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PRODUCTION OF GLUCOSE SYRUP FROM LOCAL STARCH SOURCES

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ABSTRACT
Production of glucose from yam, corn and rice starch using α- amylase and amyloglucosidase involves three processes: gelatinization, liquefaction and saccharification. A 20 g quantity of starch was mixed with 100 ml distilled water, pH adjusted to 6.5 by adding water after which the mixture was heated in a boiling water bath to gelatinize it. Liquefaction of the gelatinized starch was done by adding 0.5ml of α-amylase and the temperature raised to 100^0C, for about 15 min. The temperature was reduced to 60^0C after cooling to inactivate alpha-amylase and pH was adjusted to 4.8-5.0 using 0.1N HCl. Addition of 0.5ml of amyloglucosidase breaks down maltose to glucose. This was done for 6-8hr at 60^0 C. Amyloglucosidase was inactivated by heating to 90^0C for 5 min. Glucose concentrations were read using glucose oxidase method. Yam was found to give highest glucose concentration of 25.20 mg/dL, followed by corn (15.84 mg/dL) and rice (10.62 mg/dL). It is obvious that hydrolysis of starch from yam, corn and rice will help meet the high demand placed on sugars.

Keywords: glucose syrup, starch, amyloglucosidase, hydrolysis.

INTRODUCTION

Starch in tubers and cereals consist of two glucose polymers: amylose and amylopectin. The proportion of the two polymers varies depending on the starch origin, but is generally 15-25% amylose and 75-85% amylopectin (Anosike, 1994). Amylose is a linear polymer of glucose units linked through α -D- 1, 4 glucosidic bonds. Amylopectin is a branched polymer consisting of α -D- 1, 4 glucosidic bonds with a small number of α -D- 1, 6 glucosidic linkages present as interchain branch points (Hizsukuri, 1996 and Nelson and Cox, 2000). Glucose is made by partial or complete hydrolysis of starch, either by acid HCl or enzyme: α-amylase and amyloglucosidase (glucoamylase) respectively (Gupta *et al.,* 2003: Omemu *et al.,* 2008).

Starch-degrading enzymes like alpha-amylase and amyloglucosidase from *Aspergillus niger* (Omemu *et al*,2008) are gaining more importance among the industrial enzymes because of the importance of starch, sugars and other products in modern biotechnological era (Prakasham *et al*., 2007). Alpha-amylase (E C 3. 2. 1. 1) (1, 4 -α - D-glucan glucanohydrolase) catalyzes the hydrolysis of internal alpha- 1, 4 – glucan links in polysaccharides containing 3 or more alpha -1, 4 linked D-glucose units yielding a mixture of maltose and glucose . Amyloglucosidase (E C 3.2.1.3) also known as glucoamylase hydrolyses α - 1, 4 and α - 1, 6 linkages and produce glucose as the sole end-product from starch and related polymers (Omemu *et al,* 2005). Amyloglucosidases have applications for dextrose production,

confectionery, baking and in pharmaceuticals (Rose, 1980; Pandey *et al*, 2000).

In spite of the wide distribution of amylases, microbial sources are used for the industrial production due to advantages such as cost effectiveness, consistency, less time and space required for production and ease of process modification and optimization (Burhan *et al*., 2003).

Microbial amylases have completely replaced chemical hydrolysis in the starch processing industry, and they are also potential candidates in the medicinal, clinical and pure chemical industries (Becks *et al*., 1995; Gupta *et al*., 2003)

The hydrolytic process involves the addition of water and enzyme to breakdown the starch into simpler sugars known as D-glucose. Since glucose powder or crystals is basically derived from glucose syrups, this work is directed towards finding out how this sugar can be produced from yam, rice and corn starch. The glucose syrup from the starch sources named above can compete favourably well with that produced from sugar cane (which currently is dominantly used), and can comfortably serve as a surrogate if adequate attention is given towards its production. Its uses will be enormous as it is used in soft drinks production, jams, and jellies, baking confectioneries, ice cream and pharmaceutical processes. In pharmaceuticals, it is a valuable vehicle for cough syrups and vitamin based tonics and may be used as a granulating agent for tablet coating (Rose, 1980; Pandey *et al*, 2000., & Omemu, 2008).

