

THE USE OF POLIHEKSAMETHYLENEGUANIDINE (PHMG) SALTS IN ALCOHOL PRODUCTION FROM STARCH-CONTAINING RAW MATERIALS

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Abstract

Expediency of the use of poliheksamethyleneguanidine (PHMG) salts is reasonable as the antiseptic in alcohol production from starch-containing raw materials. In working environment its influence on the course of microbiological and biochemical processes, quality of semiproducts and alcohol was investigated and efficiency of the preparation « PHMG » for inhibition of contaminating microflora growth was confirmed.

Keywords: alcohol production, contaminating microflora, antiseptic preparation (antiseptic).

Introduction

Intensive introduction of the newest energy- and resource-saving technologies in alcohol production predetermined a transition of a number of enterprises in the industry to the technology of the low-temperature boiling and wide utilizing of unconventional and untraditional raw materials that is the basic source of infecting microorganisms in a manufacturing process [4,5]. It is known that products of metabolism of external microflora have a negative influence on the vital functions of yeasts, enzyme activity and

predetermine the super rational growth of wort acidity, that results in decrease of alcohol output and worsening its quality [1,2,3]. In the case of the thermal ferment processing use of grain raw materials, the problem of microbiological purity of production takes on the special significance.

For a long time the only way of the problem solving was periodic temperature sterilization of yeast fermentation equipment with the use of disinfectants [5]. Nowadays in alcohol production from starch-containing raw materials the use of antiseptics is gain-

ing greater popularity to inhibit the contaminating microflora development and decrease its activity. However, despite the spectrum of antiseptics being used in alcohol production technology is wide enough nowadays, information about technological and economic efficiency of their use, influence on the final product quality is absent. In this case there is a necessity to conduct researches towards that goal and to elaborate the recommendations for the use of antiseptics in alcohol industry.

« PHMG » in the ethanol production.

The implementing of the continuous fermentation mash method from starch-containing raw materials in the industry is limited by excessive growth of wort acidity. The use of the effective antiseptic preparation « PHMG » provided mash fermentation in conditionally-sterile environments, receiving the regulated indexes of fermented wort, that will allow to pass on the continuous way of mash fermentation from starch-containing raw materials.

Nowadays the antiseptic preparation «PHMG» is one of the most widespread in food industry, which basic descriptions are brought in table. 1.

Table 1.

Description of the antiseptic preparation « PHMG »

Active substance	Concentration of the active substance, %	Solubility in water	pH of solution
Poliheksamethyleneguanidine (PHMG)	20	good	6,0...9,0

The advantage of such preparations is a wide spectrum of antimicrobial action on gram-negative and gram-positive bacterium, viruses, yeast-like fungi and dermatophytes. In addition, the given preparation is characterized by good solubility and high inertness to metallic surfaces, glass and rubber, that eliminates possibility of equipment corrosion as a result of its using.

We investigated the influence of the antiseptic preparation «Polidez» on the techno-chemical indexes of the productive yeasts, mash in the process of its fermentation and chemical-technological indexes of fermented wort. The marked indexes were determined by the methods generally accepted in the industry [1].

The research of the use efficiency of the given antiseptic preparation was conducted in the conditions of a

state enterprise (SE) "Martynivskiy spyrtovyi zavod" (village Martynivka, Vinnytsya region) [2].

Corn is a basic raw material for the alcohol production on this enterprise. Indexes of raw material quality are brought in table 2.

For preparation of a batch maize was milled on a hammer crusher. Granulometric composition of grade was characterized by a passing through a sieve with the diameter of apertures 1 mm – 85...92%. The temperature of the batch was 38...40° C.

The batch was boiled at a temperature of 155...158° C during 40...45 min. Boiled mass was sugared at a temperature of 57...58° C during 35...40 min.

Table 2.

Indexes of raw material quality (maize)

