Reprinted from *Indian Food Industry*, Vol. 5, April / June 1986, pp. 81-84

Utilization of Potato Biomass for the Production of Confectioner's Syrup

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Various parameters such as concentration of acid, saccharification time and temperature were investigated for conversion of potato biomass into confectioner's syrup. The Dextrose Equivalent (DE), values in the range of 37-46 were obtained by saccharification with 3 and 4 per cent HCl at 15 and 10 psi pressure for 10 minutes respectively. At atmospheric pressure 6 per cent acid is needed with steaming time of 60 min. Both HCl and H_2SO_4 can be used for saccharification though the concentration of H_2SO_4 required is lower. The hydrolysate processing experiments to produce confectioner's syrup have also been carried out.

Introduction

Potato, a major tuber biomass of India is produced on a very large scale in Northern India and West Bengal[1]. In 1982–83, about 7.50 lakh hectare area was cultivated to produce 101.08 lakh tonnes of potatoes[2]. Potato fetches very low price during the harvest season due to large surplus available. In addition, about 10 per cent of the total produce accounts for the culled variety which fetches comparatively low price and is also not very ideal for cold storage. Therefore, efficient utilization of surplus potatoes in glut season and of the culled variety is of importance.

With the rapid growth of confectionary and baking industries in India during recent years, the demand for confectioner's syrup is increasing and therefore utilization of surplus potato biomass for production of confectioner's syrup has great potential. In India, merely 0.364 lakh tonnes glucose was produced against the licenced capacity of 0.80 lakh tonnes of liquid glucose and 0.32 lakh tonnes of dextrose[4].

In the manufacture of confectioner's syrup, acid hydrolysis of starch is a preferred method over the enzyme-enzyme process because the former is a one step process requiring comparatively low conversion times. The reduction in viscosity is more rapid in the acid process and it also offers simplicity and ease of operation. The present communication deals with the investigations on the conversion of potato biomass by acid hydrolysis and processing of the hydrolysate to produce confectioner's syrup.

Materials and Methods

Potatoes, Bangalore variety, available in the local market were procured and were mashed to fine pulp in a waring blender after washing, wiping and slicing. The pulp in 100 gm quantity was taken in 250 ml capacity beakers covered with aluminium foil for the acid hydrolysis experiments.

Experiments were conducted to standardize acid concentration, autoclaving time and pressure to obtain confectioner's syrup from potato. The hydrolysate was hand squeezed through nylon cloth and filtered through Whatman filter paper No. 1. The hydrolysate was tested for the presence of starch, glucose content, Brix value, pH and the color of the hydrolysate was noted visually. The residue left over after filtration of the hydrolysate was dried and weighed. Parameters were also standardized for hydrolysis with acid under atmospheric pressure. Hydrochloric and sulphuric acids of both AR and commercial quality were used for comparison purposes.

The hydrolysate was processed for deproteinization, decoloration, deacidification and deashing by treatment with kaolin, activated carbon, sodium hydroxide and cationic as well as anionic ion-exchange resins. Weak base anion exchanger Indion 860 and strong base cation exchanger Indion 225 H manufactured

Part of this data was presented at the 37th Annual Session of the Indian Institute of Chemical Engineers, IIT New Delhi, December, 17-20, 1984.

by Ion Exchange (India) Ltd., Bombay were employed. The hydrolysate was then subjected to vacuum concentration at 45-50°C to 80° Brix to yield confectioner's syrup.

Results and Discussion

The potatoes used were those which have undergone ambient temperature storage of about 4 months under local market conditions. Consequently, they showed changes in texture, flavour and taste and contained about 11-13 per cent starch and 77-85% moisture.

Experiments under pressure:

The data on the effect of hydrochloric acid concentration on the degree of saccharification is presented in Fig. 1. It is evident that 3 and 4 per cent acid concentrations give syrup of 48 and 62 DE respectively. At acid concentrations below 3 per cent, the saccharification is absent probably because of the buffering action of potatoes resulting in higher pH values with these acid concentrations. The slight increase in saccharification at 5 per cent acid is followed by decrease in saccharification with the increase in acid concentration, due to further degradation of glucose at these higher acid concentrations. The residue after hydrolysis was at its minimum value of about 3 per cent at 4 per cent and higher acid concentration but increased at lower acid concentrations. The residue value should be the minimum, indicating the complete conversion of the available starch. However, even with 3 per cent acid, it may be possible to reduce the residue by variation of other parameters and therefore both 3 and 4 per cent acid concentrations were selected for the studies

