UDC: 663.533

EFFECT OF THE CONCENTRATION OF DRY MATTER IN WORT ON THE CHARACTERISTICS OF OSMOPHILIC ALCOHOLIC RACES OF YEAST

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DOI: https://doi.org/10.15673/fst.v15i1.1967

Article history

Received 14.08.2020
Reviewed 22.10.2020
Revised 12.12.2020
Approved 03.02.2021

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Cite as Vancuver style citation

Kovalchuk S, Mudrak T. Effect of the concentration of dry matter in wort on the characteristics of osmophilic alcoholic races of yeast. Food science and technology. 2021;15(1):54-62. DOI: https://doi.org/10.15673/fst.v15i1.1967

Цитування згідно ДСТУ 8302:2015

Kovalchuk ., Mudrak T. Effect of the concentration of dry matter in wort on the characteristics of osmophilic alcoholic races of yeast // Food science and technology. 2021. Vol. 15, Issue 1. P. 54-62 DOI: https://doi.org/10.15673/fst.v15i1.1967

Abstract. The main factors of the influence of the culture medium on the growth and development of different races of distiller's yeast have been studied. To study how the dry matter concentration of the wort effects on the morphophysiological features of distiller's yeast cells, the following *S. cerevisiae* races were selected: DO-16, DO-11, K-81, and XII. The novelty of the work consists in studying how the dry matter concentration of the wort effects on the morphophysiological features of distiller's yeast and in screening alcoholic races for fermentation of highly concentrated wort. There are not enough research data on the morphology of cells of alcoholic races of the yeast *S. cerevisiae* cultured on a starch-containing medium. It has been found that the cells of the races *S. cerevisiae* DO-16 and DO-11 were smaller than those of the thermotolerant and mesophilic *S. cerevisiae* races K-81 and XII at the DM concentration of the wort 28%. However, the *S. cerevisiae* races DO-16 and DO-11 have larger quantities of yeast cells. During fermentation of the highly concentrated wort, these parameters characterise the increase of the working surface of the yeast in the fermented medium, which allows intensifying the fermentation process. It has been studied how the dry matter concentration effects on the size and shape of giant colonies of alcoholic races of yeast. The culture samples were taken in the stationary growth phase. The studies of the giant colonies of alcoholic yeast races cultured on wort with the DM concentration 28% indicate that the *S.cerevisiae* race DO-16, unlike other races, can withstand high concentrations of wort. The size and shape of the giant colonies of this race indicate that the yeast cells are in a satisfactory physiological condition. To ferment the highly concentrated wort, the distiller's yeast of the races *S.cerevisiae* DO-16, DO-11, K-81, XII, with thermotolerant and osmophilic properties, has been screened according to its morphophysiological characteristics. Based on the theoretical and experimental studies, it has been found that the morphophysiological characteristics of the yeast race *S.cerevisiae* DO-16 obtained by selection make it superior to the races DO-11, K-81, XII in fermentation of the highly concentrated wort. Thus, to ferment highly concentrated wort from grain raw materials, *S.cerevisiae* DO-16, a highly productive race of distiller's yeast with increased osmophilicity, has been selected.

Keywords: distiller's yeast, culturing, highly concentrated wort, dry matter.

Introduction. Formulation of the problem

An urgent problem of the alcohol industry is selection and screening of new races of alcohol yeast that are highly productive in relation to ethanol and have thermotolerant osmophilic properties [1]. Studying the cultural, morphological, physiological, and biochemical features allows selecting yeast races to ferment of the wort of high concentrations, in particular, to produce bioethanol [2-4]. The morphophysiological state of yeast cells reflects the changes of the conditions in the culture medium [5-7]. The studies presented in the article are related to biotechnology of alcohol.

Analysis of recent research and publications

Alcoholic fermentation can bintensified using osmophilic, thermotolerant, acid-resistant races of distiller's yeast [8-10]. The use of high-performance

distiller's yeast strains is the basis of resource-efficient and energy-saving technologies, a way to reduce the cost of ethyl alcohol and increase its profitability [11,12].

