

Studies on facile biotic production of bioethanol exposed to Sodium n-dodecyl benzene sulphonate (SDBS)

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Abstract : The global bioethanol market is valued at USD 83.4 billion in 2023 and is projected to reach USD 114.7 billion by 2028, growing at 6.6% cagr during the forecast period. Bioethanol, obtained from biomass sources like corn, sugarcane, or cellulosic materials, has extensive applications across various industries. In the present communication some of the important techniques has been taken for the higher facile biotic production of bioethanol exposed to some chemical micelles specially Sodium n-dodecyl benzene sulphonate (SDBS) by some microbial strains such as *Thermoanaerobacter matheranii* ARC-1603, *T. pseudoethanolicus* ARC-1604, *T. pentosaceus* ARC-1605, *Zymomonas mobilis* ARC-1606 and *Saccharomyces cerevisiae* ARC-1607. It has been noted that *Saccharomyces cerevisiae* ARC-1607 has been found most successful bioethanol producer. It has been observed that the micelles, i.e, Sodium n-dodecyl benzene sulphonate (SDBS) has stimulatory and significant impact on bioethanol production and enhances the yield of bioethanol to an extent of 25.581% higher in comparison to control, i.e., 6.45ml/100 ml when 23.5% (w/v) molasses solution is allowed to ferment for 60 hrs of optimum incubation period, 4.8 pH, and 34.5°C temperature along with some other nutritional ingredients required by the fungal strain under trial.

(Keywords : Bioethanol, fermentation, micelles, Sodium n-dodecyl benzene sulphonate (SDBS) and *Saccharomyces cerevisiae* ARC-1607)

Introduction

As a biofuel, bioethanol is one of the most intriguing because of its beneficial environmental impact¹⁻². It is currently made primarily from sugar and starch-containing raw

ingredients. Most biofuels may be used either as a stand-alone fuel or in a blend with gasoline. ethanol is by far the most common type. Raw materials for ethanol manufacturing include sugars, starches, and lignocellulosic materials, as well as algae biomass³⁻⁴. This article addresses overview of several aspects of bioethanol production, such as worldwide trends, diverse raw materials, the status and recent advancements of applicable technologies, biorefinery aspects, as well as the benefits and drawbacks of fuel ethanol⁵⁻⁸. Currently, global bioethanol output is at an all-time high. Bioethanol looks to have a bright future because there is a strong need for sustainable energy sources to decrease reliance on foreign oil⁹⁻¹⁰.

Micelles are amphiphilic colloidal structures, with particle diameters from 5 to 100 nm range. Micelles consist of molecules containing two completely different regions that have opposite affinities against water. These amphiphilic molecules, which form the micelles, associate at certain temperatures an appropriate concentrations. The core of the micelles, is formed by the hydrophobic fragments of amphiphilic molecules, whereas micelle's shell consist of hydrophilic fragments of micellar molecules. Micelles are approximately spherical in shape. Other phases, including shapes such as ellipsoids, cylinders, and bilayers, are also possible. The shape and size of a micelle are a function of the molecular geometry of its surfactant molecules and solution conditions such as surfactant concentration, temperature, pH, and ionic

strength. The process of forming micelles is known as micellisation and forms part of the phase behaviour of many lipids according to their polymorphism¹¹⁻¹³. A number of recent review articles have been written on the rheology and applications of wormlike micelle solutions¹⁴⁻²⁶. However, as the salt concentration of micelles is increased and the head group charges are sufficiently screened, the wormlike micelles can form three-point or four-point junctions. Thus, from the above brief review it is evident that micelles are required for exploitation specially for bioethanol fermentation²⁷⁻³⁰ and in view of this the authoress has studied the impact of Sodium n-dodecyl benzene sulphonate (SDBS) on biotic production of bioethanol by *Saccharomyces cerevisiae* ARC-1607

Experimental

The influence of Sodium n-dodecyl benzene sulphonate (SDBS) on facile biotic production of bioethanol by yeast *Saccharomyces cerevisiae* ARC-1607. The constitution of production medium for the fermentative bioproduction of bioethanol from molasses by *Saccharomyces cerevisiae* ARC-1607 is prepared as follows :

Molasses Solution : 23.5 % (w/v)

Malt-Extract : 1.45%, Yeast-Extract : 1.45%

Peptone : 1.45%, Distilled water : To make up 100 ml pH : 4.8

Distilled water was added to make up the volume up to '100 ml'. The pH of the medium was adjusted to 4.8 by adding requisite amount of lactic acid. Now, the same production medium for facile biotic production of bioethanol from molasses by *Saccharomyces cerevisiae* ARC-1607 was prepared for 315 fermentor-flasks, i.e., each containing hundred ml of production medium.

