

LSF bioproduction of H₃Cit exposed to ammonium lauryl sulfate

Pragati Kiran

Department of Chemistry, Magadh University, Bodh-Gaya (Bihar) India

Email : pragatikiran27@gmail.com

Manuscript received online 24 April 2020, accepted on 18 July 2020

Abstract: The efficacy of ammonium lauryl sulfate on liquid substrate fermentative production of citric acid (H₃Cit) by fungal strains of *Aspergillus aculeatus* NCIM-1212, *Aspergillus carbonarius* NCIM-1375, *Aspergillus foetidus* NCIM-1454, *Aspergillus wentii* NCIM-1535 and *Aspergillus clavatus* NCIM-1679 has been assessed. It has been found that the fungal strain specially *Aspergillus clavatus* NCIM-1679 is most effective and best citric acid producer. It has been noted that ammonium lauryl sulfate has stimulatory effect on liquid substrate fermentative production of citric acid (H₃Cit) and enhances the yield of citric acid (H₃Cit) to an extent of 14.693% higher in comparison to control fermentor flasks, i.e., 9.115g/100 ml under the optimized conditions.

(Key words : Citric acid fermentation, LSF, (H₃Cit) ammonium lauryl sulfate and *Aspergillus clavatus* NCIM-1679)

Introduction

Ammonium lauryl sulfate is the common name for ammonium dodecyl sulfate. The anion consists of a nonpolar hydrocarbon chain and a polar sulfate end group. The combination of nonpolar and polar groups confers surfactant properties to the anion: it facilitates dissolution of both polar and non-polar materials. A micelle is stable formation of amphipathic molecules, or molecules that have a polar head and a nonpolar tail. Polarity is the factor that determines whether a molecule interacts with or runs away from water. A micelle, then, is a spherical structure in which the nonpolar tails of amphipathic molecules hide on the inside and are shielded from water by the

polar heads that line the outside. Micelles have important roles in fat and vitamin absorption in the intestine. Micelles are lipid molecules that arrange themselves in a spherical form in aqueous solutions¹⁻⁸. The formation of a micelle is a response to the amphipathic nature of fatty acids, meaning that they contain both hydrophilic regions (polar head groups) as well as hydrophobic regions (the long hydrophobic chain). A number of recent review articles have been written on the rheology and applications of wormlike micelle solutions⁹⁻¹³. 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.¹⁴⁻¹⁸

Thus, from above brief review it is evident that micelles are required for exploitation specially for citric acid fermentation¹⁹⁻²⁰ and in view of this the authoress has studied the influence of ammonium lauryl sulfate on citric acid production by *Aspergillus clavatus* NCIM-1679.

Experimental

The influence of ammonium lauryl sulfate on citric acid production by *Aspergillus clavatus* NCIM-1679.

The composition of the production medium for citric acid production by *Aspergillus clavatus* NCIM-1679 has been prepared as follows: Molasses : 32% (w/v), NH₄NO₃ : 0.36%, KH₂PO₄ : 0.36%, MgSO₄·7H₂O : 0.50%, pH : 1.8

The pH of the production medium was adjusted to 1.8 by adding requisite amount of KCl-

Table - 1
LSF bioproduction of H₃Cit by *Aspergillus clavatus* NCIM 1679
exposed to ammonium lauryl sulfate

Concentration of micelle used $A \times 10^{-x} \text{ M}$	Incubation Period in days	Yield of citric acid* in g/100 ml	Molasses* left Unfermented in g/100 ml	% of citric acid increased after 12 days
Control	12	9.113	4.886	-
1.0x10 ⁻⁵ M	12	9.185	4.818	+0.790
2.0x10 ⁻⁵ M	12	9.258	4.749	+ 1.591
3.0x10 ⁻⁵ M	12	9.404	4.598	+ 3.193
4.0x10 ⁻⁵ M	12	9.687	4.315	+ 6.298
5.0x10 ⁻⁵ M	12	9.860	4.148	+ 8.197
6.0x10 ⁻⁵ M	12	10.060	3.939	+10.391
7.0x10 ⁻⁵ M	12	10.288	3.715	+12.893
8.0x10 ⁻⁵ M**	12	10.452***	3.549	+14.693
9.0x10 ⁻⁵ M	12	9.814	4.188	+7.692
10.0x10 ⁻⁵ M	12	9.413	4.586	+3.292

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

*** Optimum yield of citric acid (+) values indicate % increase in the yield of citric acid after 12 days. Experimental deviation ($\pm$) 1.5-3%

HCl buffer solution, and this pH was also ascertained by a pH meter. The above composition medium represents volume of a fermentor flask, i.e., "100ml" for citric acid production by *Aspergillus clavatus* NCIM-1679.

Now, the same production medium for citric acid production by *Aspergillus clavatus* NCIM-1679 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 ammonium lauryl sulfate was prepared and from the above micellar 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 micelle.

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 ammonium lauryl sulfate in 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th subsets were approximately as given below :

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

1.0x10⁻⁵M to 10.0x10⁻⁵M respectively.

Where : A = amount of micelle.

in ml, i.e. 1.0 ml to 10 ml.

x = Molarity of the micelle solution

The above fermentor flasks were then sterilized, cooled inoculated, incubated at 32°C and analysed after 9, 12 and 15 days for citric acid²¹ formed and molasses²² left unfermented.

