A STUDY ON THE BEHAVIOR OF A COMMERCIAL INVERTASE IN DIFFERENT ACTION CONDITIONS. INDUSTRIAL APPLICATIONS♦

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Abstract: This work presents the use of an enzymatic preparate based on invertase in the obtaining of invert sugar syrup. Sucrose syrup having various concentrations (70%; 75%; 80%) has been used as substrate. These concentrations were chosen in order to reduce the risk of a possible fermentation during experiments. The technological parameters which vary during the experiments are the pH of sucrose solution and the concentration of enzyme solution. It was observed that the optimal pH value for obtaining the maximal invert sugar quantity (when the substrate concentration and the enzyme adding level were maintained constant) was 4.5. It was noticed the fact that the optimal level of initial sucrose solution concentration for obtaining the maximal invert sugar quantity (when the pH value and the enzyme adding level were maintained constant) was 70%. Also, the optimal enzyme adding level (when the pH value and the substrate concentration were maintained constant) was 25 g / 3000 g sucrose.

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INTRODUCTION

The invertase (saccharase, β-fructofuranosidase – E.C. 3.2.1.26) is the enzyme which catalyses the hydrolytic scission of sucrose, the reaction products being the equimolecular mixture of glucose and fructose, mixture named invert sugar [1]. The invert sugar has a sweetening power better then sucrose (28 – 30% sweeter than table sugar). That's why a smaller quantity from this is needed in order to obtain the same level of sweet taste in food products. On the other hand, the fructose is a sugar which can be consumed even by diabetic patients. This is because its metabolism is insulin independent. Hence, it is a completely healthy sweetener. The bio-inversion is a better alternative as it does not produce furfurol and any polymerized byproducts as seen in case of acid inversion [4]. As applications of invert sugar in food industry may be mentioned: biscuits industry – for caramelization, enhanced flavor and a better texture; breadmaking – for a better crust color, a softer crumb and a faster yeast cell activation; fruit processing – for a longer shelf life, invert sugar providing a better taste profile and enhances flavour; obtaining of lemonades and instant energy drinks – glucose and fructose are fastly metabolizable energy sources and provide a better taste; sugar products industry (confectionery) – for obtaining of chocolate or fondant covered bonbons, with soft or fluid core; the bonbons shaping and glazing are made when the core are still firm; the invertase, added at a low level, slowly hydrolyses sucrose when the products are stored in cold conditions, resulting in a soft cream which is localized in center of the core [2, 4].

MATERIALS AND METHODS

For saccharose invertion, invertase as liquid product with the commercial name "*GAMINVERT 30000L*" has been used. Three types of analysis were made:
Exp.1 – the pH of sucrose solution with concentration of 70% was varied, adding citric acid until the values $pH_1 = 2.7$; $pH_2 = 3.6$; $pH_3 = 4.5$, $pH_4 = 5.4$.
Exp.2 – the sucrose solution concentration was varied to values $P_1 = 70\%$; $P_2 = 75\%$; $P_3 = 80\%$.
Exp.3 – the enzyme dosage was varied to values $P_1 = 12.5$ g enzyme/3000 g sucrose; $P_2 = 18.75$ g enzyme/3000 g sucrose; $P_3 = 25$ g enzyme/3000 g sucrose.
The experiments consisted in:

- sucrose solubilization in water until the achievement of values above mentioned;
- pH adjustment of the obtained solution, by using citric acid;
- enzyme addition;
- invertion for 6 hours at 55 °C.

The invert sugar content of the samples, reported at the dry matter, was established afterwards.
As working methods were used:

- the Schoorl method for determination the content of invert sugar.
- the refractometric method for establishing the dry matter content of the inverted solutions.

RESULTS AND DISCUSSION

The results of the three series of experiments are presented in tables 1 – 3.

Table 1. *Invert sugar obtained at different pH values*
(Sucrose solution concentration = 70%; Enzyme dosage = 12.5 g/3000 g sucrose)

Sample	pH	Invert sugar (%)	Invert sugar (% d.m.*)	Dry mater (%)
S1	2.7	47.60	65.74	72.4
S2	3.6	52.97	72.86	72.6
S3	4.5	57.90	79.31	73.0
S4	5.4	55.25	75.89	72.8

* dry matter

Table 2. *Invert sugar obtained at different sucrose concentrations in solution*
(pH = 4.5; Enzyme dosage = 12.5 g/3000 g sucrose)

Sample	Sucrose solution concentration (%)	Invert sugar (%)	Invert sugar (% d.m.)	Dry mater (%)
S1	70	57.90	79.31	73.0
S2	75	54.64	70.23	77.8
S3	80	Sucrose crystallized		

* dry matter

Table 3. *Invert sugar obtained at different enzyme dosage*
(pH = 4.5; sucrose solution concentration = 70%)

Sample	Enzyme dosage (g enzyme/3000 g sucrose)	Invert sugar (%)	Invert sugar (% d.m.)	Dry mater (%)
S1	12.50	57.90	79.31	73.0
S2	18.75	65.14	88.86	73.3
S3	25.00	72.21	98.11	73.6

* dry matter

As shown in table 1, the optimal pH value for obtaining the maximal invert sugar quantity (when the substrate concentration and the enzyme adding level were maintained constant) was 4.5.
From the results presented in table 2 it was observed the fact that the optimal level of initial sucrose solution concentration for obtaining the maximal invert sugar quantity (when the pH value and the enzyme adding level were maintained constant) was 70%. It is necessary to mention that at 80% initial sucrose solution concentration, the sucrose from solution was crystallized. This is probably due to insufficient quantity of formed invert sugar, the enzyme efficiency decreasing with the increase of substrate

concentration over 70%. We can't discuss about S3 because the sucrose crystallization on the technological lines creates problems in manipulating and dosing operations.
Data in table 3 lead to the conclusion that the optimal enzyme adding level (when the pH value and the substrate concentration were maintained constant) was 25 g/3000 g sucrose. Because at this enzyme dosage the increase of inverting level is 23.7% comparative with enzyme dosage from S1 and 10.4% comparative with enzyme dosage from S2, and knowing the fact that storage stability and thermal treatment stability of invert sugar syrup decrease with the increase of its concentration, we recommend the use of 12.5 g enzyme/3000 g sucrose like optimal concentration. Moreover, considering the costs induced by the increase of enzyme dosage, we recommend the use of the same level of added enzyme.
The invert sugar syrup obtained in our experiments was used to realize based fondant products, determining its optimal concentration for achieve a good quality fondant mass.

CONCLUSIONS

The optimum conditions for obtaining the invert sugar syrup were the following:

- ✓ the concentration of sucrose solution – 70%;
- ✓ the pH of the solution – 4.5;
- ✓ the enzyme concentration – 12.5 g/3000 g sucrose;
- ✓ the invertion temperature – 55 °C.

This syrup can be used as anticrystallization supplement at the manufacture of the fondant syrup, from which it can be obtained sweets on fondant base. Depending on the added quantity of the invert sugar syrup the report between the liquid phase and the solid phase of the fondant can be improved [3] and also it can be establish the destination of this one (fondant for cover, fondant for nucleus, Turkish delight). This study represents the subject for the future researches.

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