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Impact of Tryptamine on biotic production of ethanol by *Saccharomyces cerevisiae* SP-25

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Abstract : Tryptamine, an indole alkaloid derived from the decarboxylation of nicotine sulfate, has been recognized for its regulatory influence on microbial metabolism. The present study investigates the impact of tryptamine supplementation on the biotic production of ethanol by *Saccharomyces cerevisiae* strain SP-25. Experimental cultures were subjected to varying concentrations of tryptamine to assess its effect on yeast growth dynamics, sugar utilization efficiency, and ethanol yield. Results demonstrated that optimal concentrations of tryptamine significantly enhanced ethanol productivity by stimulating cellular metabolism and improving fermentation kinetics. However, excessive concentrations exhibited inhibitory effects, likely due to metabolic stress and altered membrane permeability. The findings suggest that controlled application of nicotine sulfate, can modulate yeast physiology, leading to improved bioconversion efficiency in bioethanol production systems. This study highlights the potential of bioactive indole compounds as metabolic enhancers in industrial fermentation processes. It has been found that tryptamine at 7.0 $x10^{-5}$M molar concentration enhances the yield of ethanol by *Saccharomyces cerevisiae* SP-25 to an extent of 18.085% higher in comparison to control i.e; 4.70 ml/100ml in 58 hrs of incubation period, 4.5pH and 30^0C temperature with 15%(w/v) molasses solution.

(Keywords : Molasses solution, ethanol, tryptamine, and *Saccharomyces cerevisiae* SP-25).

Introduction

Ethanol is one of the most significant biofuels, serving as a renewable and sustainable alternative to fossil fuels. Its biological production, commonly referred to as bioethanol fermentation, primarily involves the yeast *Saccharomyces cerevisiae* due to its high fermentative efficiency, substrate versatility, and tolerance to ethanol toxicity. However, the optimization of ethanol yield remains a major research focus, influenced by various physiological and biochemical factors that regulate yeast metabolism. Tryptamine, an indole alkaloid derived from the decarboxylation of the amino acid tryptophan, plays diverse roles in microbial and plant systems. It is known to act as a signaling molecule influencing cellular growth, stress response, and metabolic regulation. Recent studies suggest that exogenous tryptamine and its derivatives can modulate enzymatic activities involved in energy metabolism, redox balance, and secondary metabolite production in microorganisms.

The interaction between tryptamine and *S. cerevisiae* metabolism presents an interesting area for investigation, especially in the context of biotic ethanol production. Tryptamine may influence yeast physiology through modulation of mitochondrial function, oxidative stress responses, and the regulation of key glycolytic and fermentative enzymes such as alcohol dehydrogenase and pyruvate decarboxylase. Moreover, specific yeast strains, such as *S. cerevisiae* SP-25, may exhibit unique metabolic responses to tryptamine exposure due to genetic or adaptive variations.

Understanding the impact of tryptamine on ethanol production by *S. cerevisiae* SP-25 could provide new insights into metabolic regulation during fermentation and help in

developing strategies to enhance bioethanol yield. Such research bridges microbial biotechnology, biochemical modulation, and renewable energy production, contributing to the broader goal of sustainable biofuel development.

The impact of tryptamine on biotic production of ethanol by *Saccharomyces cerevisiae* SP-25 have not been studied extensively[1]. Since some alkaoids[2-18] are known to be stimulatory during some fermentation process it is obvious that such alkaoids being toxic and poisonous in nature are not toxic to the organisms involved in various fermentation process. The present study has been undertaken to assess and analyze impact of tryptamine on biotic production of ethanol by *Saccharomyces cerevisiae* SP-25.

Experimental

The influence of tryptamine on microbial bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25. The composition of the production medium for microbial bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25 is prepared as follows :

Molasses : 15% (w/v), Malt-Extract : 1.25% , Yeast-Extract : 1.25%, Peptone : 1.25% Distilled water : To make up 100 ml, pH : 4.5, Distilled water was added to make up the volume up to '100 ml'. The pH of the medium was adjusted to 4.5 by adding requisite amount of lactic acid.

Now, the same production medium for ethanol production by *Saccharomyces cerevisiae* SP-25 was prepared for 99 fermentor-flasks, i.e., each containing 100 ml of production medium. These fermentor-flasks were then arranged in 10 sets each comprising 9 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.

