

183. Study to Investigate the Effect of Temperature on Performance of Thermotolerant *Kluyveromyces Marxianus* during the Production of Ethanol Using Numerical Simulation

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Abstract

Production of ethanol from renewable source give a new area of research for future fuel requirement. During fermentation reaction heat generated that create problem and ultimate decrease microbial growth. In Pakistan temperature ranges from 40-50C in summer season during that production of ethanol effected by temperature due to usage of yeast that grow in temperature ranges up to 29-36C regarding this thermotolerant yeast is best for these environmental conditions . Temperature effect were investigated using numerical technique with the help of C++ software. Experimental and model results also compared, the optimized experimental results were found at 45-50C ethanol production maximum up to 74g/l. But as for numerical study were concerned the best results at higher temperature ranges 45-50C is about 76g/l. Thermotolerant had advantages can be used in hot environmental conditions.

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1. Introduction

Pakistan level among other countries is 7th regarding sugarcane, ethanol production through fermentation is one of the well identified technique Numerical techniques had been used to solve various differential equation that could effect on ethanol production. During process of fermentation exothermic reaction occur that reaction emit handsome amount of heat. Temperature effect on ethanol production were investigated through use of mathematical model fermentation process done by different microorganism but mostly used microorganism is nothing but the *saccharomyces crevasse*. Molasses were used as feed stock as well as. *Saccharomyces cerevisiae* were used as biocatalyst to carry out fermentation [1]. During process of bioethanol from native microorganism temperature effect had considered regarding growth of microorganism. Model were prepared that express one factor which utilize to sort out multiple growth of microorganism [2] Sanchez et al. discussed the temperature dependency that effect production of ethanol and xylitol kinetic parameter. [3] For explaining denaturation of ribosomes and enzymes explained through linear model. A were developed [4] an empirical linear model were developed for describing the temperature & nutritional effect on ethanol production through fermentation [5]. It had been well-known that microorganism activity could effect by environmental condition. Apart from this fermentation process is also victim of theses environmental condition that change the phenomena of process. Fermentation environmental condition which couple with mass transfer and metabolic behavior of microorganism that utilize to convert substrate into product. To gain insight into the morphology-associated time-variant process dynamics, various kinetic models associated with key parameters for ethanol fermentation have been proposed [6-16]. This work is related with the effect of temperature on ethanol production using numerical techniques.

2. Methodology

Experimental data were collected from Aziz 2009 different temperature ranges were used to see the effect on

ethanol production by applying numerical method. Monod model equations were used to investigate the temperature effect on ethanol production.

Figure 01 shows the successive steps for development procedure to carryout numerical simulation. Numerical simulation were done on the basis of numerical method (RK Ode4) using C++ programming as tool. Results were compared and analyzed by doing comparison between simulations with experimental results.

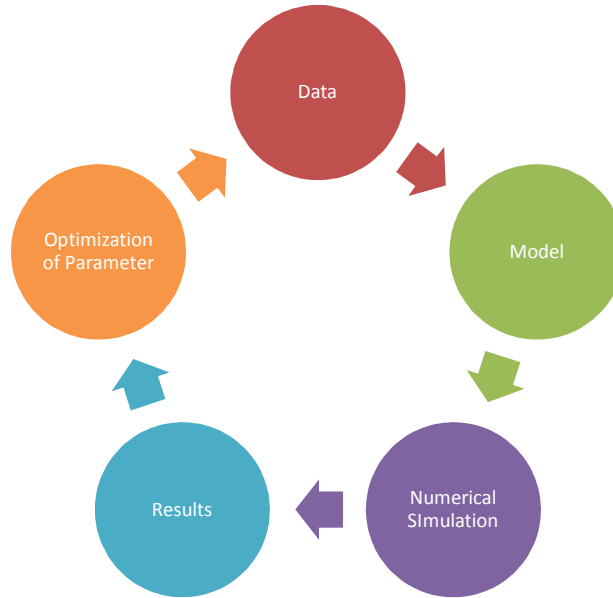


Fig 1. Flow Chart for Numerical Simulation of Ethanol Production

3. Model

Monod kinetic model were used to investigate the temperature effect on ethanol production. For cell growth, substrate utilization and ethanol production