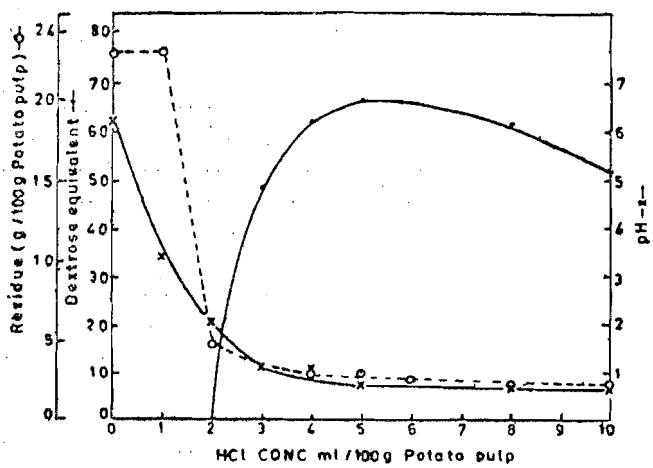

Fig. 1. Effect of hydrochloric acid concentration on the degree of saccharification at 15 psi pressure for 10 minutes.

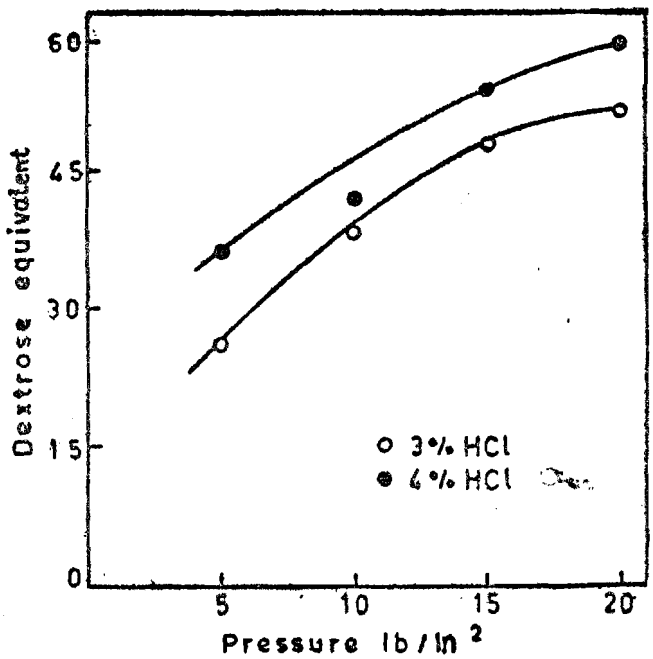

Fig. 2. Effect of different pressures on saccharification at 15 psi pressure with 3 and 4 per cent hydrochloric acid.

on the effect of autoclaving. These studies revealed that the hydrolysis with 3 per cent acid at 15 psi pressure gave hydrolysate with 48 DE while DE value was 54 with 4 per cent acid (Fig. 2). At lower pressure, the DE values obtained were lower than desired while these were more than desired at higher pressure. Though hydrolysis with 3 per cent acid gave desired DE value, it was positive for starch test indicating incomplete saccharification. Consequently, 4 per cent acid concentration and 15 psi was selected for further

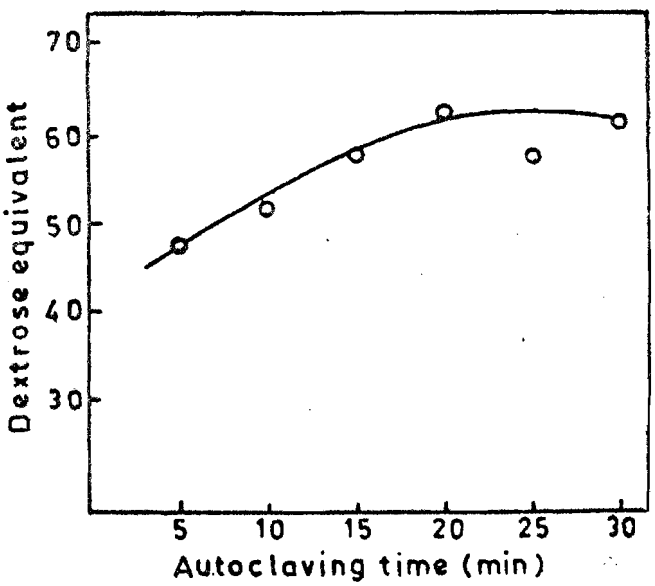

Fig. 3. Effect of contact time on the saccharification with 4 per cent hydrochloric acid at 15 psi pressure.

studies even though it gave DE values higher than the minimum desired as it is possible to reduce the autoclaving time.

