

Studies on bioenergetic transformation of molasses pollutant to ethanol production exposed to sodium lauryl sulphate (NaLS)

Suresh Prasad* and Rafat Perween**

*Department of Chemistry Nalanda College Bihar Sharif, Nalanda -803101, Bihar

**Department of Chemistry, M.G. College, Gaya - 823001, Bihar

Email : prabhanshurajmits@gmail.com, rafat4nov@gmail.com

**Main Authoress

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Abstract : Micelles can impact fermentation process in various ways. Micelles can enhance mass transfer rates, potentially improving substrate uptake and product formation. Micelles can influence enzyme activity, either enhancing or inhibiting enzyme catalysed reaction. Micelles might not be suitable for all microorganisms for fermentation processes due to potential interaction or toxicity. The use of micelles in fermentation process requires careful consideration of their potential effects on microorganisms, enzymes and the overall processes. The efficacy of micelles, i.e sodium lauryl sulphate (NaLS) on bioenergetic transformation of molasses pollutant to ethanol by *Saccharomyces cerevisiae* NCIM - 1154 has been studied. It has been observed that the NaLS under study has enhanced the production of ethanol to an extent of 6.930% higher in comparison to control in 55 hours of optimum incubation period, 4.2 pH and 33°C temperature with 22% (W/V) molasses solution.

(Keywords : Molasses, EtOH, NaLS, *S.cerevisiae* NCIM - 1154).

Introduction

Sodium Lauryl sulphate (NaLS) forms micelles, in aqueous solutions due to its amphiphilic nature. Sodium lauryl sulphate can impact enzyme activity and cell membrane integrity in fermentation processes. NaLS can potentially denature enzymes affecting their activity and stability. NaLS can interact with cell membranes potentially disrupting their structure and function. NaLS might help release enzymes from cells, potentially enhancing disrupting their structure and function. NaLS could be used to extract enzymes from microbial cells.¹⁻⁸ A micelle or micella is an aggregate of surfactant molecules

dispersed in a liquid colloid. The molecules (surfactants) are amphiphilic, which means having spatially distinct polar and nonpolar parts. The micelles are in rapid equilibrium with single molecules (or ions), commonly referred to as monomers. Micelles either accelerates or retards the organic reactions depending on its nature⁹⁻¹⁸. It is assumed that micelles are moderators of enzyme actions in some biological systems. There are several known micelles, but a very few micelles have been used in submerged fermentation processes¹⁹⁻²⁹. Since micellar effect on fermentation studies especially alcoholic fermentation is relatively new and almost unexplored, it needs careful and specific experimentations.³⁰⁻⁴¹ In the present investigation the authors have made an attempt to study the effect of Sodium Lauryl sulphate (NaLS) on ethanol fermentation by *Saccharomyces cerevisiae* NCIM-1154.

Experimental

The influence of Sodium Lauryl sulphate (NaLS) on bioproduction of ethanol by *Saccharomyces cerevisiae* NCIM -1154.



Saccharomyces cerevisiae

The composition of the production medium for bioproduction of ethanol by

Saccharomyces cerevisiae NCIM -1154 has been prepared as follows :

Molasses : 22% (w/v), Malt extract :0.40%, Yeast extract 0.40%, Peptone : 0.60%, $(\text{NH}_4)_2\text{HPO}_4$: 0.30%, pH : 4.2

The pH of the production medium was adjusted to 4.2 by adding requisite amount of lactic acid and this pH was also ascertained by a pH meter. The above composition medium represents volume of a fermentor flask, i.e., "100ml" production medium for bioproduction of ethanol by *Saccharomyces cerevisiae* NCIM -1154. Now, the same production medium for bioproduction of ethanol by *Saccharomyces cerevisiae* NCIM -1154 was prepared for 99-fermentor flask, i. e; each contained '100ml' of production medium.

The above 99-fermentor flasks were then arranged to 11-sets each comprising of 9-fermentor flasks. Each set was then rearranged in 3-subsets, each consisting of 3-fermentor flasks. The remaining 9-fermentor flasks out of 99-fermentor flasks were kept as control and these were also rearranged in 3-subsets each consisting of 3-fermentor flasks.