MATERIALS AND METHODS

Sample Collection

The yam tuber, corn and rice were bought from Eke Awka Market in Anambra State.

Determination of Starch By Iodine Method

Principle

A characteristic blue-black, red or violet colour is obtained when iodine reacts with starch. This characteristic colour could be due to trapping of iodine molecules in spaces in-between the carbohydrate molecules.

Procedure:

- 2ml of starch solution was put in test-tube
- A drop of iodine was added using dropper
- The mixture immediately turned blue-black

Assay For Glucose Concentration (Glucose Oxidase Method; Trinder, 1969)

Calibration curve was done using concentration of glucose standard in mg/dL and glucose concentration of the test sample extrapolated from the calibration curve at 540 nm

RESULTS

The result obtained after gelatinization, liquefaction, saccharification, centrifugation and filteration, of yam, corn and rice are as shown in Table 1.

DISCUSSION

Most green plants produce starch as a means of energy storage. It is deposited as small granules (1-100 μm) in (Chloroplasts and amyloplasts). These tiny white granules occur in various parts of plants, for example in cereals and wheat, in roots (tapioca) and in tubers (potatoes) [Swinkels, 1985].

Results of glucose concentration of yam, corn and rice showed a glucose level of 25.20 mg/dL, 15.84 mg/dL and 10.62 mg/dL respectively. Yam was found to give the highest

