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STUDIES ON INFLUENCE OF PULLULANASE ACTION ON MALTODEXTRINS PROPERTIES

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Key words: pullulanase, maltodextrins, starch hydrolyzates.

Enzymatic degradation of starch makes possible produce of starch hydrolyzates with great flexibility of properties in final products. Attemps to change of maltodextrins properties as a result of additional treatment of pullulanase on the low conversion starch hydrolyzates have been made. The investigations have indicated the influence of pullulanase action on some physico-chemical properties of modified products — carbohydrates compositon, iodine absorbance value, viscosity, filterability.

INTRODUCTION

Literature describes many attmeps for improvement of low conversion starch products properties. One of them concerns increasing of their filterability by treating non-waxy starches with bacterial alpha amylase for extended period in high temperature [5]. Non-hazing low DE starch hydrolyzates are obtained by subjecting starch conversion syrup to molecular exclusion reducing their dextrose equivalent [3]. Syrups of the maltodextrins which are capable of remaining haze-free for long periods of time at high solids concentrations are prepared by enzymatic hydrolysis of oxidized starch [4]. The aqueous solution of maltodextrin which remains stable against microbial growth for several months can be obtained by application of sorbic acid and sufficient acidified agent to attain the required pH in the solution [2]. Modification of carbohydrate composition of low DE maltodextrins is presented by enzymatic treatment with the use of maltogenic or glucogenic saccharifying enzymes [6]. By hydrolyzing wheat starch solution using different combinations of alpha amylase and pullulanase it has been possible to achieve significantly different oligosaccharide product spectra in hydrolyzates with the same dextrose equivalent [1].

A study has been undertaken on compositon and properties of maltodextrins as a result of additional treatment of pullulanase on the low conversion starch hydrolyzates.

MATERIAL AND METHODS

Polish commercial maltodextrins with DE value between 5 and 15 produced from potato starch by *Bacillus subtilis* alpha amylase Amylogal CS were used. *Bacillus* species pullulanase was obtained from Novo Nordisk A/S as Promozyme 200 L. Suitable amount of spray-dried maltodextrins were redissolved in water to a concentration of 30% DS, the pH was adjusted to 5.0 with sodium hydroxide. Different amounts of tested debranching enzyme were added. The hydrolysis process was effected at 60°C and took 3 h. The reaction mixtures were sampled every hour.

The following measurements were made:

— the amounts of reducing groups by modified Schoorl-Rogenbogen method,

— the carbohydrate compositon by Low Pressure Gel Chromatographic Separation using Bio-Gel P-2 minus 400 mesh,

— the viscosity measured by Rootest viscometer in 30°C or Brabender viscogragh,

— the iodine absorbance value defined as the optical density at 500 nm using a 4 cm cell,

— the filtration rate using 7 cm filtration funnel equipped with Whatman filter paper under the pressure of 0.6 bar.

RESULTS AND DISCUSSION

CARBOHYDRATE COMPOSITION

Maltodextrin material with DE value between 5 and 15 hydrolyzed with pullulanase used in different dosages — 0.05, 0.1, 0.2 PUN/g DS within 3 h indicate only the slight increase of DE. The differences exist in carbohydrate composition. The influence of pullulanase action on modification of final carbohydrate profile is shown by the example of maltodextrin with 13.2 DE. After 2 h of debranching enzyme treatment used in dosage of 0.1 PUN/g DS the increases of carbohydrates fractions from G_1 to G_{10} oscillate in a range of 0.5-3.5% while the high molecular weight fraction decreases significantly by 15.8%. Obtained lower polisaccharide material remains create the possibility of obtaining high yields of maltodextrins.

VISCOSITY

The influence of pullulanase addition on the viscosity measurements of potato starch with the use of Brabender viscograph is shown by Fig. 2. After adjusting pH of starch solution to 5.0 pullulanase was added in the amount of 0.1 PUN/g DS. Obtained results indicate that the enzyme involvement decreases the starch viscosity maximum 3 times. Brabender measurements of maltodextrin

