

THESIS INFORMATION

Title : Research on high gravity brewing with immobilized yeast in Ca-alginate gel

Major : Food and Beverage Technology

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Research objective

To select the technical solutions for improving the fermentation efficiency of high gravity brewing with immobilized yeast in Ca-alginate gel.

Research Contents

- Determine the technological parameters of yeast immobilization in alginate gel and the effects of immobilization on the yeast morphology and fermentation performance in high gravity brewing.
- Select the technical solutions for improving the fermentation efficiency of high gravity brewing with the immobilized yeast in Ca-alginate gel, using the wort with and without addition of maltose syrup adjunct.
- Set up the stoichiometry equation for the fermentation in high gravity brewing using free yeast and immobilized yeast.

Thesis contributions to fundamental science

- Fermentation kinetics of sugar uptake by the free and immobilized yeast in high gravity brewing.
- Stoichiometry equation for high gravity brewing with free and immobilized yeast.

Thesis contributions to applied science

- Technological parameters of yeast immobilization for the application to high gravity brewing.
- Technical solutions for improving the fermentation efficiency of high gravity brewing using 24°Bx wort and immobilized yeast in Ca-alginate gel.

Thesis results for fundamental science

1. Fermentation kinetics of sugar uptake by the free and immobilized yeast in high gravity brewing:
 - The free and immobilized yeast metabolised glucose, fructose, saccharose and maltose at the beginning of the fermentation.
 - The immobilization made the yeast metabolise maltotriose at the beginning of the fermentation, whereas the free yeast metabolised maltotriose after the first 48 fermenting hours.
2. Stoichiometric equation for high gravity brewing with the free and immobilized yeast
 - The biomass yield of the immobilized yeast was 92.0% higher than that of the free yeast.
 - The ethanol yield of the immobilized yeast was 8.3% lower in comparison with that of the free yeast.
 - The glycerol, organic acid and high alcohol yields of the immobilized yeast were 39.1; 13.7 and 53.8%, respectively lower than those of the free yeast.

Thesis results for applied science

1. The fermentation characteristics of the immobilized yeast were better than those of the free yeast in high gravity brewing. When the initial density of wort increased from 12% to 28%:
 - The maximum of cell number in the immobilized yeast was culture 18.8% - 35.7% higher than that of the free yeast culture and the viability of the immobilized yeast did not fall below 97%.

- The reducing sugar and free amino nitrogen uptake rates of the immobilized yeast were 39.1% - 85.4% and 114.2% - 377.3%, respectively higher in comparison with that of the free yeast.
 - The ethanol production rate of the free and immobilized yeast was not significantly different in the 12°Bx wort. When the initial density of wort increased from 12% to 28%, the ethanol production rate in the immobilized yeast was 35.9% -55.3% higher than that of the free yeast.
 - The suitable conditions for yeast immobilization in Ca-alginate gel for high gravity brewing were as follows: yeast concentration in the gel beads was 5.0×10^7 cells/mL & alginate concentration in the gel beads was 2.5% w/v. under these conditions, the immobilized yeast fermented 24°Bx wort with 30 repeated during the period of 150 days and the fermentation performance of the immobilized yeast was always better than that of the free yeast.
2. High gravity brewing with 24°Bx all malt wort and immobilized yeast in Ca-alginate gel:
- The inoculum size was 1.0×10^7 cells/mL.
 - After pitching the suitable aeration time for yeast was 12h. During the aeration, the dissolved oxygen concentration in the culture was maintained at 7.5 ppm. Under these conditions, the fermentation time and the ethanol concentration in the green beer reduced 25% and 4.7%, respectively in comparison with those of the control aerated before pitching.
3. High gravity brewing with 24°Bx wort add by 30% maltose syrup adjunct and immobilized yeast in Ca-alginate gel:
- For batch fermentation: Supplementation Tween 80 (0.3% v/v) and ergosterol (0.18 mg/L) to the wort reduced the primary fermentation time of 22.2% in comparison with those of the control sample. This supplementation did not affect ethanol concentration in the green beer.
 - For continuous fermentation: When the pitching rate increased from 1.0×10^7 to 7.0×10^7 cells/mL, the dilution rate increased 3.2 times, the average ethanol

content in green beer reduced 30.9% and the time of using immobilized yeast reduced 45.5%.

Advisors

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