$$\frac{dx}{dt} = \mu_{\max} \left(\frac{S}{k_{xx} + S} \right) X \quad (1)$$

$$\frac{dP}{dt} = q_{\max} \left(\frac{S}{k_{sp} + S} \right) X \quad (2)$$

$$\frac{dS}{dt} = - \left(\frac{1}{Y_x} \frac{dx}{dt} \right) - \left(\frac{1}{Y_p} \frac{dP}{dt} \right) \quad (3)$$

Where μ_{\max} = maximum cell growth, X = cell growth, S = substrate utilization, k_{xx} = half saturation constant, q_{\max} = maximum specific growth, $Y_{x/s}$ = yeild coefficient cell.

4. Results And Discussion

Experimental Results were analyzed with simulation tool C++ with to see the effects of temperature on ethanol production. Temperature ranges from 30-50 °C under study to observe effect on cell mass (g/l), Substrate (g/l) and Production of ethanol (g/l). Monod kinetic **model** were utilized to investigate the temperature effect on ethanol production.

4.1 Effect of temperature on Cell Mass (g/l)

During microbial growth in fermentation process effect by varying temperature because microorganism did not survive with unsatisfactory environment. Regarding this study was made to optimize the temperature ranges for cell growth, using simulation tool for solving model proposed by researcher for temperature effect. By keeping other process parameter under optimized conditions. The maximum cell growth occur at 40°C about 7.8g/l and minimum at 55°C during fermentation

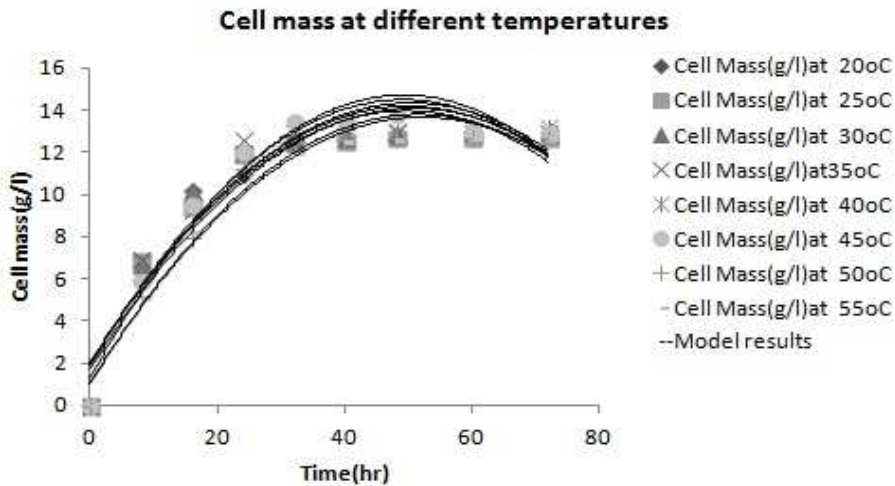


Fig. 2. Cell mass at temperature ranges from 20-55°C

4.2 Effect of temperature on substrate utilization

Numerical simulation were using Monod model at different temp ranges to investigate the maximum utilization of substrate for alcohol production. Because when substrate utilize increase alcohol production increases. Temperature ranges from 25-55°C step size of 5°C were used to observe the maximum substrate utilization for alcohol production from molasses. Monod model give a best results at temperature 45°C for maximum utilization of substrate.

