

## ABSTRACT

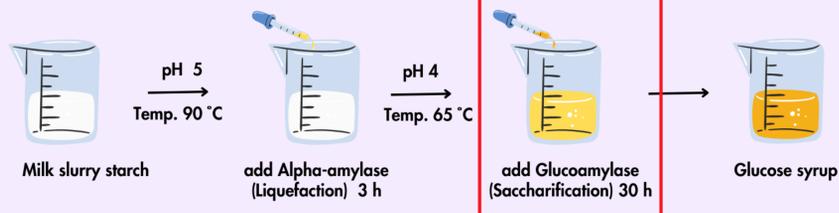
This study aims to determine the optimal concentration of a new glucoamylase enzyme for the saccharification process of starch, with the objective of producing glucose syrup that meets the quality standards established by the industry. The findings from this experiment will be used to assess the feasibility of replacing the currently used glucoamylase in the saccharification process with the new glucoamylase. Preliminary studies have demonstrated that, at the same concentration, the new glucoamylase produces a higher-quality sugar product compared with the enzyme currently utilized by the industry, therefore detailed experiment is needed for justification. This study investigated four different concentrations of the new glucoamylase: 0.4X I/DS-t, 0.2X I/DS-t, 0.1X I/DS-t, and 0.0X I/DS-t, in comparison with the currently used glucoamylase (0.6X I/DS-t). The saccharification process was conducted for 30 hours, and the results were evaluated based on Reducing Sugar (RS), Total Reducing Sugar (TRS), Saccharification Percentage (%Saccharification), and Degree of Polymerization (DP). The experimental results indicated that enzyme concentrations of 0.4X I/DS-t, 0.2X I/DS-t, and 0.1X I/DS-t met the quality standards specified by the industry in terms of RS, TRS, %Saccharification, and DP. However, the concentration of 0.0X I/DS-t did not meet the required criteria, as its lower concentration necessitated a hydrolysis period exceeding 30 hours under the saccharification conditions currently employed in industrial processes. Based on these findings, it can be concluded that the minimum concentration of the new glucoamylase that can be utilized in the saccharification process within 30 hours while ensuring that the glucose syrup meets industry quality standards is 0.2X I/DS-t.

## INTRODUCTION

In the sugar production process, there are two main steps, liquefaction, that uses alpha-amylase enzymes to break down starches into shorter chains, and saccharification in which, glucoamylase enzymes further break down the chains into simple sugars. Currently, the saccharification step employs the glucoamylase A. Previous studies comparing glucoamylase A with glucoamylase B, revealed that glucoamylase B enhanced sugar quality but was more expensive. Therefore, this study aims to determine the optimal amount of glucoamylase B for use in the saccharification process to assess cost-effectiveness for future applications.

## METHODOLOGY

### Sugar production process



#### The evaluation point for Saccharification process

-DP	
-DP1	>94%
-DP2, 3, 4	<4%
-Saccharification Ratio	>98%
-Sediment volume	<10%

Enzymes (Saccharification time for 30h)	Dosage (I/DS-t)
Glucoamylase A (Standard)	0.6X
Glucoamylase B	0.4X
Glucoamylase B	0.2X
Glucoamylase B	0.1X
Glucoamylase B	0.0X

\*Some confidential data are marked as X

## REFERENCES

•Smith, J., & Johnson, M., Advancements in saccharification enzymes for sugar production. Journal of Biotechnology, (2020):45,123-35.

## RESULTS AND DISCUSSTION

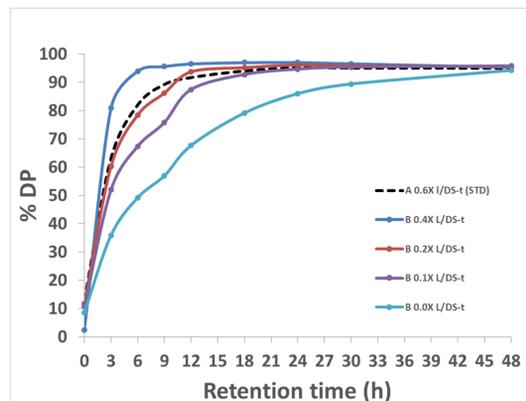


Fig. 1 DP1 profile under different conditions

Table 1 presents the DP profiles of glucoamylase A and glucoamylase B under different condition at 30 h of the saccharification process. It was found that dosages at least 0.1X I/DS-t met the factory standards whereas the dosage of 0.0X I/DS-t, did not meet the factory standards in DP1 and DP 2.

Table 1 DP profiles under different conditions

Dosage (I/DS-t)	Degree of Polymerization (%)			
	DP1	DP2	DP3	DP4
Target	>94.0%	<4.0%	<4.0%	<4.0%
Glucoamylase A 0.6X (STD)	95.0	2.1	1.3	1.4
Glucoamylase B 0.4X	96.6	2.4	0.7	0.2
Glucoamylase B 0.2X	95.8	2.1	1.3	0.6
Glucoamylase B 0.1X	95.4	1.7	1.8	1.0
Glucoamylase B 0.0X	89.3	5.2	3.5	1.8

Fig.1 presents the DP1 profile of glucoamylase A and glucoamylase B under different condition at 30 h of the saccharification process. It was found that the dosages at least 0.1X I/DS-t met the factory standards of 94%. From the third hour onward, the dosage 0.2X I/DS-t exhibited enzyme activity comparable to that of glucoamylase A. However, a dose of 0.1X was in the increasing phase of enzyme activity, posing a risk of not meeting the factory's standard requirements in practical applications.

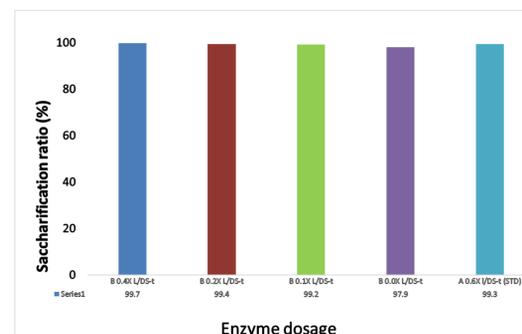


Fig. 2 The Saccharification Ratio under different conditions

Fig. 2 presents the saccharification ratio of glucoamylase A and glucoamylase B under different condition at 30 h of the saccharification process. The standard criteria of saccharification ratio is higher than 98%. It was found that dosages at least 0.1X I/DS-t met the factory standards.

Fig.3 presents the sediment volume of glucoamylase A and glucoamylase B under different condition at 30 h of the saccharification process. The standard criteria of sediment is lower than 10%. It was found that all dosages met the factory standards.

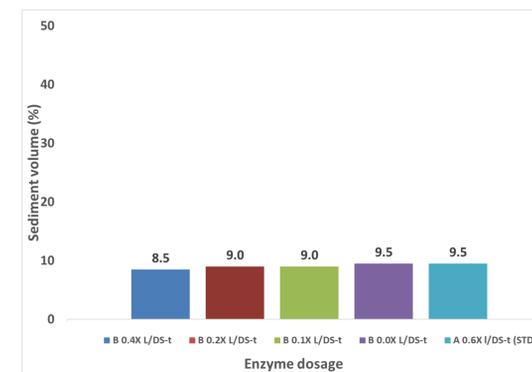


Fig. 3 The sediment volume under different conditions

## CONCLUSIONS

The dosage 0.1X I/DS-t is the minimum dosage passed all the standard at 30 h. However, the dosage 0.2X I/DS-t is optimal dosage. It can be concluded that the enzyme dosage of 0.2X I/DS-t is the most effective to assure that the product will fall into standard criteria.

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