These fermentor-flasks, i.e., each containing hundred ml of production medium. These fermentor-flasks were then arranged in twenty one sets each comprising fifteen fermentor-flasks. The remaining fifteen fermentor-flasks out of 315 fermentor-flasks

were kept as control and these were also rearranged in five subsets each consisting of three fermentor flasks. Now, M/1000 solutions of Sodium n-dodecyl benzene sulphonate (SDBS) was made and 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0 ml of this solution was added to the fermentor -flasks of first 20 sets respectively. The control fermentor-flask contained no chemical micelles. The total volume in each fermentor flask was made upto '100 ml' by adding requisite amount of distilled water. Thus, the concentration of Sodium n-dodecyl benzene sulphonate (SDBS) in 1st to 20th subsets were approximately as given below:

$A \times 10^{-x} M$,

$1.0 \times 10^{-5} M$, to $10.0 \times 10^{-5} M$

Where, A = amount of micelles in ml, ie; from 1.0 ml to 10.0 ml.

and x = molarity of the solution respectively.

The fermentor-flasks were then steam sterilized, cooled, inoculated, incubated at 34.5°C and analysed colorimetrically after 35, 50, 60, 70, and 80 hours for bioethanol³¹ formed and molasses sugars³² left unfermented.

Results and Discussion

The influence of sodium n-dodecyl benzene sulphonate (SDBS) on biotic production of bioethanol by the yeast *Saccharomyces cerevisiae* ARC-1607.

The data given in the table - 1 show that the sodium n-dodecyl benzene sulphonate (SDBS) was found to be stimulating for biotic production of bioethanol by the yeast *Saccharomyces cerevisiae* ARC-1607 upto its concentration from $1.0 \times 10^{-5} M$ to $10.0 \times 10^{-5} M$ in two phases: In the first phase, i.e., from $1.0 \times 10^{-5} M$ to $6.0 \times 10^{-5} M$ the effect of the micelle sodium n-dodecyl benzene sulphonate (SDBS) is significant and the biotic production of bioethanol increases gradually till a maximum value is reached at $6.0 \times 10^{-5} M$ i.e., 8.10 ml/100 ml in 60 hrs of optimum incubation period which is 25.581% higher in comparison to control, i.e., 6.45 ml/100 ml.

Table -1
Studies on facile biotic production of bioethanol exposed to
Sodium n-dodecyl benzene sulphonate (SDBS)

Concentration of micelles used $A \times 10^{-X} M$	Incubation Period in hours	Yield of bioethanol* in ml/100 ml	Molasses sugars* left unfermented in g/100 ml	% Difference in the yield of bioethanol in comparison to control after 60 hrs
Control	35	2.40	10.825	-
	50	4.25	8.706	-
	60	6.45	8.168	-
	70	5.55	6.720	-
	80	4.10	3.015	-
$1.0 \times 10^{-5} M$	35	****	-	-
	50	4.36	5.596	-
	60	6.62	7.998	+ 2.635
	70	5.69	6.580	-
	80	****	-	-
$1.5 \times 10^{-5} M$	35	****	-	-
	50	4.38	8.576	-
	60	6.66	7.958	+ 3.255
	70	5.72	6.550	-
	80	****	-	-
$2.0 \times 10^{-5} M$	35	****	-	-
	50	4.47	8.486	-
	60	6.80	7.818	+ 3.426
	70	5.84	6.430	-
	80	****	-	-
$2.5 \times 10^{-5} M$	35	****	-	-
	50	4.55	8.406	-
	60	6.91	7.708	+ 7.131
	70	5.94	6.330	-
	80	****	-	-
$3.0 \times 10^{-5} M$	35	****	-	-
	50	4.64	8.316	-
	60	7.05	7.568	+ 9.302
	70	6.06	6.211	-
	80	****	-	-
$3.5 \times 10^{-5} M$	35	****	-	-
	50	4.71	8.249	-
	60	7.20	7.418	+ 11.627
	70	6.16	6.112	-
	80	****	-	-

Contd...