To ferment grain wort, Ukrainian distilleries use yeast races called saccharomycetes. However, they are not effective enough for alcohol production when the wort is high in dry matter. A disadvantage of using dry distiller's yeast is its high cost and unstable quality characteristics. Scientists from different countries are breeding new high-yielding yeast *S. cerevisiae* with strains that differ in the intensity of wort fermentation and yield more biomass [13].

In order to obtain high-yielding industrial yeast breeds, selective breeding of new races with osmophilic, thermotolerant, and acid-resistant properties is carried out [13-15].

The use of highly productive races of alcoholic yeast is one of the most effective ways to intensify ethanol production. Modern science is searching for possible ways to increase fermentation efficiency in the following directions: improvement of technological conditions; selection of more productive yeast strains [7,15].

The high concentration of dry matter and ethanol in the mash and the temperature increase during fermentation inhibit the activity of yeast cells and reduce their fermentation activity. These factors are responsible for a number of disturbances in cell metabolism. This leads to inefficient hydrolysis of wort carbohydrates, reduced ethanol yield, an increase in its production cost, and deterioration of the quality of alcohol due to by-products that appear in it (fusel oil, organic acids, aldehydes, etc.) [14,16].

Studying the morphophysiological features allows establishing the sensitivity of yeast cells to certain stress: acidic, osmotic, thermal. When researching the morphological and physiological characteristics of the yeast *S. cerevisiae*, the object of study is the shape and size of cells, type of reproduction, growth on culture media, spore formation, the effect of culturing conditions on the growth and reproduction of yeast [16,17]. Many authors found that changes in cell structures were, by and large, of the same type for microorganisms that cause fermentation. So, it was concluded that cells were rearranged by fermentation, which was related to the cell size [16-19].

The formation of the organised morphology of a colony is undoubtedly the result of organised, coordinated behaviour of cells within the colony (which reflects changes in the cellular environment), availability of nutrients, signalling among colonies and within the colony. Under standard conditions, the morphology of a colony is specific to a particular strain of yeast, which indicates that the reproducibility of a structure, apparently, is a sign of programmed development [5]. However, under stressful conditions, namely high acidity, increased osmotic pressure or cultivation temperature, the morphological characteristics of distiller's yeast cells changes.

The morphology of the distiller's yeast S. cerevisiae, which is cultured on a starch-containing medium, is studied but insufficiently, so it is advisable to study the effect of the dry matter concentration in wort on the morphological and physiological characteristics of yeast cells.

Purpose: studying the morphophysiological characteristics of osmophilic, thermotolerant races of distiller's yeast cultured on highly concentrated wort.

Research objectives:

1. Determining the effect of the dry matter concentration of wort on culturing distiller's yeast races and on the shape and size of their cells.
2. Studying how the dry matter concentration effects on the size and shape of colonies of distiller's yeast races.
3. Based of theoretical and experimental studies, screening races of distiller's yeast for fermentation of highly concentrated wort.

Research materials and methods

The research used milled maize grain, the dispersion of which was 100% undersize on a screen with the mesh diameter 1 mm. Bioconversion of polymers of starch-containing raw materials in the alcohol industry is carried out by enzyme preparations from the company Danisco. Amylex 4T, glucoamylase Diazyme TGA were used as α-amylase. The enzyme preparations were introduced by units of activity. The maize grain used in the research had the starch content 69.0%. Thermoenzymatic treatment of the starch-containing raw materials was performed at 90-92°C for 3 h, and saccharification of the diluted mixture at 50-55°C for 30min. The concentration of thermostable α-amylase was 0.4:0.60 units AA/g starch; that of glucoamylase was 5.0 units GA/g starch.

The grain moisture was determined by drying to constant weight (ISO 712:2007). The particle size distribution of the milled grain was determined by sieving on metal and nylon 6 sieves (DSTU 4525:2006). The yeast was cultured at 30°C, the concentrations of dry matter (DM) in the wort were 18, 20, 23, 25, and 28%, the alcohol races of yeast used were *S.cerevisiae* DO-16, DO-11, K-81, XII [20-22]. The starch content of the original grain was determined by Ewers's method, the concentration of dry matter was determined using a saccharimeter and a refractometer of the type RPL-3 [23].

