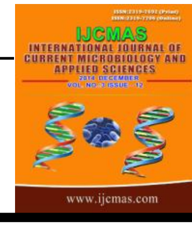

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Original Research Article

Glucose syrup production from cassava peels and cassava pulp

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A B S T R A C T

The glucose level of cassava peel and pulp and the effect of enzyme variation on the glucose yield were determined using enzyme hydrolysis method. Parameters measured include the pH, glucose concentration and total dissolved solids known as brix. A total of nine (9) samples were used; three (3) each from the cassava peel, pulp, and pure starch. The enzyme concentrations were 20/IU/L, 30/IU/L and 40/IU/L for the three feedstock at a constant value. The brix decreased as the quantity of enzymes used for the hydrolysis increased for all the feedstock used. When the enzyme concentration was 20/IU/L, the glucose yield for the cassava peel, pulp, and pure starch were 3.76mg/ml, 6.16mg/ml and 7.20mg/ml respectively; whereas the concentration of glucose at the same enzyme concentration of 30/IU/L was 4.00mg/ml, 6.98mg/ml and 7.56mg/ml respectively. At 40/IU/L enzyme level, the glucose yields were 4.25mg/ml, 7.14mg/ml and 8.22mg/ml. The pH slightly increased with increase in enzyme concentration. Cassava peels yielded a substantial amount of glucose with adequate amount of enzyme, although slightly lower than that of the pulp. Hence, cassava peels can be used to make glucose syrup that could be used as food additives.

Keywords

Cassava, enzyme hydrolysis and glucose concentration

Introduction

The need to expedite development and self-reliance through optimal utilization of local raw materials has made the utilization of cassava for novelty foods and non-foods imperative. However Nigeria is regarded as one of the highest producer of cassava in the world, (CBN report, 2000).

Traditionally, cassava is processed into fermented products and starch. The starch is mainly used in the textile industry, for warpsizing, cloth and felt finishing (IITA, 1990). However, starch has other economic potentials, for instance, as a raw material for glucose syrup production (Kent, 1983). Federal Office of Statistics Annual Report (2000) indicated millions of naira was spent on the importation of sugar syrups in Nigeria. Glucose syrups are essentially industrial sugars used in the manufacture of food products, and are mainly consumed in the confectionery industries (Dina and Akinrele, 1970).

The starch molecule consists of glucose units which are linked by α-1, 4-glycosidic bonds to form amylose chain while amylopectin shows a highly branched structure with α-1, 6-glycosidic bonds, in addition to the α-1, 4- linkages. Hydrolysis of starch occurs when linkages between the anhydrouspyranose units are broken catalytically by acid or enzyme catalysis (Akinola and Ayanleye, 2004).

However, the use of enzymes is preferred to acid, since it produces high yields of desired products and less formation of undesired products such as toxic compounds (Sanj ust, 2004).

The breaking down of the α-1,4 and α-1 ,6 linkages to small units of glucose (monosaccharide) is made possible by the actions of α- amylase and glucoamylase (enzymes) respectively (Wong *et al.*2001).
Glucose syrup is made from the hydrolysis of starch. Maize is commonly used as the source of the starch, in which the syrup is called "corn syrup", but glucose syrup is also made from other starch crops, such as potatoes, wheat, barley, rice and cassava (Peter, 2010).

Glucose syrup containing over 90% glucose can be *used* in industrial fermentation (Dziedzic and Kearsley,1995), but syrups used in confectionery manufacture contain varying amounts of glucose, maltose and higher oligosaccharides, depending on the grade, and can typically contain 1 0% to 43% glucose (Jackson,1 995).

Glucose syrup is used in foods to soften texture, add volume, prevent crystallization of sugar, and enhance flavour. By converting some of the glucose in corn syrup into fructose (using an enzymatic process), a sweeter product, high-fructose corn syrup can be produced (Knehr, 2008).This research work is aimed at determining the amount of glucose produced from cassava peel and Pulp and the effect of enzyme variation on the yield of glucose syrup from cassava peel and pulp. It also compared the yield and quality of glucose syrup from cassava peel and pulp using enzyme hydrolysis method.