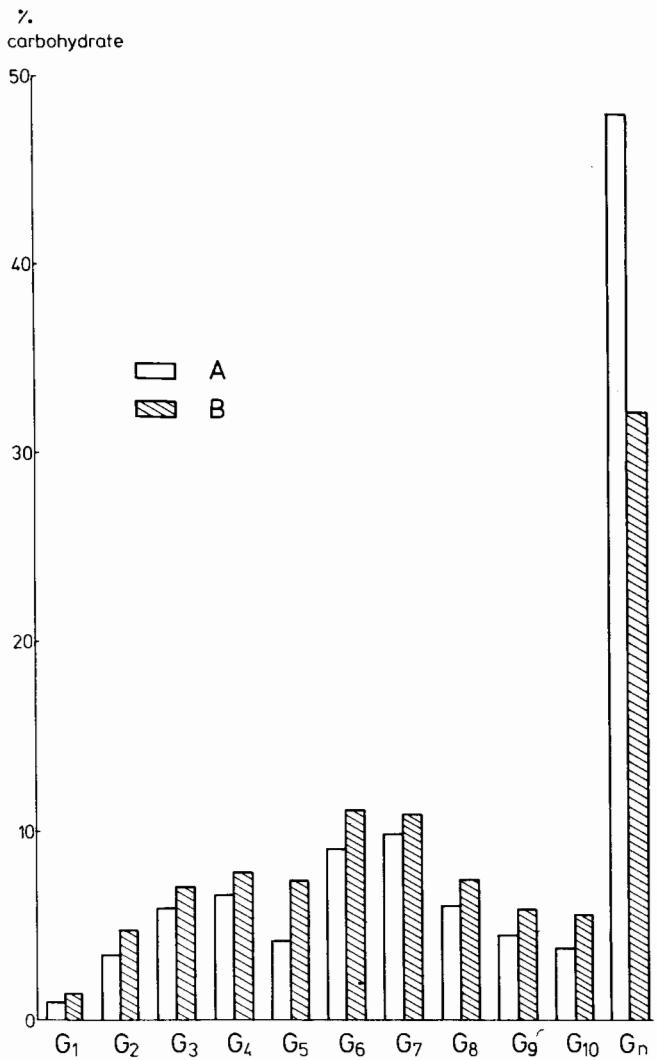

Fig. 1. Inflence of pullulanase action on carbohydrate composition; A — maltodextrin with 13.2 DE; B — maltodextrin treated pullulanase 30% DS, 2h, 60°C, pH 5.0, enzyme dosage 0.1 PUN/g DS

viscosity in comparison to hydrolyzate viscosity with the same additional amount of pullulanase as in the case of potato starch indicates faster decrease of viscosity when the pullulanase is present in solution (Fig. 3).

Figure 4 illustrates the effect of pullulanase action on maltodextrin with 5.4 DE viscosity. The enzyme was used in the dosage of 0.05, 01 and 0.2 PUN/g DS within 3 hours. Maltodextrin viscosity decreases both by way of the enzyme dosage growth and the reaction time extention. After 2 h of pullulanase hydrolysis with the dosage of 0.1 PUN/g DS the decrease of viscosity amounts to 38% of initial maltodextrin viscosity. The used highest dosage and the longest time of hydrolysis cause 48% reduction of maltodextrin viscosity.

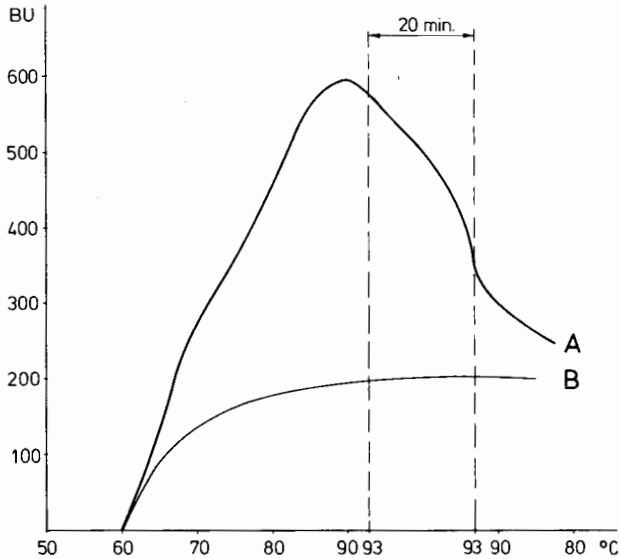

Fig. 2. Effect of pullulanase addition on maximum starch viscosity; A — potato starch, B — potato starch with pullulanase addition in dosage 0.1 PUN/g DS