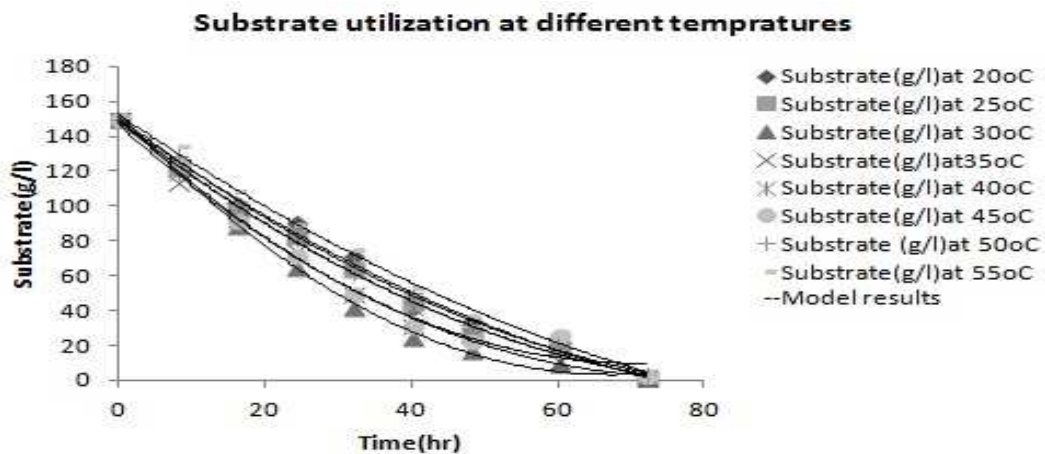


Fig. 3. Substrate at temperature ranges from 20-55°C

4.3 Effect of temperature on ethanol production

Study was made on different temp ranges to investigate the temp at which maximum alcohol production occur, Monod model were used in this study using C++ programming for ethanol production from different temperature. The maximum ethanol production were occur at 33 °C. At this temp numerical simulation gave ethanol production about 76g/l. and for experimental results also gave 76g/l. the minimum ethanol production occur at 20-25 °C for numerical results.

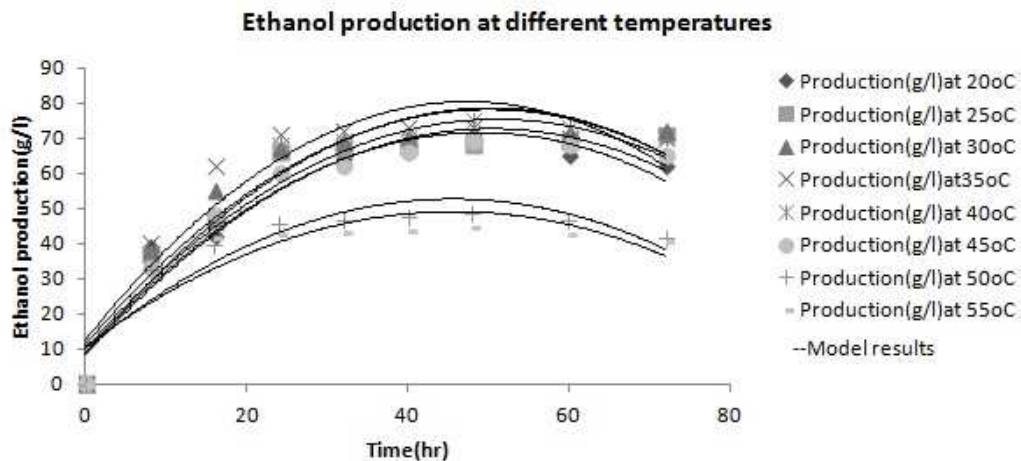


Fig. 4. Ethanol production at temperature ranges from 20-55 °C

5. Conclusion

Study was made for carryout temperature effect on ethanol production from molasses, it was found through experimental and numerical study that temperature had effect on ethanol production due to microbe use to carryout fermentation process. Cell growth, substrate utilization and ethanol production were made to study the effect of temp on it. It was found that by utilizing temperature 33-40c give maximum cell growth 10g/l, maximum substrate utilize and maximum ethanol production about 76g/l for experimental and model results.

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