The data on the effect of autoclaving times on the degree of saccharification at 15 psi with 4 per cent acid is presented in Fig. 3. Autoclaving for 5 min. results in a hydrolysate with 48 DE with no starch in it. The DE values of more than 40 were obtained at higher contact time. Based on these studies, hydrolysis for 5 minutes at 15 psi with 4 per cent acid are selected as the most suitable for the manufacture of confectioner's syrup from potato by acid (HCl) saccharification under pressure. When sulfuric acid is used as an hydrolysing agent, 1.5 per cent acid with 5 min. autoclaving time at 15 psi is sufficient to obtain hydrolysate of 43 DE value (Fig. 4). No differences in the degree of hydrolysis were noted when either AR or commercial grade acids were employed.

Atmospheric pressure experiments:

The hydrolysis of potato starch into confectioner's syrup under pressure needs capital intensive and sophisticated equipment and thus will be confined to organized sectors. With a view to develop simple technology for adaptation in rural sector, experiments were also conducted to standardize parameters for hydrolysis under atmospheric pressure. The data on the effect of hydrochloric acid concentration (Fig. 5)

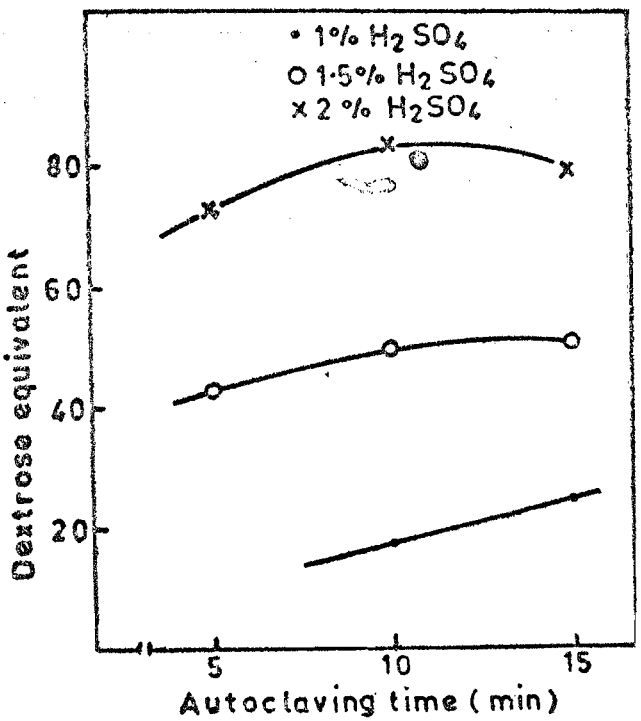

Fig. 4. Saccharification with sulfuric acid at different autoclaving time at 15 psi pressure.

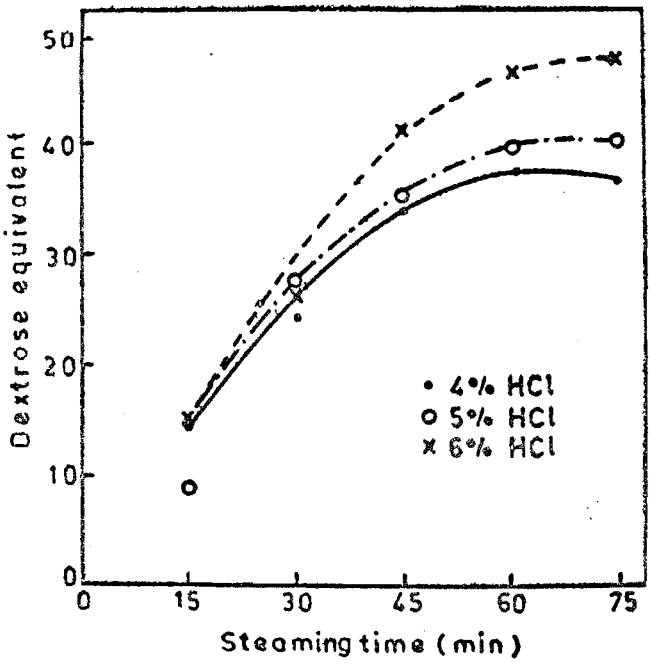

Fig. 5. Saccharification at atmospheric pressure with different concentrations of hydrochloric acid and varying steaming time.