The reference was a sample of wort with the dry matter concentration 18%. The yeast inoculum was introduced in the amountf 20 million/cm³ of wort. The total number of yeast cells in 1cm^3 was determined by direct count in the haemocytometer. The physiological state of yeast cells was determined by colouring a yeast cell with Lugol's solution, the content of dead cells was established using methylene blue, the budding yeast and their accumulation were quantified in the

haemocytometer. The average size of yeast cells was determined using an eyepiece-micrometer. Giant yeast colonies were obtained after four days of growing on wort agar.

The morphological studies were conducted in research laboratories of the Zabolotny Institute of Microbiology and Virology (NAS of Ukraine).

All quality parameters were determined in triplicate with subsequent statistical analysis of the results.

Results of the research and their discussion

The effect of wort concentration on the morphophysiological characterisitcs of yeast cells has been studied. The research involved using the yeast races *S. cerevisiae* DO-16, DO-11, K-81, XII. The results are presented in Tables 1, 2, 3, 4 respectively.

It has been established that at the DM concentration 20.0%, in the yeast of the race *S. cerevisiae* DO-16, after 12 hours' culturing, there were synthesised by 11.7% more yeast cells than it was with the race DO-11, and a day later, the difference was 16.5%. When increasing the DM concentration, the synthesis of yeast cells of the race *S. cerevisiae* DO-16 and DO-11 increased, too. The largest concentration of yeast cells was observed at the wort concentration 28% of DM. The concentration of yeast cells of the race *S. cerevisiae* DO-16 was by 1.18 times higher than that of the race *S.cerevisiae* DO-11 (Tables 1, 2).

Table 1 – Effect of the DM concentration of wort on the morphological characteristics of the yeast race *S.cerevisiae* DO-16

DM concentration of the wort, %	Duration of production yeast culturing, h													
	2			5			7			12			24	
	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm
18±0.2	28	12	7.5±0.5 6.2±0.8	89	15	7.3±0.8 7.3±0.5	135	12	7.8±0.4 7.5±0.6	168	0.05	7.2±0.5 7.5±0.4	190	0,03	7.7±0.6 7.1±0.5
20±0.2	30	18	6.5±0.3 6.2±0.6	105	16	7.5±0.4 5.5±0.6	190	14	7.1±0.6 6.1±0.4	205	0.08	7.9±0.3 6.3±0.5	285	0	7.2±0.5 6.9±0.4
23±0.2	47	23	5.1±0.6 5.2±0.3	107	19	5.3±0.4 5.2±0.5	208	18	5.9±0.5 5.2±0.6	285	0.05	5.8±0.5 5.2±0.4	305	0,01	5.5±0.6 5.2±0.8
25±0.2	51	25	4.8±0.3 4.2±0.4	108	19	4.5±0.6 4.1±0.8	171	18	4.5±0.6 4.4±0.5	302	0.10	4.5±0.3 4.2±0.4	325	0	4.6±0.4 4.5±0.3
28±0.2	61	33	3.5±0.3 3.4±0.2	124	20	3.9±0.3 3.8±0.2	275	17	3.8±0.2 3.7±0.3	324	0.08	3.8±0.5 3.5±0.5	340	0	3.8±0.5 3.6±0.4

Table 2 – Effect of the DM concentration of wort on the morphological characteristics of the yeast race *S.cerevisiae* DO-11

DM concentration of the wort, %	Duration of production yeast culturing, h													
	2			5			7			12			24	
	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm
18±0.2	16	10	6.9±0.5 5.9±0.6	89	13	6.7±0.5 5.4±0.4	121	11	7.4±0.4 6.3±0.5	145	0,2	7.3±0.5 5.8±0.6	165	0.05	7.5±0.4 5.6±0.5
20±0.2	20	15	5.9±0.6 4.7±0.5	90	14	6.2±0.6 5.3±0.6	170	13	6.9±0.5 5.3±0.7	181	0,04	7.2±0.5 6.7±0.5	238	0.02	7.7±0.5 6.8±0.5
23±0.2	28	19	6.9±0.6 5.8±0.5	95	17	6.9±0.4 5.8±0.6	218	10	6.9±0.5 5.4±0.4	275	0,05	6.5±0.6 4.1±0.4	312	0.01	6.5±0.5 4.2±0.4
25±0.2	33	23	5.8±0.6 5.7±0.5	98	18	5.9±0.2 5.3±0.4	228	14	5.2±0.4 5.1±0.4	284	0,05	5.8±0.4 5.1±0.3	301	0.02	5.8±0.4 5.4±0.4
28±0.2	35	28	4.6±0.5 4.8±0.4	101	19	4.3±0.4 4.1±0.5	239	12	4.7±0.4 4.5±0.4	285	0,02	4.2±0.4 4.4±0.5	292	0	4.4±0.5 4.5±0.3