After preparing the above sets of fermentor flasks M/1000 solution of Sodium Lauryl sulphate (NaLS) was prepared and from the above Sodium Lauryl sulphate (NaLS) solution 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0 and 10 ml was added to the fermentation flasks of above 1st to 10th sets respectively. The control fermentor flasks contained no. Sodium Lauryl sulphate (NaLS).

Now, the total volume in each fermentor flasks was made upto 100 ml by adding requisite amount of distilled water. Thus, the molar concentration of Sodium Lauryl sulphate (NaLS) in 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and

10th subsets were approximately as given below :

$A \times 10^{-x} \text{M}$, i.e.,
 $1.0 \times 10^{-5} \text{M}$ to $10.0 \times 10^{-5} \text{M}$

A = amount of sodium lauryl sulphate (NaLS), in ml, i.e., 1.0 ml to 10 ml.
 x = Molarity of the sodium lauryl sulphate (NaLS) solution

The above fermentor flasks were then sterilized, cooled inoculated and incubated at 33°C and analysed after 50, 55 and 60 hours for ethanol⁴² formed and molasses⁴³ left unfermented.

Results and Discussion

The influence of sodium lauryl sulphate (NaLS).

The results recorded in the table - 1 show that sodium lauryl sulphate (NaLS) is not much favourable and stimulating for the bioenergetic conversion of molasses pollutant to ethanol by *Saccharomyces cerevisiae* NCIM -1154. The maximum yield of alcohol, i.e., 8.64 ml/100 ml in the presence of sodium lauryl sulphate (NaLS) micelle has been observed at $6.0 \times 10^{-5} \text{M}$ which is 6.930% higher in comparison to control fermentor flasks in 55 hours of optimum incubation period. It has been found that gradual addition of sodium lauryl sulphate (NaLS) from $1.0 \times 10^{-5} \text{M}$ to $6.0 \times 10^{-5} \text{M}$ gradually increases the yield of alcohol and a maximum yield of alcohol was attained at $6.0 \times 10^{-5} \text{M}$ molar concentration of the micelle sodium lauryl sulphate (NaLS).

However, addition of the micelles sodium lauryl sulphate (NaLS) to fermentation medium of molar concentration in between $1.0 \times 10^{-5} \text{M}$ to $10 \times 10^{-5} \text{M}$ enhances the production of alcohol and thus the yield of alcohol at each concentration of the micelle used was found to be higher in comparison to control fermentor -flasks in 55 hrs of optimum incubation period.

Table - 1
Studies on bioenergetic transformation of molasses pollutant to ethanol production exposed to sodium lauryl sulphate (NaLS)

Concentration of Micell used A X 10 ^{-x} M	Incubation Period in hours	Yield of Alcohol* in ml/100 ml	Molasses sugars* left unfermented in g/100 ml	% Difference in yield of alcohol in 55 hrs.
Control	55	8.08	2.620	—
1.0 x 10 ⁻⁵ M	55	8.12	2.612	+0.495
2.0 x 10 ⁻⁵ M	55	8.20	2.606	+0.495
3.0 x 10 ⁻⁵ M	55	8.30	2.590	+1.485
4.0 x 10 ⁻⁵ M	55	8.39	2.586	+2.722
5.0 x 10 ⁻⁵ M	55	8.55	2.566	+3.836
6.0 x 10 ⁻⁵ M**	55	8.64***	2.520	+6.930
7.0 x 10 ⁻⁵ M	55	8.47	2.596	+4.826
8.0 x 10 ⁻⁵ M	55	8.40	2.601	+4.826
9.0 x 10 ⁻⁵ M	55	8.32	2.615	+2.970
10.0 x 10 ⁻⁵ M	55	****	—	—

* Each value represents mean of three trials. ** Optimum concentration of micelle used.

*** Optimum yield of alcohol in 55 hours. (+) Values indicate % increase in the yield of alcohol after 55 hours. Experimental deviation (\pm) 1.5–3%.

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