

A STUDY OF LIQUID GLUCOSE PRODUCTION AS A MEDIUM SCALE INDUSTRY USING CASSAVA STARCH (*Manihot esculenta*)

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INTRODUCTION

Liquid glucose is a highly viscous, slightly sweet and colourless substance. It is a concentrated aqueous solution containing glucose, maltose, dextrin and other oligosaccharides (Bean and Sester, 1992). Liquid glucose is extensively used as a sweetening agent in confectionary, bakery and other food preparations. It is used to prevent crystallization of sucrose and produces a clear non crystalline product in boiled sweets, candies and other types of confectioneries (Radley, 1976).

Over three thousand metric tons of liquid glucose is currently imported to Sri Lanka spending more than 10 million rupees annually. (External Trade Statistics, 1995-2002). Therefore, food manufacturers have to spend much money for the importation of liquid glucose.

Starch is the raw material for making liquid glucose. Starch is commercially produced from corn, wheat and root and tubers. Cassava is a good source of starch and therefore an ideal raw material for the production of liquid glucose. Utilization of cassava at industrial level not only adds value to the crop but also reduces post harvest losses of the crop. This study was undertaken to find out optimum parameters to complete acid hydrolysis of cassava starch to produce liquid glucose as a medium scale industry.

MATERIALS AND METHODS

Extraction of starch

Freshly harvested cassava tubers were washed, peeled, and sliced into small pieces. These pieces were ground with adequate water to extract starch and filtered. Filtrate was allowed to settle for four hours. The supernatant was decanted and starch was separated. The separated starch was sun dried for two days to remove moisture. Dried starch was packed in moisture proof containers and stored in a cool dry place for further use.

Preparation of liquid glucose

Cassava starch slurry was prepared by adding cassava starch to 2-2½ times of water. Prepared slurry was transferred to twenty seven glass

bottles. Samples were separately treated with equal volumes of acid in concentrations of 2 M, 4 M and 6 M of hydrochloric acid. All samples were autoclaved at three different pressure levels $68.94 \times 10^3 \text{ N/m}^2$, $103.41 \times 10^3 \text{ N/m}^2$ and $137.88 \times 10^3 \text{ N/m}^2$ at 120°C . Three replications were done for each treatment and the completion of the hydrolysis was qualitatively measured using iodine solution (Woods and Aurand, 1977). Best acid concentration and pressure level for the total hydrolysis of starch were determined using this technique. Samples were neutralized with 2N sodium carbonate to remove free acid and the pH value was kept at 5 to 7. Neutralized samples were decolorized by adding activated carbon for about twelve hours and filtered.

Determination of physicochemical properties of liquid glucose

Total soluble solid of prepared liquid glucose sample was measured using a refractometer. Dextrose Equivalent (DE) was determined by Lane and Eynon method (Kent-Jones and Amos, 1957). Moisture content of samples was measured by oven drying technique (Guptha and Vershaneg, 1989). Total ash was determined by heating to 550°C in a muffle furnace. The colour was observed and classified using the Royal horticultural colour chart.

Jujubes were prepared using cassava liquid glucose and market samples of liquid glucose. Prepared jujubes samples were evaluated by twenty panelists for its colour, texture, taste, aroma, appearance and overall acceptability.

RESULTS AND DISCUSSION

The optimum condition for preparation of liquid glucose was by using 6 M hydrochloric acid and $137.88 \times 10^3 \text{ N/m}^2$ at 120°C respectively as given in Table 1. Liquid glucose obtained from this treatment had highest level (19.8) of total soluble solids content compared to other treatments (Table 2).

Table 1. Time required for the complete hydrolysis of cassava starch at different acid concentration and pressure levels, at 120°C .

| Acid concentration | Time taken in different pressure levels (min.) | | |
|--------------------|--|------------------------------------|------------------------------------|
| | $68.94 \times 10^3 \text{ N/m}^2$ | $103.41 \times 10^3 \text{ N/m}^2$ | $137.88 \times 10^3 \text{ N/m}^2$ |
| 2 M | 30 | 20 | 10 |
| 4 M | 20 | 15 | 7 |
| 6 M | 20 | 12 | 5 |

Table 2. Total soluble solid content of Liquid glucose after application of different treatments, at 120°C.