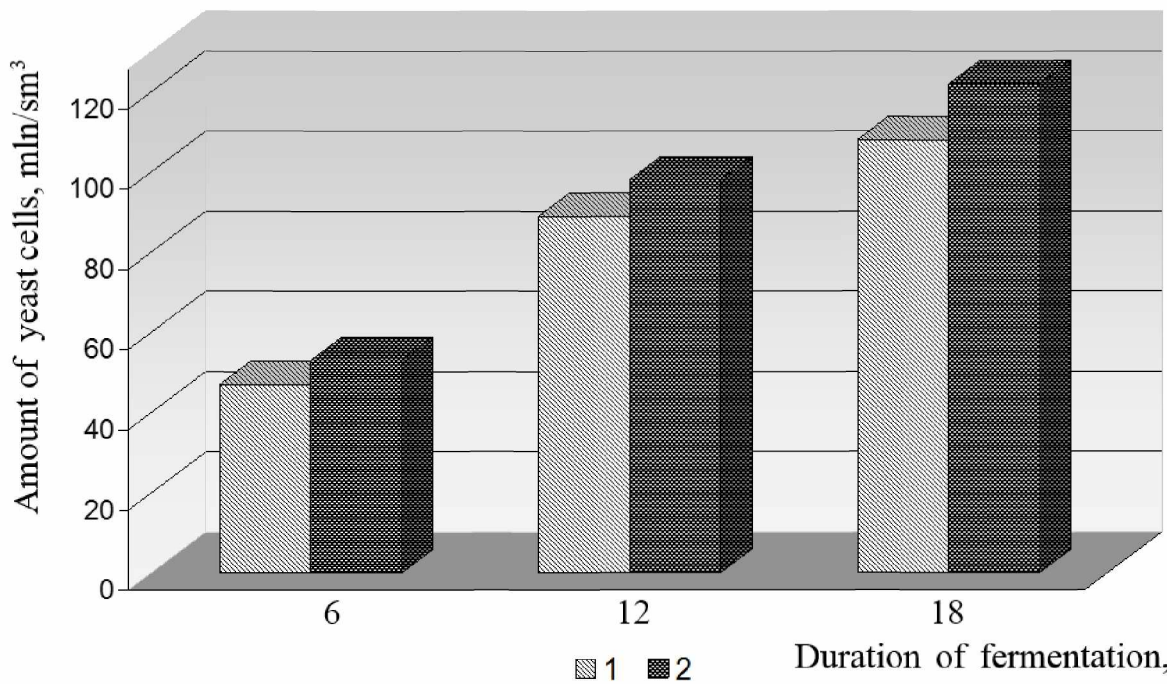
Starchiness, %	Humidity, %	Impurity, %
59,1...59,7	15,0...15,5	2,0

The sugaring of the batches was accomplished with the use of enzyme preparations BAN 480 L, San-Extra 240 L, which charges made up according 180 and 800 sm³/t of conditional starch. Mash fermentation was conducted with the use of sulphate yeasts of K-81 race. Duration of productive yeasts growing made up 15...18 hours at a temperature of 28...34 °C.

The content of dry substances (DS) of basic mash and mash for productive yeasts growing folded 16,5...17,5 %.

The techno-chemical indexes of semiproducts in alcohol production were determined in 10 yeast seed vessels and 10 fermenters without adding an antiseptic preparation (a control), and in the same amount of fermenters and yeast seed vessels, with adding the antiseptic preparation " PHMG " with the concentration 20 sm³/m³ of mash into them.

Mash fermentation and preparation of yeasts was accomplished by a periodic method. The capacity of one fermenter made up 110 m³ and 120 m³, yeast seed vessels – 12 m³.



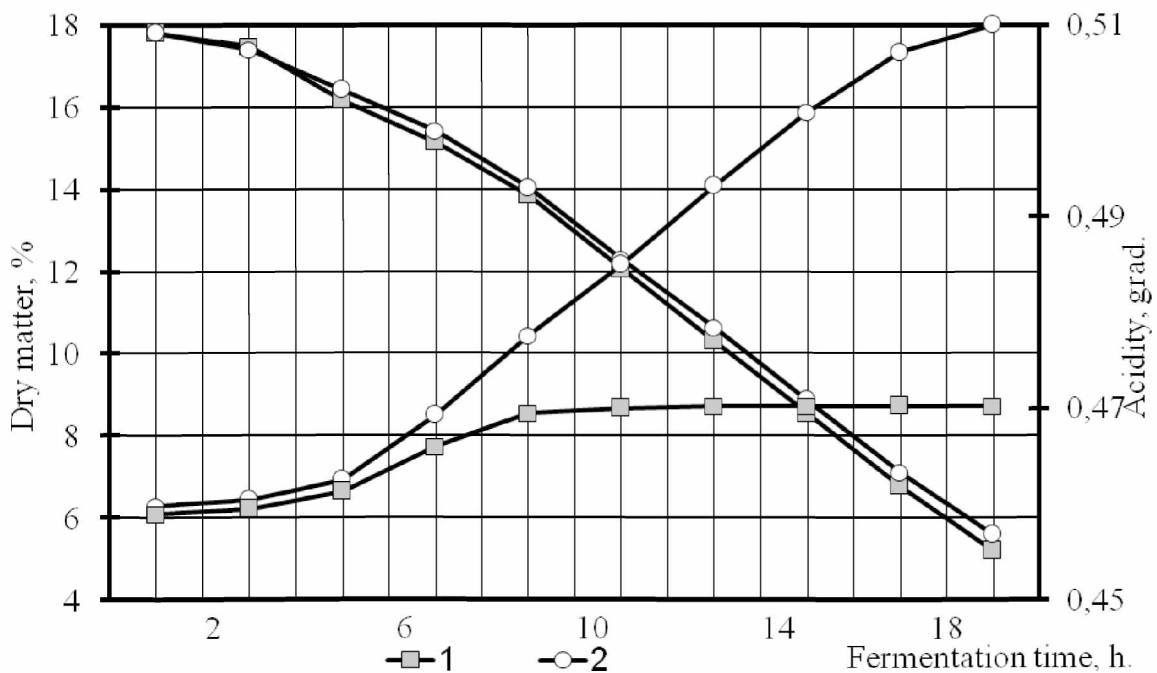
Draw. 1. The biomass accumulation of productive yeasts during growing them on mash: 1 – without the antiseptic 2 - with adding the antiseptic preparation "PHMG" with the concentration 20 sm³/m³ of mash (average value).