with respect to different steaming times indicated that 6 per cent acid and 60 min. time gives a hydrolysate with 47 DE value. At lower acid concentrations even with the steaming time of 75 minutes, the DE values were 40 or lower. When hydrochloric acid was replaced by sulfuric acid, 4 per cent sulfuric acid was needed with 45 min. steaming time to obtain similar DE value (Fig. 6). At lower steaming times,

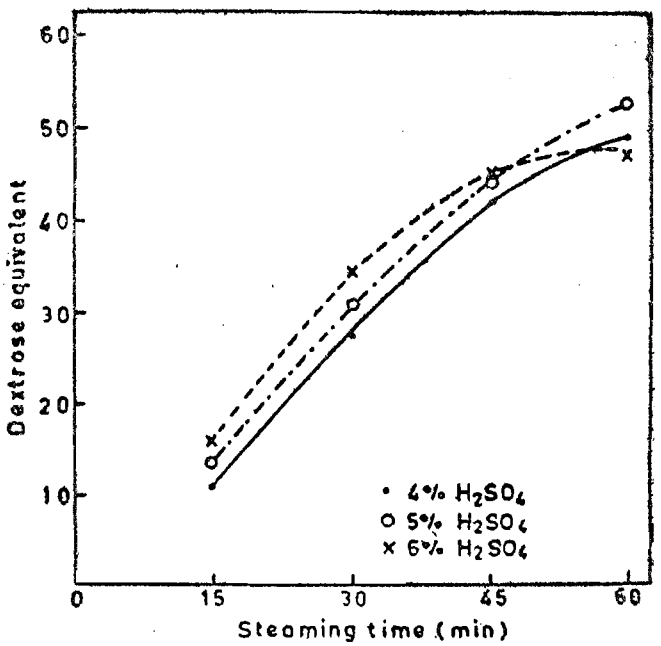

Fig. 6. Effect of sulfuric acid concentrations and steaming times on saccharification at atmospheric pressure.

the DE values were below the requirement with 5-6 per cent sulfuric acid concentrations. It was also observed that the degree of saccharification at atmospheric pressure was not affected by the use of AR or commercial grade acids.

Processing of the hydrolysate

The hydrolysate obtained by acid treatment at atmospheric or higher pressures is a yellowish-brownish liquid containing about 18 mg/ml protein. Activated carbon at 5 per cent (w/v) is needed to decolorize the hydrolysate by allowing contact time of 30 min. at 80°C. Incidentally, the carbon treatment results in deproteinization to an extent of about 20-25 per cent. The partially deproteinized and decolorized hydrolysate was neutralized to pH 4.8-5.5 by using sodium hydroxide solution. Neutralization with calcium carbonate was not possible due to uncontrollable foam formation. After the pH adjustment, the hydrolysate was deashed to contain less than 0.3 per cent ash by passing through cationic and anionic resin columns. By concentration of the hydrolysate under vacuum to 80° Brix, 42 DE confectioner's syrup conforming to ISI standards can be obtained.

By taking into consideration the existing market prices of commercial grade hydrochloric and sulfuric acids, the use of hydrochloric acid is more economical as it is about 25 per cent cheaper based on the quantity required for hydrolysis. However, the use of sulfuric acid for hydrolysis is preferred due to its various advantages such as low degree of corrosiveness and fuming as well as the ease in handling and usage[5].

Conclusions

The production of confectioner's syrup from potato biomass can be considered only in those states such as UP and West Bengal where potatoes are cultivated on a large scale. By taking into consideration that about 10 per cent is of culled variety, it was calculated that about 900 thousand tons of potato biomass/yr containing about 15 per cent starch can be processed in UP to yield 560 tons of confectioner's syrup of 80° Brix per day. The economics at present do not appear attractive as based on the raw materials alone, it will cost about Rs. 6.00 per kg. of the confectioner's syrup.

Acknowledgement

The active interest shown in the work by Director, CFTRI, Mysore is gratefully acknowledged.

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