Materials and Methods

Sample Collection

The cassava tuber (*Manihot esculenta*), which is the feed stock for the project was harvested from the farm in Abakaliki Local Government Area of Ebonyi State. It is the major staple food within the locality, cheaply available and easily processed into Garri or Akpu. The drying, hydrolysis and all other analytical works were carried out at Project Development Institute (PRODA), Emene Enugu in Enugu State.

Preparatory Procedure

The harvested cassava was washed with water, peeled and the fiber content removed. The fleshly peeled cassava sample was spread on a clean floor. The peels and the flesh were allowed to stay under the sun for seven days, to ensure drastic reduction of the moisture content. The brittle dehydrated cassava sample was further milled by a roller-mill into a granular form. The milling was repeated to obtain a more uniform material. The roller-mill milled and sieved the sample simultaneously. A powdery dust-like product was obtained.

Enzyme Hydrolysis

Twenty (20) grams of the dried, milled, and sieved cassava peel sample was weighed into 3 different beakers. Similarly, 20 grams of the dried, milled and sieved cassava flesh was weighed into 3 other beakers. Finally, 3 beakers were also set up each containing 20 g of pure starch as a control. 20 ml of distilled water was added to each of the nine beakers and mixed with a glass stirrer to form dough like substance. Then another 70 ml of distilled water was added to each of the beakers and stirred continuously to ensure uniformity. This formed a slurry substance, which was allowed to stay for ten (10) minutes to ensure that the starch swells up so as to allow the enzyme act upon it. The pH of the soaked samples were determined with an electronic pH meter.

Each of these mixtures was brought to gelatinization on a hot plate at a temperature of 65ºC. At this point, 130 ml of distilled water was added so as to form a slurry substance. The slurry mixture was allowed for 1hour 30 minutes on a magnetic stirrer at 43ºC for partial hydrolysis to take place. The pH of the slurry mixture was checked again with an electronic pH meter.

The slurry mixture was filtered using a cheese cloth to remove the non-hydrolysate (Crude fiber). Twenty millilitres of α and β-amylase solution each, was added to three beakers containing cassava peel solution, cassava flesh solution, and pure starch control.

A volume (30ml) of α and β-amylase solution each, was added to 3 beakers containing cassava peel solution, cassava flesh solution, and pure starch control. 40ml of α and β-amylase solution each, was added to 3 beakers containing cassava peel solution, cassava flesh solution, and pure starch control.

All the nine beakers for enzyme hydrolysis were held in a water bath at 65ºC for 1hour for amylase activity. The temperature was reduced to 58ºC and 3 ml of amyloglucosidase added to each of the nine beakers and further allowed for 1hour 45 minutes to breakdown the entire remaining starch, maltose and other dextrins into glucose. Thereafter a cheese cloth was used to extract the syrup-like filtrate. The nine beakers were then transferred to a fume cupboard for evaporation and concentration.
The pH of the resulting concentrated glucose syrup was determined. The Brix was measured with a refractometer, and the glucose content was determined using Fehling's method of glucose estimation.

Result and Discussion

The results of the analysis carried out on the glucose syrups obtained at the end of the enzyme hydrolysis of cassava peel, cassava pulp and the control starch are presented in the tables below.

Enzyme Hydrolysis of Cassava Peel

From the result obtained in the hydrolysis of the cassava peel, the yield of glucose increased as the concentration of enzyme added increased. However the Brix decreased as the enzyme concentration increased as shown in Table 1.

Enzyme Hydrolysis of Cassava Pulp

The glucose yield increased as the concentration of enzyme added increased. The Brix however decreased as the enzyme concentration increased just like in the peels.

Enzyme Hydrolysis of Pure Starch Control

As the concentration of enzyme increased the yield of glucose in the syrup increased just like in the test samples. The Brix decreased as the concentration of enzyme increased as shown in Table 3.

