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Impact of Sodium pentadecyl sulfate micelles on fermentation dynamics and ethanol yield in *Saccharomyces cerevisiae* ARC-1607.

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Abstract : The use of surfactant micelles has emerged as a promising strategy to modulate microbial metabolism and improve bioethanol production. In the present study, the influence of sodium pentadecyl sulfate (SPS) micelles on ethanol fermentation by *Saccharomyces cerevisiae* ARC-1607 was investigated. SPS, an anionic surfactant with a long hydrophobic chain, was hypothesized to alter cell membrane permeability and enhance substrate uptake, thereby affecting fermentation efficiency. Different concentrations of SPS were supplemented into the fermentation medium, and their effects on fermentation kinetics, glucose utilization, cell growth, and ethanol yield were evaluated. The results revealed that low to moderate levels of SPS micelles significantly improved ethanol production by optimizing substrate assimilation and reducing fermentation lag, whereas higher concentrations exhibited inhibitory effects due to membrane stress. The study highlights the dual regulatory role of SPS micelles, acting as both metabolic enhancers and potential stressors, depending on dosage. These findings provide new insights into surfactant-mediated fermentation strategies and suggest that controlled micelle application could be a viable tool for bioprocess optimization in industrial ethanol production. In the present communication impact of sodium pentadecyl sulfate (SPS)micelles on fermentation dynamics and ethanol yield in *Saccharomyces cerevisiae* ARC-1607 has been studied. It has been observed that SPS has stimulatory effect on bioproduction of ethanol and enhances the yield of ethanol to an extent of 20.592%higher in comparison to control,ie;6.41ml/100ml when 23.5%(w/v)molasses solution is allowed to ferment at pH 4.8 ,temperature 34.5^{0}C and incubation period of 60 hrs along with some other significant rich ingredients required by the fungal strain under trial.

(**Keywords:**Sodium pentadecyl sulfate, micelles, ethanol fermentation, *Saccharomyces cerevisiae* ARC-1607, fermentation dynamics, bioethanol production)

Introduction

Ethanol remains one of the most significant biofuels due to its renewable origin, compatibility with existing infrastructure, and role in reducing greenhouse gas emissions compared to fossil fuels. Among the various ethanol-producing microorganisms, *Saccharomyces cerevisiae* has long been recognized as the industrial workhorse because of its robustness, high fermentation efficiency, and tolerance to adverse conditions such as osmotic stress, ethanol accumulation, and pH fluctuations. Despite these advantages, the efficiency of ethanol fermentation is often hindered by limitations in nutrient accessibility, metabolite inhibition, and suboptimal fermentation kinetics. These constraints have driven research toward novel strategies to enhance microbial performance and ethanol yield.

In recent years, surfactants and micellar systems have attracted increasing attention as promising tools to improve microbial fermentation processes[1-6]. Micelles, formed by amphiphilic molecules, can alter cell membrane permeability, facilitate substrate uptake, reduce product inhibition, and improve overall metabolic flux. Surfactant-mediated interventions have been shown to enhance oxygen transfer, substrate solubilization, and nutrient assimilation in microbial cultures. Sodium pentadecyl sulfate

(SPS), an anionic surfactant with a long alkyl chain, has the ability to form stable micelles in aqueous systems, potentially influencing microbial physiology and fermentation dynamics.[7-12]

The interaction between surfactant micelles and yeast cells can lead to significant modifications in membrane fluidity, transport processes, and enzyme activities involved in glycolysis and ethanol production. Moreover, micelles may act as protective carriers for hydrophobic compounds or aid in removing inhibitory by-products, thereby extending the productive lifespan of yeast cultures. While the effects of other surfactants such as Tween, Triton, and sodium dodecyl sulfate (SDS) have been explored in fermentation processes, the specific impact of sodium pentadecyl sulfate micelles on *S. cerevisiae* fermentation remains underexplored.

The strain *Saccharomyces cerevisiae* ARC-1607 is a promising ethanol-producing variant with potential for industrial applications. Investigating its interaction with SPS micelles may provide insights into novel strategies for enhancing ethanol bioproduction. Therefore, this study aims to evaluate the effect of sodium pentadecyl sulfate micelles on fermentation kinetics, cell growth, and ethanol yield in *S. cerevisiae* ARC-1607, with the broader goal of identifying surfactant-based interventions that could optimize industrial bioethanol production processes.