However, with an increase of the DM concentration of the wort to 28%, the concentrations of yeast cells of the races *S. cerevisiae* K-81 and XII decreased, and their cell sizes remained almost unchanged. This indicates that the cells are not adapted to the high osmotic pressure of the substrate. Similar studies of the effect of the osmotic pressure of the environment on the morphophysiological characteristics of yeast cells of alcohol races were conducted by the researchers Vanda Renata Reis, Ana Paula Guarnieri Bassi, Jessica Carolina Gomes da Silva, L. V. Rimareva, E.M.Serba, and others. The objects of their research were other races of distiller's yeast and methods of its culturing.

It is known that formation of yeast biomass is accompanied by complex synthetic processes. Culturing on media with a high dry matter content creates stressful conditions for yeast cells [23-25]. For each race of yeast, there are optimal parameters of culturing: temperature, pH, dry matter concentration of the medium [26-27]. The size and shape of yeast cells depend on many factors, primarily on the race of yeast, cultivation methods, environmental conditions [28-29]. It has been observed that in the osmophilic races *S. cerevisiae* DO-16 and DO-11, with increasing DM concentration of wort, the cells had a tendency to decrease in size. So, at the DM concentration of wort 18%, in the race *S.cerevisiae* DO-16, they were 7.5±0.5μm×6.2±0.8μm, and at the DM concentration of wort 28%, they were 3.5±0.3μm×3.4±0.2μm. In the race *S. cerevisiae* DO-11, the cell size was 6.9±0.5μm×5.9±0.6μm and 4.6±0.5μm×4.8±0.4 μm respectively (Tables 1, 2).

Cultivation of yeast of the race *S. cerevisiae* DO-16 at the DM concentration 28% leads to a marked increase in the synthesis of yeast cells: their concentration increased by 46% during the first 2 h, and in race DO-11, by 45%, as compared with the test where the DM concentration of wort was 18% (Tables 1, 2).

However, in the races K-81 and XII the concentration of yeast cells decreased by 31% and 46% respectively (Tables 3, 4). Regardless of the race studied, the largest number of budding cells was in the first hours of culturing, the highest percentage of budding cells was observed during the first 12 hours (Tables 3, 4).

Studies have shown that the yeast race *S. cerevisiae* DO-16 at all concentrations can synthesise more yeast cells compared with the races *S. cerevisiae* DO-11, K-81, and XII. Therefore, the selected race DO-16 has high regenerative properties, which are preserved under the conditions of culturing and fermentation of substrates with a high content of dry matter.

Cells of the races of distiller's yeast *S. cerevisiae* DO-16 and DO-11 were smaller in size compared with the thermotolerant and mesophilic races of *S. cerevisiae* K-81 and XII at the DM concentration 28%. However, the yeast cells in the races *S.cerevisiae* DO-16 and DO-11 are larger in number. When fermenting highly concentrated wort, these indicators characterise an increase in the working surface of yeast in the medium fertilised, which allows intensifying the process of alcohol fermentation [8,15].

Among the factors determining the physiological and biochemical state of the yeast population, the osmotic pressure is the most influential. Studing the morphological features of alcoholic races of yeast makes it possible to establish the state of yeast cells when they are cultured on substrates with high osmotic pressure [2,3]. The size of giant colonies depends on the race of distiller's yeast and the concentration of wort the yeast was cultured on [1].