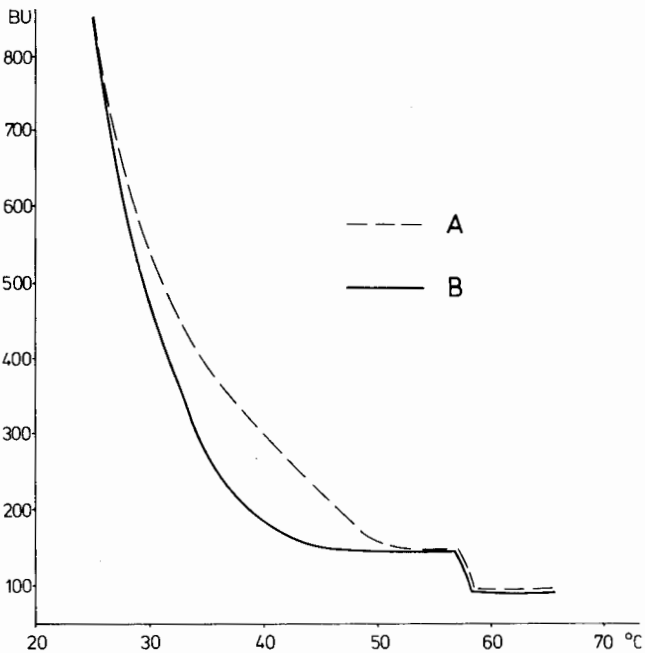

Fig. 3. Effect of pullulanase addition on maltodextrin viscosity; A — control maltodextrin with 5.6 DE; B — maltodextrin with pullulanase dosage 0.1 PUN/g DS

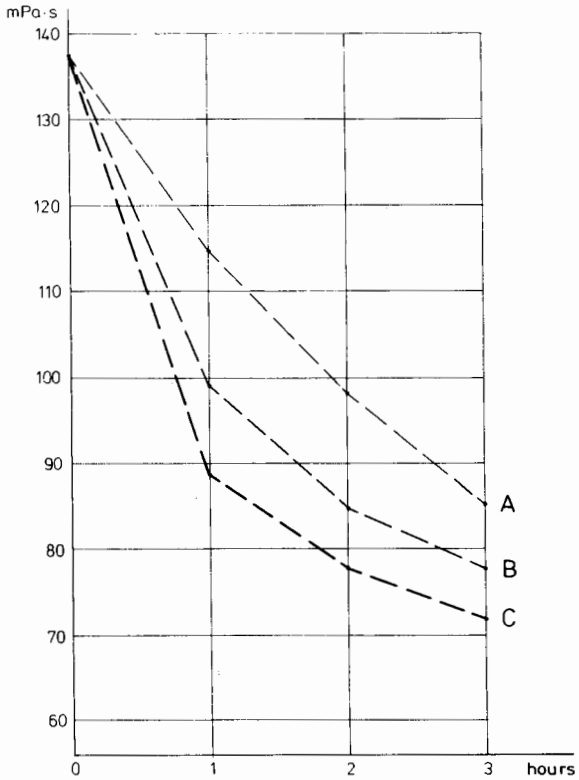

Fig. 4. Influence of pullulanase action on viscosity; substrate: 30% DS solution of DE 5.4 maltodextrin, 60°C, pH 5.0

IODINE ABSORBANCE VALUE

The influence of pullulanase action on iodine absorbance value of the same maltodextrins is shown by Fig. 5. After 1 h of hydrolysis the increase of enzyme concentration to 0,1 PUN/g DS gives similar results of iodine absorbance value to the case of hydrolysis with the application of enzyme dosage reduced by half but used during time extended to 3 hours. The same time — 3 h of pullulanase action on maltodextrin solution diminishes the iodine absorbance value by 0.10, 0.15 and 0.16 units respectively to used enzyme concentration in amount of 0.05, 0.1 and 0.2 PUN/g DS. The decrease of iodine absorbance value is connected with higher water solubility of starch hydrolyzates and lower probability of haze formation in the solution.

FILTERABILITY

The changes of filterability under the influence of pullulanase action on maltodextrin solution with 5.4 DE are illustrated by Fig. 6. The increase of filterability is connected with enzyme dosage and hydrolysis time. After

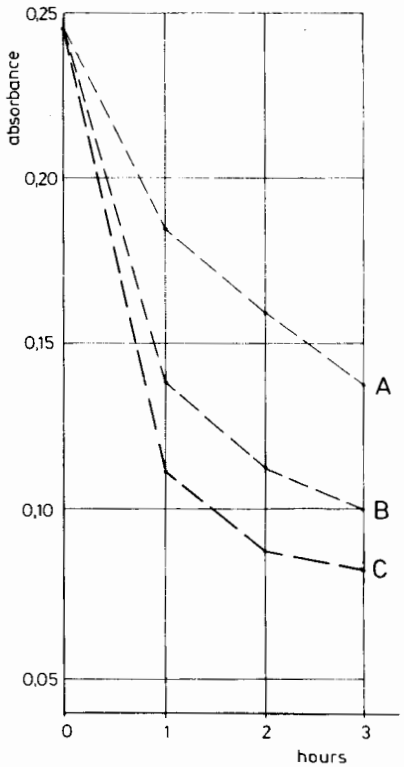

Fig. 5. Influence of pullulanase action on iodine absorbance value; substrate (see Fig. 4)