Table - 1
Impact of tryptamine on biotic production of ethanol

Concentration of alkaloid used $A \times 10^{-x}$ M	Incubation Period in hours	Yield of ethanol* in ml/100 ml	Molasses sugars* left unfermented in g/100 ml	% Difference in yield of ethanol after 58 hours in comparison to control.
Control	58	4.70	2.480	–
1.0×10^{-5}M	58	4.72	2.460	+0.425
2.0×10^{-5}M	58	4.77	2.421	+1.489
3.0×10^{-5}M	58	4.86	2.322	+3.404
4.0×10^{-5}M	58	4.95	2.241	+5.319
5.0×10^{-5}M	58	5.15	2.301	+9.574
6.0×10^{-5}M	58	5.42	1.762	+15.319
7.0×10^{-5}M **	58	5.55***	1.640	+18.085
8.0×10^{-5}M	58	5.30	1.881	+12.765
9.0×10^{-5}M	58	5.10	2.001	+8.510
10.0×10^{-5}M	58	4.92	2.262	+4.680

* Each value represents mean of three trials. ** Optimum concentration of the alkaloid used.
*** Optimum yield of ethanol in 58 hours. (+)Values indicate % increase in the yield of ethanol in comparison to control. Experimental deviation ($\pm$) 1.5–3%.

Now, M/1000 solution of tryptamine was prepared and 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, and 10.0 ml of this solution was added to the fermentor-flasks of first 10 sets respectively. The control fermentor-flask contained no tryptamine. The total volume in each fermentor-flask was made upto '100 ml' by adding requisite amount of distilled water.

Thus, the concentration of tryptamine in first, second, third, fourth, fifth, sixth, seventh, eighth, ninth and tenth subsets were approximately as given below :

$A\times10^{-x}$M, 1.0×10^{-5}M to 10.0×10^{-5}M respectively.
Where, A= amount of tryptamine in ml, ie; from1.0 ml to 10.0 ml.
x = molarity of the tryptamine solution.

The fermentor-flasks were then steam sterilized, cooled, inoculated, incubated at 30^0C and analysed colorimetrically after 48, 58, and 65 hours for ethanol[19] formed and molasses sugars[20] left unfermented.

Results and Discussion

The influence of tryptamine on bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25

The data recorded in the table-1 shows that tryptamine has stimulatory effect on bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25.

The data (table-1) reveals that the alkaloid, i.e., tryptamine stimulates the bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25 and enhances the yield of ethanol upto its nicotine sulphate concentrations from 1.0×10^{-5} M to 7.0×10^{-5} M in two phases:

In the first phase, ie; from 1.0×10^{-5} M to 7.0×10^{-5} M the effect of tryptamine on the productivity (the yield) of ethanol was gradually in increasing order and achieves its best function at 7.0×10^{-5} M where maximum yield of ethanol, i.e; 5.55 ml/100 ml is obtained in 58 hours of optimum incubation period which is 18.085% higher in comparison to control fermentor flasks (4.70ml/100 ml).

In the second phase of coumarins effect the molar concentrations, i.e.; from 8.0×10^{-5} M to 10.0×10^{-5} M the production of ethanol has been enhanced but the order of ethanol productivity is found reversed in respect to increasing molar concentrations of nicotine sulphate. However, the bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25 under the influence of each concentration of tryptamine used has been stimulating and the yield of ethanol has been found greater than that obtained in the control fermentor flasks.

Concentration of tryptamine on bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25

from 1.0×10^{-5} M to 7.0×10^{-5} M .
Productivity of ethanol: 0.425%, 1.489%, 3.404%, 5.319%, 9.574%, 15.319% and 18.085%
Concentration of tryptamine from 8.0×10^{-5} M to 10×10^{-5} M .
Productivity of ethanol **:** 12.765%, 8.510%, and 4.680%

Thus, it is concluded that tryptamine at lower concentrations is found stimulatory and at higher concentrations it is deterioratory for bioconversion of molasses to ethanol by *Saccharomyces cerevisiae* SP-25

The growth pattern of *Saccharomyces cerevisiae* SP-25 was significantly influenced by the concentration of tryptamine added to the fermentation medium. At lower concentration of tryptamine the yeast *Saccharomyces cerevisiae* SP-25 exhibited a slight in the growth rate and cell biomass compared to the control,indicating a possible stimulatory effect of tryptamine on

cell metabolism. However at higher concentration levels of tryptamine resulted in a progressive decline in growth suggesting cytotoxic or stress-inducing effects at higher level doses.

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