Table 3 – The effect of the DM concentration of wort on the morphological characteristics of the yeast race *S.cerevisiae* K-81

DM concentration of the wort, %	Duration of production yeast culturing, h														
	2			5			7			12			24		
	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, μm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, μm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, μm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, μm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, μm
18±0.2	26	18	7.1±0.3 7.2±0.5	89	17	7.3±0.5 7.1±0.3	128	12	7.8±0.3 7.5±0.1	148	0.02	7.7±0.5 7.6±0.4	151	0.03	7.2±0.6 7.1±0.5
20±0.2	20	14	6.4±0.1 6.1±0.3	104	18	6.5±0.4 6.4±0.6	131	14	6.3±0.6 6.1±0.4	151	0.06	6.9±0.3 6.3±0.5	183	0.02	6.1±0.5 6.7±0.4
23±0.2	27	16	5.1±0.6 5.2±0.3	105	20	5.3±0.4 5.2±0.5	168	16	5.9±0.5 5.2±0.6	190	0.02	6.8±0.5 5.2±0.4	194	0.01	5.5±0.6 4.9±0.8
25±0.2	31	11	5.6±0.3 5.2±0.4	103	15	5.5±0.6 4.1±0.8	291	5	5.5±0.6 4.9±0.5	222	0.01	5.3±0.3 4.7±0.4	205	0	5.8±0.4 4.9±0.3
28±0.2	21	9	5.5±0.3 5.9±0.5	69	8	5.9±0.3 5.8±0.2	95	0.5	5.9±0.2 5.2±0.3	114	0	4.9±0.5 5.2±0.5	118	0	4.1±0.5 5.9±0.4

Table 4 – The effect of the DM concentration of wort on the morphological characteristics of the yeast race *S.cerevisiae* XI

DM concentration of the wort, %	Duration of production yeast culturing, h														
	2			5			7			12			24		
	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm	Concentration of yeast cells, million/cm³	Budding, %	Average cell size, µm
18±0.2	27	13	6.5±0.1 6.2±0.3	91	16	6.3±0.5 6.9±0.3	121	12	6.8±0.4 6.5±0.6	128	0,05	6.2±0.5 6.9±0.4	141	0.03	6.2±0.6 6.1±0.5
20±0.2	29	14	5.5±0.3 5.2±0.6	103	11	7.5±0.4 5.5±0.6	126	14	8.1±0.6 6.1±0.4	131	0,08	7.9±0.3 6.3±0.5	155	0.03	8.1±0.5 5.7±0.4
23±0.2	22	12	5.1±0.6 5.2±0.3	96	10	6.3±0.4 5.2±0.5	138	18	5.9±0.5 5.2±0.6	140	0,05	6.8±0.5 5.2±0.4	165	0.01	5.5±0.6 4.9±0.8
25±0.2	21	8	4.8±0.3 4.2±0.4	89	12	5.5±0.6 4.1±0.8	91	18	6.5±0.6 4.4±0.5	121	0,04	5.3±0.3 4.7±0.4	145	0	5.8±0.4 4.9±0.3
28±0.2	14	6	4.5±0.3 4.3±0.2	54	3	4.9±0.3 4.8±0.2	75	0,5	4.0±0.2 5.9±0.3	93	0,01	5.8±0.5 6.2±0.5	95	0	6.2±0.4 4.1±0.5

The osmophilic races *S.cerevisiae* DO-16 and *S.cerevisiae* DO-11 are characterised by more colonies compared with the thermotolerant race *S.cerevisiae* K-81 and the mesophilic race *S.cerevisiae* XII. The yeast races studied differed in the pattern on their surface. The colonies of osmophilic races were more compact. The yeast race *S.cerevisiae* DO-16 at the DM concentration of wort 20% formed round colonies, 18.2mm in size, with small radial wrinkles and flat wavy edges, with a barely noticeable concentric circle and a smooth centre raised slightly in the form of a peak. Strains of *Saccharomyces cerevisiae* resistant to stress from high ethanol and glucose concentrations and low pH have colonies with the smooth surfaces [6]. The colour of the colonies is matt, translucent in bright light (Fig. 1a, b).

a **b**

Fig. 1. Colonies of the yeast *S. cerevisiae* DO-16 cultured on wort with the concentration of DM: a) 20%, b) 28%

At the DM concentration 28%, the size of the giant colony decreased to 14.5mm, its surface had a large radial fold. The elevation of the colony decreased, slight roughness was formed on its surface (Fig. 2b).