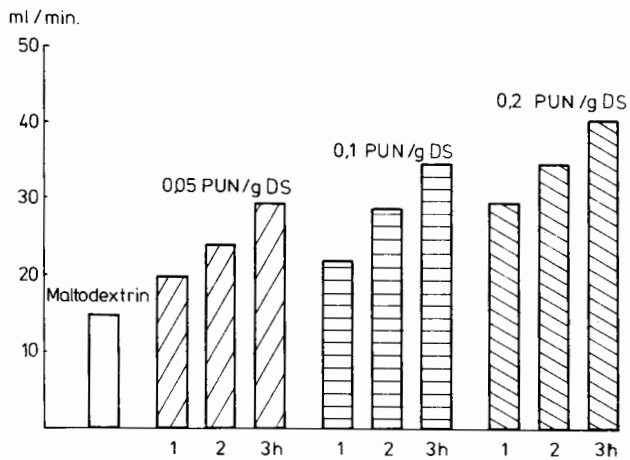

Fig. 6. Influence of pullulanase action on filterability; substrate (see Fig. 4)

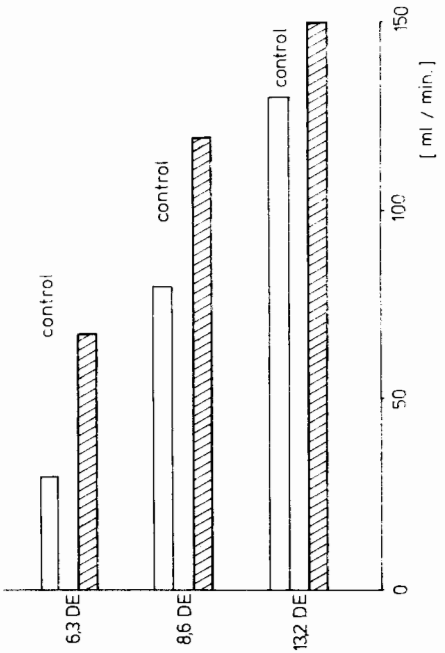

Fig. 7. Correlation between liqeufaction degree of maltodextrins and influence of pullulanase action on filterability; substrate: 30% DS solution of maltodextrins, 60°C, pH 5.0, 2h, enzyme dosage 0.1 PUN/g DS

3 h action of pullulanase on maltodextrin solution the increase of filtration rate of hydrolyzates from 0.7 to 1.7 times with the rise of enzyme concentration can be observed. Correlation between the extent of starch degradation of maltodextrins and the influence of pullulanase action on filterability is shown by Fig. 7. Maltodextrins with 6.3, 8.6 and 13.2 DE were treated for 2 h by pullulanase with the dosage of 0.1 PUN/g DS. The increase of filtration rate amounts to 0.2, 0.5 and 0.9 times more than adequate control samples but in opposite relation to DE of hydrolyzates. The application of pullulanase action in order to attain filterability improvement of maltodextrins is more effective in the case of lower conversion products.

CONCLUSIONS

Additional pullulanase treatment on maltodextrins solution influences:

— changes of carbohydrate composition,

— decrease of viscosity and iodine absorbance value according to enzyme dosage and hydrolysis time,

— increase of hydrolyzates filterability.

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STUDIA NAD WPŁYWEM DZIAŁANIA PULLULANAZY NA WŁAŚCIWOŚCI MALTODEKSTRYN

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Streszczenie

Enzymatyczna degradacja skrobi umożliwia wytwarzanie hydrolizatów skrobiowych o dużej rozpiętości ich właściwości. Przeprowadzono próby zmiany właściwości maltodekstryn przez dodatkowe działanie pullulanazy na hydrolizaty skrobiowe o niskiej konwersji. Badania wykazały wpływ działania pullulanazy na fizykochemiczne właściwości mieszaniny modyfikowanego produktu — skład węglowodanowy; wartość absorbancji kompleksu z jodem, lepkość i zdolność filtracji.