The Effect of Low Intensity Ultrasounds on Ethanol Production by Yeast

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ABSTRACT

In this study, the feasibility of using low-intensity ultrasound treatment for improving the fermentation process was investigated. Six different ultrasounds treatment were conducted to assess the effect of ultrasound. The evaluation was done by measuring alcohol content and reducing sugar during the 7-days period of fermentation. The results showed that the continuous ultrasound treatment improved the fermentation process by producing more ethanol in the shorter time. The most optimum treatment was obtained using 12% amplitude power for 3 hours. Reducing the sugar contents resulted in increasing the alcohol levels due to the anaerobic process that converted pyruvate to ethanol.

INTRODUCTION

Yeast is a microorganism that initiates fermentation; a process that converts sugar into organic acids, gases or ethanol. Fermentation is commonly used in the food industry for alcoholic beverages production such as beer, wine, and liquor. Fermentation process in alcoholic beverages production is time-consuming (e.g. beer requires a minimum of 2 weeks for fermentation[1]). This often causes industries to be less productive, possibly resulting in extra cost in production. Studies have reported the application of different technologies, such as the use of pulsed electric fields, ohmic heating, high pressure, and ultrasounds[2] to enhance the yeast fermentation process during the production of beer.

Why treating the Yeast?

In the future, we would like the findings of this research to benefit all food industries (large/small scale) by producing a ready-to-use treated yeast that can be easily purchased by anyone. Large industries wouldn't have to buy the technology, small industries would be able to afford.

Why Ultrasounds?

- Ultrasound is typically less aggressive to yeast.[2]
- Ultrasound controls the level of dissolved gas.[3] By controlling the level of dissolved carbon dioxide (DCO_2), ethanol production can be increased since fermentation is dependent of the level of CO_2.[4]
- Ultrasound increases ethanol production in fermentation due to cavitation and heat effects.[5]

METHODS

Few grams (0.1165) of yeast nutrient and 100 mL of distilled water were heated for 5 minutes then the mixture was cooled down to room temperature. Few grams (0.575) of dry yeast was added to the mixture. The mixture was continuously treated with ultrasounds. The treatments were with amplitude power of 12% for 1, 3 and 5 hours and amplitude power of 8% for 1, 3 and 5 hours. One hundred grams of dried malt extract was dissolved in 900 mL of distilled water. The treated yeast was added to the dried malt extract mixture. Fermentation was conducted for 7 days and samples were taken daily. Alcohol content was measured by a hydrometer. Reducing sugar was measured using Nelson-Somogyi's method.

RESULTS

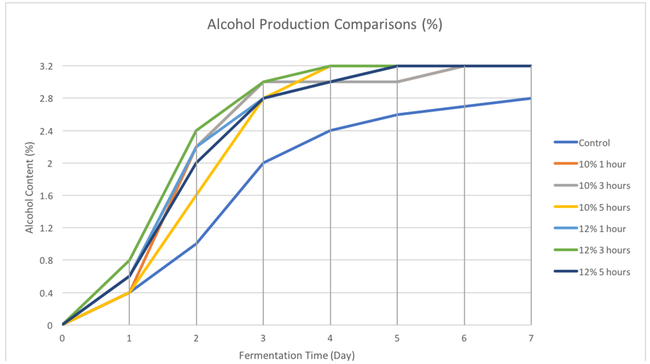

Figure 1 *Comparisons of alcohol production between different treatments*

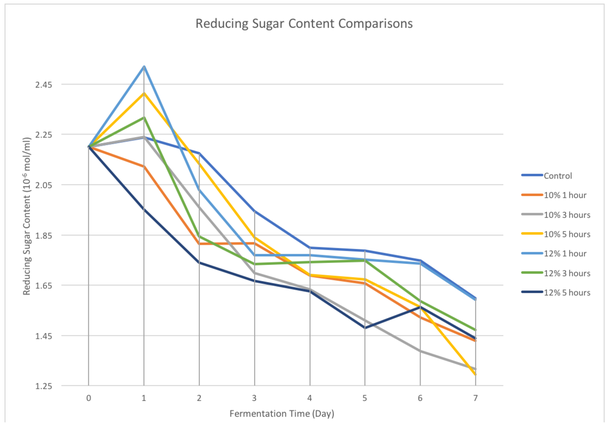

Figure 2 *Comparisons of reducing sugar content between different treatments*

DISCUSSION

Figure 1 shows that the yeast that has received ultrasounds treatments produced more alcohol in a shorter time compared to the control. Generally, 12% amplitude power worked better than 10% amplitude power. The most optimum treatment was obtained using 12% amplitude power for 3 hours as it reached 3.2% of alcohol content in 4 days when the untreated yeast (control) couldn't reach the alcohol content of 3% even after 7 days.

Figure 2 shows that reducing sugar content generally decreased by increasing the fermentation time. Decreasing the reducing sugar content resulted in increasing the alcohol content. This might be due to the reason that during alcoholic fermentation, pyruvate was converted into ethanol and CO_2. Sugar in dried malt extract went through metabolic pathways: glycolysis and fermentation. Glycolysis is aerobic, and it breaks down sugar to produce energy. The resulting product of glycolysis is pyruvate which would go to the second pathway, alcoholic fermentation and resulted in the production of ethanol and CO_2.

CONCLUSION

- Ultrasound treatment to yeast improves yeast fermentation, resulting in more alcohol produced in shorter time.
- As alcohol increases, reducing sugar decreases as reducing sugar goes through alcoholic fermentation to produce alcohol and CO_2.

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