Concentration of micelles used $A \times 10^{-X} M$	Incubation Period in hours	Yield of bioethanol* in ml/100 ml	Molasses sugars* left unfermented in g/100 ml	% Difference in the yield of bioethanol in comparison to control after 60 hrs
$4.0 \times 10^{-5} M$	35	****	-	-
	50	4.80	8.156	-
	60	7.31	7.308	+ 13.333
	70	6.27	6.001	-
	80	****	-	-
$4.5 \times 10^{-5} M$	35	****	-	-
	50	4.88	8.076	-
	60	7.44	7.178	+ 15.348
	70	6.38	5.890	-
	80	****	-	-
$5.0 \times 10^{-5} M$	35	****	-	-
	50	5.05	7.906	-
	60	7.70	6.918	+ 19.379
	70	6.60	5.670	-
	80	****	-	-
$5.5 \times 10^{-5} M$	35	****	-	-
	50	5.15	7.806	-
	60	7.82	6.798	+ 21.240
	70	6.71	5.560	-
	80	****	-	-
$6.0 \times 10^{-5} M^{**}$	35	****	-	-
	50	5.33	7.626	-
	60	8.10***	6.518	+ 25.581
	70	6.93	5.340	-
	80	****	-	-
$6.5 \times 10^{-5} M$	35	****	-	-
	50	5.18	7.776	-
	60	7.88	6.738	+ 22.170
	70	6.77	5.501	-
	80	****	-	-
$7.0 \times 10^{-5} M^{**}$	35	****	-	-
	50	5.11	7.846	-
	60	7.76	6.858	+ 20.310
	70	6.66	5.610	-
	80	****	-	-
$7.5 \times 10^{-5} M$	35	****	-	-
	50	4.99	7.966	-
	60	7.58	7.038	+ 17.519
	70	6.49	5.780	-
	80	****	-	-

Contd..

Concentration of micelles used $A \times 10^{-X} M$	Incubation Period in hours	Yield of bioethanol* in ml/100 ml	Molasses sugars* left unfermented in g/100 ml	% Difference in the yield of bioethanol in comparison to control after 60 hrs
$8.0 \times 10^{-5} M$	35	****	-	-
	50	4.86	8.096	-
	60	7.38	7.238	+ 14.418
	70	6.32	5.950	-
	80	****	-	-
$8.5 \times 10^{-5} M$	35	****	-	-
	50	4.62	8.336	-
	60	7.02	7.598	+ 8.837
	70	6.03	6.241	-
	80	****	-	-
$9.0 \times 10^{-5} M$	35	****	-	-
	50	4.52	6.435	-
	60	6.87	8.588	+ 6.511
	70	5.90	6.370	-
	80	****	-	-
$9.5 \times 10^{-5} M$	35	****	-	-
	50	4.443	8.526	-
	60	6.74	7.878	+ 4.496
	70	5.79	6.480	-
	80	****	-	-
$10 \times 10^{-5} M$	35	****	-	-
	50	4.35	8.606	-
	60	6.59	8.028	+ 2.170
	70	5.66	6.610	-
	80	****	-	-

* Each value represents mean of three trials. ** Optimum concentration of the chemical micelles used. *** Optimum yield of bioethanol in 60 hours. (+) Values indicate % increase in the yield of bioethanol in comparison to control. Experimental deviation ($\pm$) 1.5–3%.

In the second phase of micellar effect, i. e., from $6.5 \times 10^{-5} M$ and onwards the biotic production of bioethanol has been increased but in lesser amount. However, the bioethanolic fermentation by the yeast *Saccharomyces cerevisiae* ARC-1607 in the presence of sodium n-dodecyl benzene sulphonate (SDBS) at all its concentration used has been greater than that of control fermentor flasks. The micelles are long chain molecules containing twelve and more member of carbon atoms in the hydrocarbon tail with a head group. The surfactant sodium n-dodecyl benzene sulphonate (SDBS) is surface

active and lower the surface tension of water when dissolved in it. Surfactants undergo self-assembly thus sodium n-dodecyl benzene sulphonate (SDBS) also undergo self assembly, which depends on the chemical structure and nature of the media specially production medium containing different bioingredients. Opposite forces of repulsion between polar head groups (charged) and attraction between the hydrocarbon chains of the surfactants especially sodium n-dodecyl benzene sulphonate (SDBS) are responsible for self-assembly and may also influence the enzyme activity of the reaction.

Due to a balance between these hydrophilic and hydrophobic interactions, a specific structure stabilises.

However, micellar mechanism of fermentative enzyme action is not clearly known and no work has been done regarding the mechanism of influence of micelles on fermentation technology. The use of micellar systems for enzymes-catalysed reactions specially

in fermentation technology may vigorously stimulate the enzyme action and thereby enhances the yield of different fermentative production. The structure of micellar system is grossly similar to that of protein and their chemical composition is infinitely less complex. However, micelles may be taken for trial for different microbial synthesis as it may be proved to be an important biological tool in the field of fermentation technology specially in bioethanolic fermentation.

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