The colony of *S.cerevisiae* DO-11 at the DM concentration of wort 20% had the size 17.3 mm. The shape of the colony was round, with barely noticeable radial wrincles, smooth and flat edges.

The profile of the colony is convex, raised to the centre, with hollows in the middle. The top has a concentric circle with a hollow inside. The surface is dim (Fig. 2a). At the DM concentration in the wort 28%, the size of the colony decreased to 14.3mm, a concentric circle was formed on the surface of the colony near the edge, the surface was light yellow, and rough areas appeared on the surface indicating cell suppression (Fig. 2b).

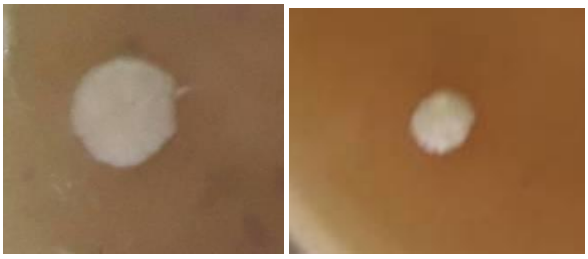
a **b**

Fig. 2. Colonies of the yeast *S. cerevisiae* DO-11 cultured on wort with the concentration of DM: a) 20%, b) 28%

The yeast *S. cerevisiae* K-81 at the concentration 20% of DM formed round colonies, 15.1mm in size, with a radial pattern, with flat wavy edges and a slightly raised smooth centre. The elevation of the colony is delineated by a concentric circle (Fig. 3a). The colour is matt.

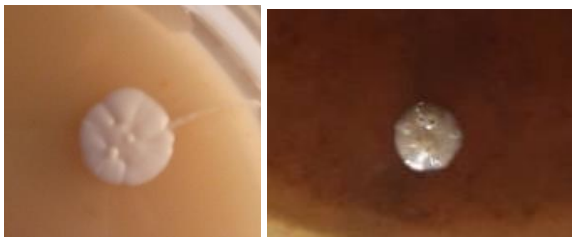
At the wort concentration 28% of DM, the size of the giant colony decreased to 11.3mm, its surface had sufficiently large radial wrinkles. The elevation of the colony decreased, the roughness on the surface increased, which indicates the suppression of cells (Fig. 3b). Studies of giant colonies of alcoholic races of yeast cultured on wort at the DM concentration 28% indicate that the race *S.cerevisiae* DO-16, as compared with other races, can withstand high concentrations of wort. Indeed, the size and shape of the giant colonies of this race indicate that the yeast cells are in a satisfactory physiological state, which makes it

reasonable to use this race in fermentation of highly concentrated wort.



a **b**

Fig. 3. Colonies of the yeast *S.cerevisiae* K-81 cultured on wort with the concentration of DM: a) 20%, b) 28%



a **b**

Fig. 4. Colonies of the yeast *S. cerevisiae* XII cultured on wort with the concentration of DM: a) 20%, b) 28%

The colony of the yeast *S. cerevisiae* XII grown at the wort concentration 20% of DM was 15.2mm in size. The colony is round-shaped, with barely noticeable radial waves. The profile of the colony is raised to the centre, with a hollow inside. The top is shaped as a concentric circle with hollows in the middle, the surface is dim (Fig. 4a). At the wort concentration 28% of DM, the size of the colony decreases to 10.8mm, the surface is light yellow, which indicates the suppression of yeast cells. The surface of the colony is characterised by considerable roughness, which indicates the suppression of cells (Fig. 4b).

The study of colonies of the yeast races considered has shown that the cells of *S.cerevisiae* XII and K-81, when cultured on a medium with the dry matter concentration 28%, were under stressful conditions. The cells of *S. cerevisiae* DO-11 and DO-16 were in satisfactory condition.

Conclusion

It has been studied how the dry matter concentration of the culture medium effect on the morphophysiological features of distiller's yeast.

