дослідження*. Активність лактобацил, визначали шляхом вимірювання втрат сухих розчинних речовин у соку в процесі бродіння та накопичення титрованих кислот в перерахунку на молочну.*

Результати. *Коливання цукрів в залежності від погодних умов та місця вирощування становлять від 0,5 до 0,9 %. Кінцевим продуктом зброджування цукрів лактобацилами, як вже зазначали, є в основному молочна кислота та інші речовини (оцтова кислота, етиловий спирт, вуглекислий газ, декстрин, манніт) в незначних кількостях.*

Термін ферментування березового соку до бажаного вмісту молочної кислоти можна корегувати шляхом додавання в нього визначеної кількості цукру. За виведеними рівняннями регресії можна прогнозувати на який день і при якій концентрації в соку буде бажана кислотність.

Концентрація титрованих кислот у перерахунку на молочну змінювалась протягом всього періоду бродіння, який відбувався у прямолінійній залежності, що підтверджується коефіцієнтами кореляції

Висновки*. Для активізації молочнокислого бродіння з незначною кількістю цукру його слід додавати у свіжозібраний березовий сік.*

Ключові слова: *соки, натуральні соки, технологія переробки сировини, консервування, концентровані (згущені), висушені рослинні соки, пігментовані соки, купажовані соки, ферментація.*