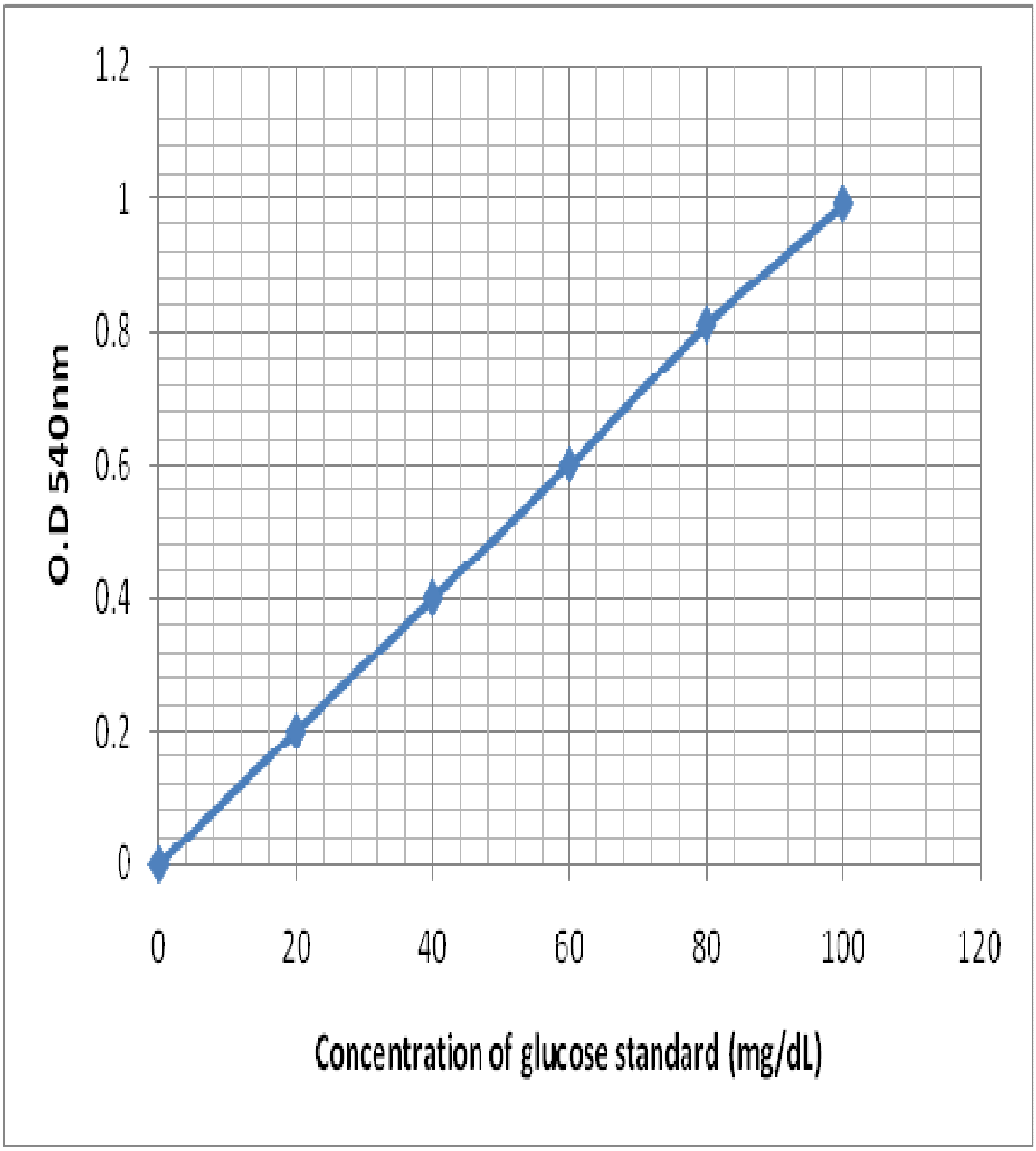

Fig 1; Glucose Calibration Curve

Legend; OD – Optical Density

Production of glucose syrup from local starch sources (Yam, corn and rice)