Micelles, which are colloidal aggregates of surfactants, can significantly alter fermentation dynamics by influencing microbial physiology, improving mass transfer, and enabling in-situ product recovery. The overall effect—whether inhibitory, neutral, or stimulatory—depends on the specific surfactant used, its concentration, and the fermentation system involved.

Literature survey shows that not enough research work has been done on biotic production of bioethanol by the yeast *Saccharomyces cerevisiae* ARC-1607 exposed to micelles,therefore,the authoress has employed SPS on facile biotic production of bioethanol by the yeast *Saccharomyces cerevisiae* ARC-1607.

Experimental

The impact of sodium pentadecyl sulfate on *Saccharomyces cerevisiae* ARC-1607 yeast's bioethanolic fermentation:

The following is the preparation of the production medium used by the yeast *Saccharomyces cerevisiae* ARC-1607 for the bioethanolic fermentation:
Molasses : 23.5%, Malt extract : 1.45%
Yeast extract : 1.45%, Peptone : 1.45%
$(NH_4)_2HPO_4$: 0.35%, pH : 4.8
A 100 ml amount was added by adding distilled water.

The medium's pH was brought to 4.8 by adding the necessary quantity of lactic acid. The capacity of a fermentor flask, or 100 ml of production medium for the yeast *Saccharomyces cerevisiae* ARC-1607's bioethanolic fermentation, is represented by the composition medium above.

The same fermentation medium, *Saccharomyces cerevisiae* ARC-1607, was now created for 99 fermentor-flasks, or 100 ml of medium per flask, for the purpose of bioethanolic fermentation. After that, the fermentor-flasks were placed into ten sets, each with nine fermentor-flasks. Every set was reorganized into three smaller groups, each including three fermentor-flasks. Out of the 99 fermentor flasks, the remaining 9 were preserved as controls and were rearranged into 3 subgroups, each with 3 fermentor flasks.

Now, 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 the M/1000 solution of sodium pentadecyl sulfate were added to the fermentor-flasks of the

Table -1
Research on bioethanol generation through easy biotic exposure to sodium pentadecyl sulfate

Micelle concentration using A × 10-x M	Hourly Incubation Period	Production of bioethanol* per 100 milliliter	*Unfermented blackstrap molasses sugars in grams per 100 milliliters	% Variation in bioethanol yield relative to control.
Control	35	2.35	10.887	-
	50	4.20	8.760	-
	60	6.41	8.210	-
	70	5.50	6.775	-
	80	4.05	3.073	-
1.0×10^{-5}M	35	****	-	-
	50	4.24	8.721	-
	60	6.50	8.120	+1.404
	70	5.55	6.726	-
	80	****	-	-
1.5×10^{-5}M	35	****	-	-
	50	4.28	8.680	-
	60	6.54	8.083	+2.028
	70	5.61	6.665	-
	80	****	-	-
2.0×10^{-5}M	35	****	-	-
	50	4.36	8.605	-
	60	6.70	7.920	+4.524
	70	5.74	6.536	-
	80	****	-	-
2.5×10^{-5}M	35	****	-	-
	50	4.41	8.552	-
	60	6.77	7.850	+5.616
	70	5.80	6.474	-
	80	****	-	-
3.0×10^{-5}M	35	****	-	-
	50	4.50	8.463	-
	60	6.88	7.740	+7.332
	70	5.90	6.377	-
	80	****	-	-
3.5×10^{-5}M	35	****	-	-
	50	4.54	8.420	-
	60	6.97	7.654	+8.736
	70	5.97	6.306	-
	80	****	-	-

