Application of immobilized yeast cells in fermentation of sugar-based raw materials for the production of bioethanol

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Abstract – This abstract describes a study of efficiency immobilized yeasts usage in the fermentation of sugar-based raw materials. It was found that the fermentation of molasses wort by yeasts immobilized in sorghum stalks particles provides an increase in the ethanol production rate per gram of biomass per hour, increases the yield of ethanol per ton of raw materials, as well as reduces the fermentation time. It is proved that this technological method could improve the bioethanol production efficiency.

Keywords – fermentation, molasses, Saccharomyces cerevisiae, bioethanol, immobilized yeasts.

Introduction

According to the current technology, the processing of sugar-based raw materials into bioethanol is accompanied by the synthesis of biomass in the amount of 18 - 22 g/dm^3, which is inactivated during the wort distillation process and removed from the production cycle with the vinasse.

The disadvantages of such technology are the sugar losses for the synthesis of biomass and the increase of the sewage pollution degree and human pressure on the environment, which is eliminated by yeasts immobilizing on different types of carriers in the fermentation zone. The system of immobilized cells helps to increase the process capacity, makes it possible to reuse biomass during a certain number of cycles and reduce costs for the production of the final product [1].

Production simplicity, high mechanical resistance, high degree of renewing, long life and low cost are advantages for using cellulose-containing raw material as an agent for immobilization.

The distribution of cultivation of sugar sorghum as a raw material for the production of syrups and ethanol in recent years in Ukraine creates the conditions for use of the crushed stalks as a matrix for the microorganisms immobilization [2], [3].

The purpose of research is to investigate technological parameters of yeasts cells immobilized on a sweet sorghum stalks matrix using in the continuous process of fermentation of wort based on sugar-beet molasses.

Materials and methods

Alcoholic yeasts K-7 were used as an ethanol producent. The wort from sugar beet molasses, obtained from the technological process, with the concentration of 24.6% solids, was used as a substrate. Dry sorghum stalk were crushed to particles 7 * 8 * 8 mm, sterilized and used as immobilization matrix. Immobilization of yeast cells on the matrix was carried out using medium with an initial concentration of dry matter of 12% and biomass content of 18 - 20 g/ dm^3. The process continued until the maximum saturation of sorption carrier surface. Continuous fermentation was carried out at the medium dilution rate 0.037 h. $^{-1}$.

Results

To determine the efficiency of continuous wort fermentation using immobilized yeast the method of "fermentation probe" was used, with identical concentration and under identical conditions. Data from studies are given in Table 1.

Table 1.

The fermentation of molasses wort with concentration of 24.6% of solids by a continuous method using immobilized yeasts and by "fermentation probe"

Indicator	The method of fermentation	
	Fermentation probe	Continuous method using immobilized yeast
Sugar put with a wort, g/dm^3	149,38	149,38
Biomass content, g/dm^3	17,50	32,80
Ethanol contetnt, %w/w.	9,18	9,50
Non-fermented sugar contetnt, g/dm^3	14,07	8,29
Duration of process, hours	80,0	29,3
Ethanol production rate, cm^3/g biomass per hour	0,066	0,099
Product yield per ton of raw materials, dal	30,97	32,05

For equal content of digestible sugars in the wort, the usage of immobilized yeast provides an ethanol content in the mature wort increase of more than 3.5% relative, and the content of non-fermented sugar lower by 41.1% compared with the "fermentation test". Under the conditions of high concentration of a fermented sugars (14.9%) and non-sugars (9.7%) in molasses wort immobilized yeasts are characterized by a higher ethanol production rate.

The use of immobilized yeast in the continuous fermentation of molasses wort increases the ethanol production rate by 30% per 1 g of biomass, the yield of ethanol by 1.08 dal per ton of raw materials and shortens the duration of the fermentation process.

Conclusions

The advantages of using immobilized yeast cells in the continuous process of fermentation of sugar-based raw materials are proven, which is a promising direction of development of technological support for bioethanol production and increase of its efficiency.

References

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