It is determined that adding the mentioned antiseptic preparation into mash for productive yeasts growing slightly reduced the reproduction speed of yeast cells (draw. 1).

But after 3 generations process intensification of yeast biomass accumulation passed during all period of their generations by 6,7...10,6 %, as a result of their adaptation to the antiseptic, comparing with the control. Furthermore, in all experienced yeast seed vessels, in which the antiseptic preparation " PHMG "

was added, dead yeast cells were absent. The concentration of yeast cells made up 120...125 mln/sm³ [2].

Adding the antiseptic preparation "Polidez" to mash repressed the accumulation of acid-formed bacterium substantially, that was confirmed by accumulation speed decrease of mash acidity. Eventual acidity of productive yeasts with addition of the antiseptic was lower in comparison with the control, by 0,04 gr. (draw.2).

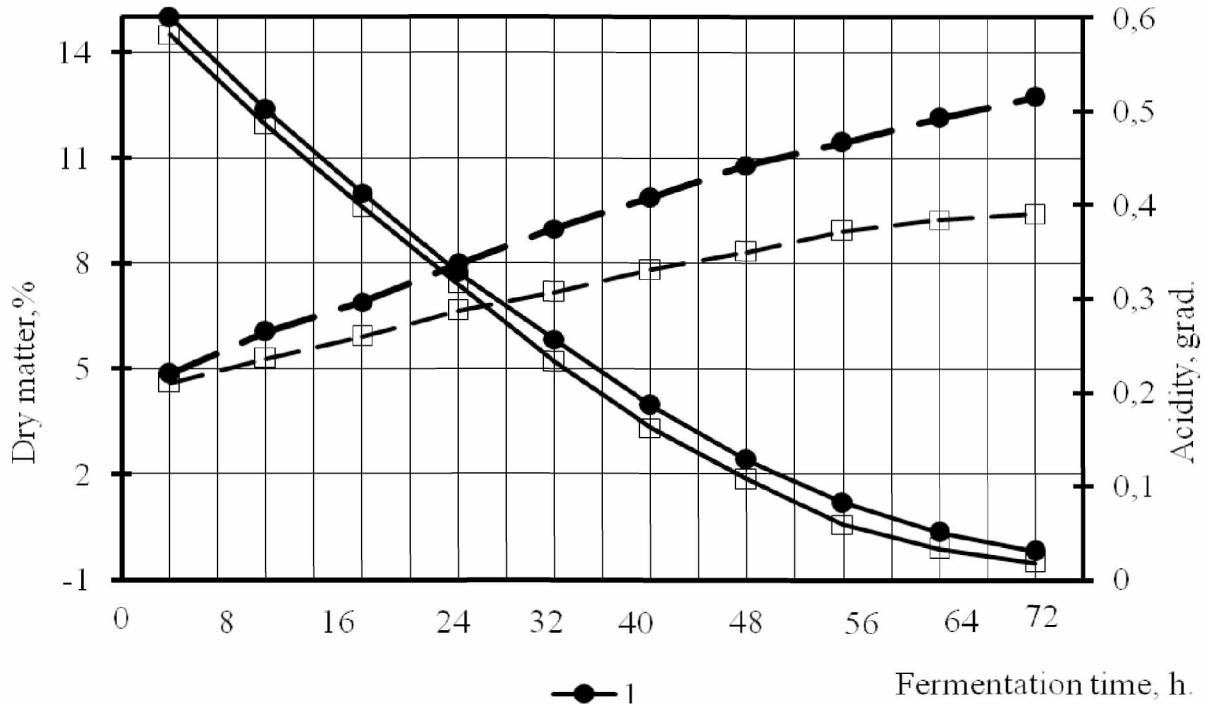


Draw. 2. Fermentation of DS and accumulation dynamics of titred acidity of productive yeasts during growing them on mash: 1 – without the antiseptic 2 - with adding the antiseptic preparation " PHMG " with the concentration 20 sm³/m³ of mash (average value) .