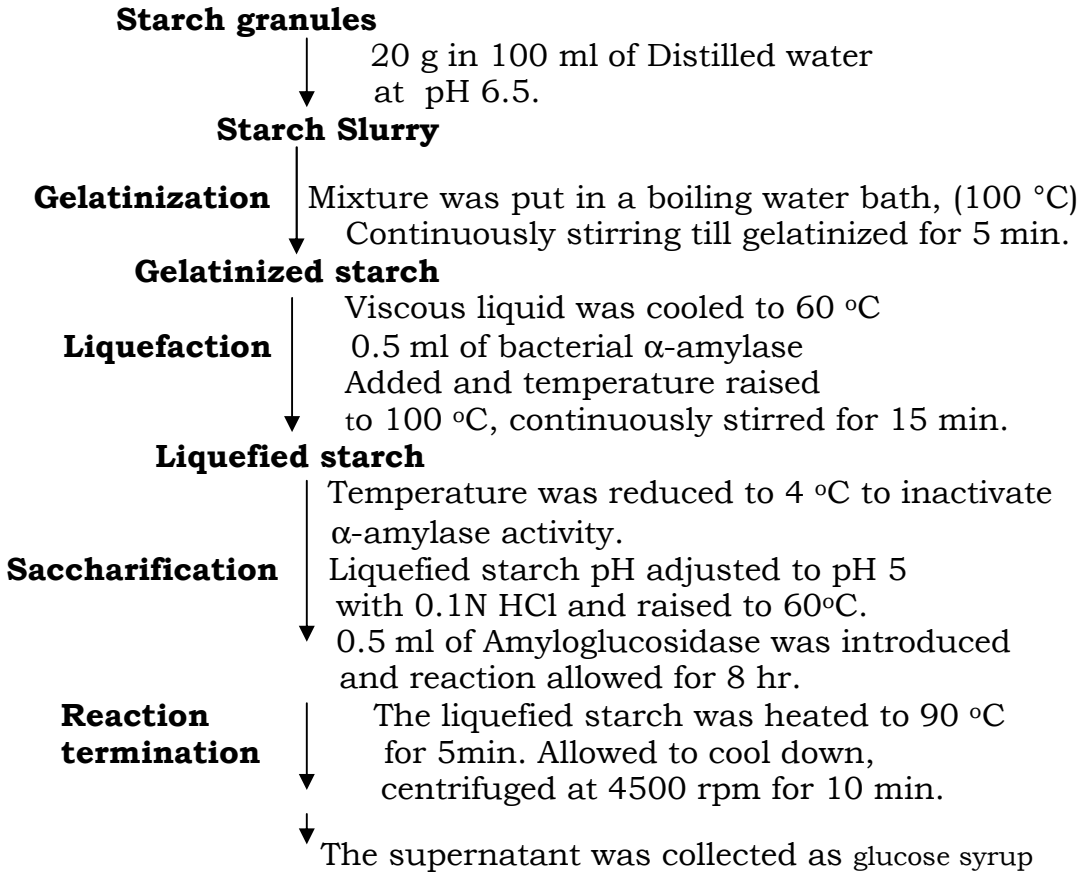

Fig 2; Chart showing the production of Glucose syrup from starch by the enzymes α-amylase and glucoamylase

Table 1: Glucose Concentration (mg/dL) and percent yield from starch sources after enzyme hydrolysis.

Starch source	Optical density (O.D) 540 nm	Glucose concentration (mg/dL)	Percent yield (%)
Yam	0.33	25.20	30
Corn	0.20	15.84	50
Rice	0.16	10.62	60

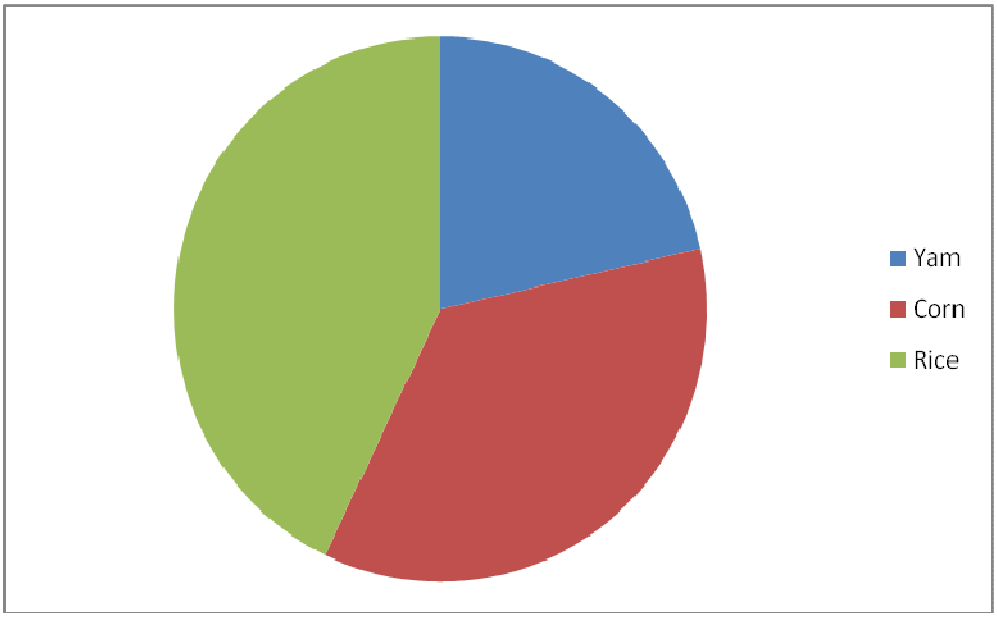

Fig 3: Pie Chart Representation of Glucose yield from Starch Sources.

glucose concentration followed by corn and rice.

According to the work done by Philips and Caldwell (1951a), corn gave a glucose concentration of 1.02mg/dL, while yam gave a glucose concentration of 0.78mg/dL which is not in agreement with the results recorded in this work. This disagreement may probably be due to difference in the method of hydrolysis. The acid hydrolysis method used in the above reference may be responsible for low yield. However in this work, enzymatic method was used involving glucoamylases and has the ability to hydrolyze both ∝ (1-4) and ∝ (1-6) linked glucose units and could completely convert starch to glucose (Omenu *et al*, 2008). This possibly led to higher glucose concentration as observed in this work. However result of percent yield of glucose volume shows that rice, corn and yam gave a percent yield of 60%, 50% and 30% respectively.