| <i>Acid concentration</i> | <i>Pressure level N/m²</i> | <i>Total soluble solids</i> |
|---------------------------|---|-----------------------------|
| 2 M | 68.94 × 10 ³ N/m ² | 15.4 |
| | 103.41 × 10 ³ N/m ² | 17.5 |
| | 137.88 × 10 ³ N/m ² | 18.6 |
| 4 M | 68.94 × 10 ³ N/m ² | 14.6 |
| | 103.41 × 10 ³ N/m ² | 18.0 |
| | 137.88 × 10 ³ N/m ² | 19.0 |
| 6 M | 68.94 × 10 ³ N/m ² | 16.2 |
| | 103.41 × 10 ³ N/m ² | 19.1 |
| | 137.88 × 10 ³ N/m ² | 19.8 |

Physicochemical properties of liquid glucose

The total soluble solid content of casava liquid glucose and market liquid glucose samples were comparable being 82 and 84 respectively (Table 3).

Moisture content of cassava liquid glucose was 13.5% where as this was 12.1% in market liquid glucose. Dextrose value of prepared liquid glucose was 38.5 where as this was 39.5 in market sample. The Dextrose Equivalent (DE) values of both samples are classified as medium conservation syrups (Jha, 2002). The liquid glucose available in the market is colourless where as casava samples were grayish yellow in colour. This may be due to high temperature involvement in the evaporation process of the liquid glucose preparation in this experiment. The high ash content of 2.7% of prepared liquid glucose may be due to the addition of sodium carbonate, in the neutralization step.

Table 3. Physiochemical properties of concentrated prepared liquid glucose and market sample.

| <i>Sample</i> | <i>Total soluble solids (TSS)</i> | <i>% Moisture content</i> | <i>Dextrose equivalent (DE)</i> | <i>% Ash</i> | <i>Colour</i> |
|-----------------------|-----------------------------------|---------------------------|---------------------------------|--------------|-------------------|
| Casava liquid glucose | 82 | 13.5 | 38.5 | 2.7 | Grayed Yellow C-D |
| Market liquid glucose | 84 | 12.1 | 39.5 | 0.2 | Colorless |

Sensory properties

The jujubes samples prepared using cassava liquid glucose and market liquid glucose had comparable values of median in all sensory properties. There was no significant difference in all sensory properties between jujube samples at 5% significance level. This study shows that

cassava starch could be utilized to produce liquid glucose successfully as a medium scale industry.

Table 4. Summary of analysis of sensory data.

| <i>Product</i> | <i>Sensory properties</i> | | | | | |
|-------------------------|---------------------------|--------------|----------------|-------------------|--------------|------------------------------|
| | <i>Colour</i> | <i>Aroma</i> | <i>Texture</i> | <i>Appearance</i> | <i>Taste</i> | <i>Overall acceptability</i> |
| | <i>M</i> | <i>M</i> | <i>M</i> | <i>M</i> | <i>M</i> | <i>M</i> |
| Prepared liquid glucose | 4.5 | 4.0 | 4.0 | 5.0 | 4.5 | 4.5 |
| Market liquid glucose | 4.0 | 4.0 | 5.0 | 5.0 | 4.0 | 4.0 |

M - Median

CONCLUSIONS

The study shows that optimum conditions to the hydrolysis of cassava starch for the production of liquid glucose is 6 M hydrochloric acid and $137.88 \times 10^3 \text{ N/m}^2$ pressure level at 120°C . The physicochemical properties and sensory properties of cassava liquid glucose are highly comparable to market samples. Cassava starch can be successfully used to produce liquid glucose as a medium level industry.

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REFERENCES

- Bean, M.M. and C.S. Sester. 1992. Polysaccharides sugar and sweeteners. In Food Theory and Application (2nd edition), Eds. J. Bovers. Pp 69-198. Macmillan Publishing Company, New York.
- External Trade Statistics. Sri Lanka 1995-2002 Statistical Division, Department of Sri Lanka. Custom, Sri Lanka.
- Guptha, A.K. and M.L. Vershaney. 1989. Practical manual for agricultural chemistry. Kalyani publishers, Lunhiana. 31-54 p.
- Jha, M. 2002. Modern technology of confectionery industries with formulae and process. Asia Pacific Business press. 1-11 p.
- Kent-Jones, D.W. and A.J. Amos. 1957. Modern cereal chemistry, 5th edition. The Northern publishing Co. Ltd, England. 546 -666 p.
- Radley, J.A. 1976. Starch production technology. Applied Science Publishers Ltd., London. 311 -397 p.
- Woods, A.E. and L.W. Aurend. 1977. Laboratory manual in food chemistry. The AVI publishing Company, INC., Westport. 11-19 p.