Results and Discussion

The influence of ammonium lauryl sulfate

The data given in the table 1 shows

that the micelle, i.e., ammonium lauryl sulfate has been found stimulatory for the LSF production of H₃Cit by *Aspergillus clavatus* NCIM 1679. From the data given in the table-1 it is obvious that ammonium lauryl sulfate influences the citric acid fermentation process in different phases. The main characteristics of the ammonium lauryl sulfate is as follows :

- (i) Ammonium lauryl sulfate is stimulatory at its all molar concentrations used during the LSF production of H₃Cit by *Aspergillus clavatus* NCIM 1679 i.e., from 1.0×10^{-5} M to 10.0×10^{-5} M.
- (ii) The molar concentration from 1.0×10^{-5} M to 8.0×10^{-5} M of ammonium lauryl sulfate influence the yield of citric acid in a approximately regular increasing order after each state, i.e., 0.790%, 1.591%, 3.193%, 6.298%, 8.197%, 10.391%, 12.893% and 14.693%.
- (iii) The molar concentration 9.0×10^{-5} M and 10.0×10^{-5} M of ammonium lauryl sulfate also influences the productivity of citric acid in a

regular decreasing manner. The % increase in the yield of citric acid at respective molar concentration of ammonium lauryl sulfate has been found to be as follows : 7.692% and 3.292%.

- (iv) The maximum yield of citric acid, i.e; 10.452g/100 ml in the presence of ammonium lauryl sulfate was observed at 8.0×10^{-5} M molar concentration in 12 days of optimum incubation period which is 14.693% higher in comparison to control fermentor flasks, i.e; 9.113 g/100 ml in the same times course and other same experimental parameters.
- (v) The higher molar concentrations of ammonium lauryl sulfate were not much favourable for the LSF production of H₃Cit by *Aspergillus clavatus* NCIM 1679. So the gradual addition of the micelle, i.e., ammonium lauryl sulfate after molar concentrations 9.0×10^{-5} M and onwards were not beneficial for the LSF production of H₃Cit by *Aspergillus clavatus* NCIM 1679.

References

1. P. Schurtenberger, R. Scartazzini, L J Magid, , Leser, M E and P I Luisi, *J. Phys. Chem.*, **94**(9) 3695 (1990)
2. H Rehage and H. Hoffmann, *Mol. Phys.*, **74**(5) 933 (1991)
3. JN Israelachvili, Intermolecular and surface forces. 2nd ed. Academic Press (London ; San Diego). xxi, 450 (1992)
4. JN Israelachvili, *Academic Press* (London), 296 (1985).
5. R G Larson, , The Structure and Rheology of Complex Fluids. Oxford University Press (New York) 364 (1999)
6. V J Anderson, J R A Pearson, and E S Boek, , The British Society of Rheology. p. 217-253. (2006).
7. J. Yang, *Current Opinion in Colloid and Interface Sci.*, **7**, 276 (2002).
8. C A Dreiss, , *Soft Matter*, **3**, 956 (2007).
9. Tung, S-H, Huang, Y-E and Raghavan, S R, *J. Am. Chem. Soc.*, **128**, 5751 (2006) .
10. J L Zakin, B Lu, and N W Bowerdorff, *Rev. Chem. Eng.*, **14**(45), 253 (1998).
11. R G Laughlin, *Academic Press* (New York) (1994).
12. M ECates and Fielding, S M, *Adv. Phys.*, **55** (7-8) 799 (2006) .
13. F. Lequeux, and S J Candau, T. McLeish, Editor. Kluwer Academic Publishers: Netherlands. p. 181-190 (1997).
14. D. Danino, Y. Talmon and R. Zana, *Langmuir*, **11**, 1448 (1995).
15. D. Danino, A. Bernheim-Groswasser, and Y. Talmon, *Physicochemical and Engineering Aspects*, **183**, 113 (2001).

16. H. Cui, T K Hodgdon, E W Kaler, L. Abezgauz, D. Danino, M. Lubovsky, Y. Talmon, and D J Pochan, *Soft Matter*, **3**, 945 (2007).
17. D. Danino, Y. Talmon, H. Levy, G. Beinert, and R. Zana, Branched threadlike micelles in an aqueous solution of a trimeric surfactant. *Science*, **269**, 1420 (1995).
18. D. Danino, Y. Talmon and R. Zana, *Physiochemical and Engineering Aspects*, **169**, 67 (2000) .
19. J. P. Kumar and S. P. Singh *J. Chemtracks* **18**(1) 57 (2016)
20. Pragati Kiran, S. R. K. Singh and S.P. Singh *J. Chemtracks*, **18**(2), 353-356, 2016
21. J. R. Marrier and M. Boulet *J. Dairy Science*, **41**, 1683 (1983).
22. M. Dubois, K.A. Gilles J. K. Hamilton and F. Smith, *Anal Chem.* **28**, 350 (1956).

Abstracted / Indexed in : Chemical Abstract U.S.A.

JC-1408/2K20 (ISSN:0973-239X), INDIA

Journal Chemtracks Vol. 22 (1&2), 333-336, January to December 2020