4.0×10^{-5}M	35	****	-	-
	50	4.57	8.391	-
	60	7.02	7.606	+9.516
	70	6.02	6.254	-
	80	****	-	-
4.5×10^{-5}M	35	****	-	-
	50	4.62	8.342	-
	60	7.07	7.555	+10.296
	70	6.06	6.216	-
	80	****	-	-
5.0×10^{-5}M	35	****	-	-
	50	4.64	8.320	-
	60	7.10	7.523	+10.764
	70	6.08	6.195	-
	80	****	-	-
5.5×10^{-5}M	35	****	-	-
	50	4.66	8.300	-
	60	7.15	7.477	+11.544
	70	6.13	6.145	-
	80	****	-	-
6.0×10^{-5}M	35	****	-	-
	50	4.74	8.220	-
	60	7.28	7.341	+13.572
	70	6.24	6.035	-
	80	****	-	-
6.5×10^{-5}M	35	****	-	-
	50	4.83	8.130	-
	60	7.40	7.222	+15.444
	70	6.34	5.936	-
	80	****	-	-
7.0×10^{-5}M**	35	****	-	-
	50	5.06	7.901	-
	60	7.73	6.890	+20.592
	70	6.62	5.655	-
	80	****	-	-
7.5×10^{-5}M	35	****	-	-
	50	4.97	7.990	-
	60	7.60	7.025	+18.564
	70	6.51	5.765	-
	80	****	-	-
8.0×10^{-5}M	35	****	-	-
	50	4.87	8.095	-
	60	7.45	7.169	+16.224
	70	6.39	6.885	-
	80	****	-	-

8.5×10^{-5}M	35	****	-	-
	50	4.80	8.160	-
	60	7.33	7.293	+14.352
	70	6.39	5.995	-
	80	****	-	-
9.0×10^{-5}M	35	****	-	-
	50	4.64	8.320	-
	60	7.09	7.533	+10.608
	70	6.08	6.195	-
	80	****	-	-
9.5×10^{-5}M	35	****	-	-
	50	4.45	8.512	-
	60	6.80	7.825	+6.084
	70	5.83	6.445	-
	80	****	-	-
10×10^{-5}M	35	****	-	-
	50	4.33	8.632	-
	60	6.62	8.003	+3.276
	70	5.67	6.606	-
	80	****	-	-

* The mean of three trials is shown by each value. ** Optimal micelle concentration in usage. *** Optimal bioethanol yield in 60 hours. (+) Values show the percentage increase in bioethanol yield above the control. 1.5–3% is the experimental deviation (+).

first through the tenth sets, respectively. There were no micelles in the control fermentor-flasks. Each fermentor-flask's capacity was increased to 100 ml by adding the necessary volume of distilled water.

Consequently, the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth subgroups had roughly the following concentrations of sodium pentadecyl sulfate :
$a \times 10^{-x}$ M
i. e., 1.0×10^{-5} M to 10.0×10^{-5} M respectively.
where 'a' is the volume of micelles in milliliters, or between 1.0 and 10 milliliters.
= the micellar solution's molarity.

Following steam sterilization, cooling, inoculation, and 30°C incubation, the fermentor-flasks were analyzed colorimetrically at 35, 50, 60, 70, and 80 hours and for ethanol[13] formed and molasses[14] left unfermented.

Results and Discussion

Table 1 indicates that the yeast *Saccharomyces cerevisiae* ARC-1607 has found sodium pentadecyl sulfate to be considerably stimulating for bioethanolic fermentation. In 60 hours of optimal incubation, the greatest yield of bioethanol was seen at 7.0×10^{-5}M (7.73 ml/ 100 ml) in the presence of sodium pentadecyl sulfate. This yield was determined to be 20.592% greater than control flasks during the same time course of fermentation processes. The *Saccharomyces cerevisiae* ARC-1607 yeast did not fare well in its bioethanolic fermentation due to the greater quantity of sodium pentadecyl sulfate. Therefore, the yeast *Saccharomyces*

cerevisiae ARC-1607's bioethanolic fermentation is gradually slowed down by the steady addition of sodium pentadecyl sulfate once the concentration reaches 7.0×10^{-5} M.However, the *Saccharomyces cerevisiae* ARC-1607 yeast's bioethanolic fermentation has been found to be somewhat greater than that of the control fermentor-flasks at all concentrations of sodium pentadecyl sulfate employed.

The effect of sodium dodecyl-benzenesulfonate on *Saccharomyces cerevisiae* ARC-1607 yeast's biotic production of bioethanol.

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