The results of the studies allow concluding that at the DM concentration in the wort 28%, the osmophilic races of *S. cerevisiae* DO-16 and DO-11 had smaller cells than the thermotolerant and mesophilic races of *S. cerevisiae* K-81 and XII. However, the number of yeast cells in the races *S. cerevisiae* DO-16 and DO-11 is higher. During fermentation, these parameters characterise the increase in the working surface of the yeast in the fermented medium, which allows accelerating the fermentation process and ensures microbiological purity of the medium. Studies of giant colonies of alcoholic races of yeast cultured on wort at the concentration 28% of DM indicate that the race *S.cerevisiae* DO-16, as compared with other races, can withstand high concentrations of wort. The size and shape of the giant colonies of this race indicate that the yeast cells are in a satisfactory physiological state, which makes it reasonable to use this race in fermentation of highly concentrated wort.

The morphophysiological characteristics of the distiller's yeast were the basis to screen the races *S.cerevisiae* DO-16, DO-11, K-81, and XII with thermotolerant and osmophilic properties for fermentation of highly concentrated wort. Based on the theoretical and experimental studies, it has been found that the selected yeast race *S. cerevisiae* DO-16, by its morphophysiological characteristics, has advantages over the races DO-11, K-81, and XII in fermentation of highly concentrated wort. Thus, to ferment highly concentrated wort from grain raw materials, the highly productive race of distiller's yeast with increased osmophilicity *S. cerevisiae* DO-16 has been selected.

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ВПЛИВ КОНЦЕНТРАЦІЇ СУХИХ РЕЧОВИН СУСЛА НА ОСОБЛИВОСТІ ОСМОФІЛЬНИХ СПИРТОВИХ РАС ДРІЖДЖІВ

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Анотація. Досліджено основні фактори впливу середовища культивування на ріст та розвиток різних рас спиртових дріжджів. Для досліджень впливу концентрації сухих речовин сусла на морфофізіологічні особливості дріжджових клітин спиртових дріжджів підібрані наступні промислові раси: *S.cerevisiae* ДО-16, ДО-11, К-81, XII. Новизна роботи полягає в дослідженнях впливу концентрації сухих речовин сусла на морфофізіологічні особливості спиртових дріжджів, скринінгу спиртових рас для зброджування висококонцентрованого сусла. Морфологія клітин спиртових рас дріжджів *S. cerevisiae*, які культивовані на крохмалевмісному середовищі вивчені недостатньо. Встановлено, що клітини раси спиртових дріжджів *S.cerevisiae* ДО-16 та ДО-11 мали менші розміри клітин в порівнянні з термотолерантною та мезофільною расами *S.cerevisiae* К–81 та XII при концентрації сухих речовин сусла 28%. Проте, досліджувані осмофільні раси *S.cerevisiae* ДО-16 та ДО-11 синтезують більшу кількість клітин в умовах культивування на суслі із зернової сировини високих концентрацій сухих речовин у порівнянні з расами К-81 та XII.

При зброджуванні висококонцентрованого сусла дані показники характеризують збільшення робочої поверхні дріжджів в зброджуваному середовищі, що дозволяє інтенсифікувати процес бродіння. Проведені дослідження по впливу концентрації сухих речовин на розмір та форму гігантських колоній спиртових рас дріжджів. Проби культур відбирали в стаціонарній фазі росту. Дослідження гігантських колоній спиртових рас дріжджів, культивованих на суслі концентрацією 28% сухих речовин вказують що, раса *S.cerevisiae* ДО-16, в порівнянні з іншими расами, здатна витримувати високі концентрації сусла. Адже, розміри та форма гігантських колоній досліджуваної раси вказують, що дріжджові клітини знаходились в задовільному фізіологічному стані. За морфофізіологічними ознаками проведено скринінг спиртових дріжджів раси *S.cerevisiae* ДО-16, ДО-11, К-81, XII з термотолерантними та осмофільними властивостями для зброджування висококонцентрованого сусла. На основі теоретичних та експериментальних досліджень встановлено, що селекціонована раса дріжджів *S.cerevisiae* ДО-16 за морфофізіологічними ознаками має переваги над расами ДО-11, К-81, XII для зброджування сусла високих концентрацій. Отже, для зброджування висококонцентрованого сусла із зернової сировини підібрано високопродуктивну расу спиртових дріжджів з підвищеною осмофільністю *S.cerevisiae* ДО-16.

Ключові слова: спиртові дріжджі, культивування, висококонцентроване сусло, сухі речовини.

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