For organizations wishing to produce high quality glucose syrup, it is recommended that yam shall be the source followed by corn then rice. For companies wishing to produce high quantity glucose syrup, rice is recommended followed by corn then yam.

REFERENCES

Alexander R.J (1992). Maltodextrins: Production, properties and applications. In: Starch Hydrolysis products; Technology, Production, and Application (F.W, Schenk and R.E. Hebeda. Eds). Pp.233-276. VCH Publishers, New York.

Anosike (1994). Structure and Chemical properties of Carbohydrates In: An introduction to the Principles of Biochemistry. Sunary Publications Limited. Port Harcourt, Lagos, Abuja, Asaba, Houston and Wembley. Nigeria & USA. Pp 43-67.

Becks, S., Bielawaski, C., Henton, D., Padala, R., Burrows, K., and Slaby, R (1995). Application of liquid stable amylase reagent on a Ciba corning express clinical chemistry system. Clin. Chem, **41**: 186.

Bello, Perez., and Sanchez Hernandez (2002) Isolation and partial characterization of banana starches. J. Agric. Food Chem. **47**: 854 – 857

Burhan, A., Nisa, U., Gokhan, C., Omer, C., Ashabil, A., and Osman, G (2003). Enzymatic properties; a novel thermostable, thermophilic, alkaline and chelator resistant amylase from an alkaliphilic *Bacillus sp*. Isolate ANT-6. Process Biochem., **38**:615-620.

Gupta, R., Paresh, G., Mohapatra, H., Goswami, V.K., and Chauhan, B (2003). Microbial Alpha Amylases; A Biotechnological perspective. Process Biochem., **38**: 1599- 1616.

Hizukuri, S (1996). Starch: Analytical Aspects. In: Carbohydrates in Food (A.C.Eliasson, ed), New York. Pp 347-429.

Jayaraman, J (1992). Iodine test in laboratory manual in biochemistry. Published by Wiley Eastern Limited New Delhi, India. Pp 52.

Nelson D.L and Cox, M.M (2000). Starch and glycogen are stored fuels in principles of biochemistry 3rd edition. Freeman publishers Pp.305.

Omemu, A.M., Akpan, I., Bankole, M.O., and Teniola, O.D (2005). Hydrolysis of raw tuber starches by amylase of Aspergillus *niger* AMO7 isolated from the soil. Afr. J. Biotechnol, **4**: 19-25.

Omemu, A.M., Bankole, M.O and Akpan. I (2008). Production and Characterization of Extracellular Amyloglucosidase from *Aspergillus niger* CA-19 by Solid-State Fermentation. Res. J. Microbiol. **3** (3): 129-135.

Pandey, A., Nigam, P., Soccol, C., Soccol, V., Singh, D. and Mohan R (2000). Advances in Microbial amylases. Biotechnol. Applied Biochem., **31**: 135-152.

Philips, L.L and Caldwell M.L (1951a) A study of action of glucoamylase, a glucose producing amylase from *Rhizopus delemar*. J. Ann.Chem Soc.**73**: 3559-3563.

Prakasham, R. S., Subba Rao, R. Ch., Sreenivas Rao and Sarma P.N (2007). Enhancement of acid amylase production by an isolated *Aspergillus awamori*. J. Applied Microbial., **102**: 204-211.

Rose, H.A (1980). Microbial enzymes and Bioconversions. Economic Microbiology, Academic Press, **5**: 116-117.

Schenck, F.W (1992). Starch hydrolysis products; an introduction and history. In: Starch hydrolysis products; Technology, Production, and Application (F.W. Schenck and R.E.hebeda, eds.), Pp. 1-22. VCH Publishers, New York.

Swinkles, J.J.M (1985). The composition and properties of commercial native starches. Starch **37**:1-5

Trinder, P (1969). Determination of glucose using glucose oxidase with an alternative oxygen acceptor. Ann. Clin. Biochem. **6:** 24-27.

Whelan, W.J and Roberts, P. J (1952). Action of Salivary Alpha amylase on amylopectin and glycogen. Nature **170**: 72-78.