During the researches it is determined that adding the antiseptic preparation "Polidez" in fermenters in amount $20 \text{ sm}^3/\text{m}^3$ of mash at the beginning of the fermentation process largely influenced on motion of biochemical processes and chemical-technological indexes of fermented wort (table.3).

It is determined that the mentioned antiseptic use in the concentration marked above repressed the process of acid accumulation in mash comparatively with the control model, accordingly by 31...46% during all process of its fermentation and reduced eventual acidity of fermented wort by 0,18 gr. (draw. 3).

Repressing the acid-formed bacteria development in mash with the use of the antiseptic preparation "Polidez" in the mentioned concentration helped more active growth and reproduction of yeasts that was confirmed 6 % higher content of yeast cells, than in fermenters without the antiseptic. Lower, comparatively with the control, content of unfermented carbohydrates and insoluble starch (table. 3) in fermented wort with the mentioned antiseptic confirms the increase of yeast fermentation activity and higher, comparatively with the control, activity of enzyme preparations.



Draw. 3. Fermentation of DS and accumulation dynamics of titred acidity of productive yeasts during growing them on mash: 1 – without the antiseptic 2 - with adding the antiseptic preparation " PHMG " with the concentration $20 \text{ sm}^3/\text{m}^3$ of mash (average value) .

Table 3.

Chemical-technological indexes of fermented wort.

Indexes	Without an antiseptic (control)	With the antiseptic «Polidez»
Insoluble starch, g/of 100 cm^3	0,0925	0,0861
Unfermented sugars, g/of 100 cm^3	0,3260	0,3120
Ethanol, at. %	8,9750	8,9857

It is necessary to mark that decline of the microbiological pollution level of productive yeasts and fermented wort assisted the process intensification of mash fermentation and the alcohol output increase, comparatively with the control – mash without the antiseptic, by 0,12 %.

The decline of the productive substrate infection and the increase of yeast fermenting activity influenced on composition and quantitative content of alcohol fermentation side products.

During research of composition and content of fermentation side products in fermented wort it is de-

termined, that the use of the antiseptic preparation "Polidez" in the concentration of $20 \text{ sm}^3/\text{m}^3$ assisted the decline of acetaldehyde content, comparatively with the fermented wort, got from mash without an antiseptic, in 1,5 times, that affirms about more complete fermentation of carbohydrates, and also the decline of ether content in 1,4 times, that obviously related with smaller content of higher alcohols and acids than in the control, which products of interaction in fermented mass are complex ethers (table. 4).

Table 4.

Accumulation of volatile admixtures in fermented wort, mg/dm ³		
Index	Control (without the antiseptic)	With addition of the antiseptic « PHMG »
Aldehydes	90,45	59,91
Ethers	32,50	23,06
Acids	168,60	94,50
Higher spirits	455,30	330,45

Conducted comparative evaluation of alcohol quality got without the use of the antiseptic and with the use of the antiseptic preparation « PHMG » has shown, that content and physical and chemical indexes

of the alcohol sample, got with the use of the antiseptic, corresponded to the requirements of his state standard (table.5).

Table 5.

The physical and chemical indexes of rectified ethyl alcohol

Name of index	Control (without the antiseptic)	With adding the antiseptic "Polidez"
Volume part of ethanol, at a temperature of 20 °C, %	96,4	96,4
A test on cleanness with sulphuric acid	passes	passes
Test on oxidability at a temperature of 20 °C, min	21,0	23,0
Mass concentration of fusel oil, in a count on mixture isoamyl and isobutyl alcohols (1:1) in a waterless alcohol, mg/dm ³	2,2	1,9
Mass concentration of aldehydes, in a count on an acetaldehyde in a waterless alcohol, mg/dm ³	1,0	0,8
Mass concentration of ethers, in a count on acetethyl ether in a waterless alcohol, mg/dm ³	2,8	2,5
Volume part of methanol in a count on a waterless alcohol, %	1,8 10 ⁻³	1,6 10 ⁻³
Mass concentration of free acids (without CO ₂), in a count on acetic acid, in a waterless alcohol, mg/dm ³	9,0	7,5

Conclusion

Conducted researches affirm efficiency of the antiseptic " PHMG " use for repressing the acid-formed microflora progress in mash. The antiseptic preparation « PHMG » stimulates the production yeasts development during the optimal concentration of the antiseptic in productive substrate 20 sm³/m³.

Using the investigated antiseptic preparation for a continuous method will allow to provide microbiological cleanness of alcohol production semiproducts and to bring down the side product content of alcohol fermentation that will provide the improvement of ethanol quality indexes.

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