From the results obtained in this study, it was observed that although the cassava pulp yielded more glucose (mean value of 6.76 mg/ml) than the cassava peel (mean value of 4.00 mg/ml), yet the cassava peel yielded a substantial amount of glucose, and from the sensory evaluation carried out, it was found to be sweet and smelled nice, indicating that it could be a potential source of raw material for glucose syrup production.

Tewe *et al*, 1996, reported that cassava wastes constitute the major by-products of tubers used for preparing human foods and industrial starch and that the mechanization of garri in Nigeria has resulted in large quantities of peel wasted mostly from small-sized tubers, which are difficult to process and therefore discarded.

More so, the effect of enzyme concentration on the yield of glucose was studied, and it was observed that the higher the enzyme concentration, the more the glucose yield, indicating that the maximum amount of enzyme added was lower than the enzyme saturation level (Barrie, 2001). Therefore adding the enzymes up to the saturation level of the substrate is essential in obtaining optimal glucose yield from the feedstock.

The pH was found to increase with increase in the yield of glucose (which also means increase in enzyme concentration). This increase, tending towards the optimum pH of the enzyme, probably indicates that as the enzyme level approached saturation level, the internal hydrolytic reactions led to the generation of more alkali leading to the increased pH as was also reported by Ramasubbu *et al* (1996).

Comparing the yield of glucose in the cassava peel, cassava pulp and pure starch at the varying enzyme concentrations, it was found that for any enzyme variation, the pure starch control yielded the highest amount of glucose, followed by the cassava pulp, and lastly the cassava peel, as shown in Table 4. This showed that the cassava pulp contained more starch than the cassava peel probably due to higher impurities contained in the peel than in the pulp (Onwume, 1982; Tewe and Egbunike, 1988).

From the observations made in this study, it can be concluded that the cassava peels yielded a substantial amount of glucose with adequate amount of enzyme, although slightly lower than that of the pulp; hence, cassava peels can be used to make glucose syrup that could be used as a replacement wholly or in part in the manufacture of food additives like thickeners, sweeteners, and humectants, as well as in the manufacture of carbonated beverages and in the bakery industry.

The obvious outcome of such a venture on a large scale would be the reduction in the level of environmental pollution, which these wastes might constitute due to their indiscriminate disposal.

It is therefore recommended that companies producing glucose syrup, should not only limit themselves to the use of the feedstock like corn, millet, etc but should also use cassava peels as it is cheaper, readily available and almost always wasted, or underutilized if not used for such economical purposes as glucose syrup production.

Table.1 Enzyme Hydrolysis of Cassava Peel

Quantity of Starch(GM)	Quantity of Enzyme(IU/L)	P^H	Brix	Glucose Concentration (mg/ml)
20	20	4.98	20.02	3.76
20	30	5.06	16.10	4.00
20	40	5.12	14.15	4.25
Mean	**30**	**5.05**	**16.76**	**4.00**

Table.2 Enzyme Hydrolysis of Cassava Pulp

Quantity of Starch(gm)	Quantity of Enzyme(IU/L)	P^H	Brix	Glucose Concentration (mg/ml)
20	20	5.54	11.20	6.16
20	30	5.56	10.04	6.98
20	40	5.59	9.20	7.14
Mean	**30**	**5.56**	**10.15**	**6.76**

Table 3: Enzyme Hydrolysis of pure starch control

Quantity of Starch(gm)	Quantity of Enzyme(IU/L)	pH	Brix	Glucose Concentration (mg/ml)
20	20	5.43	9.67	7.20
20	30	5.47	9.01	7.56
20	40	5.48	8.56	8.22
Mean	**30**	**5.46**	**9.08**	**7.66**

Table.4 Comparism of Glucose Yield of the Different Substrates at Different Enzyme Concentration

Quantity of Starch (mg)	Quantity of Enzyme (IU/L)	pH	Brix	glucose Concentration (mg/ml)
20mg of peel	20	4.98	20.02	3.76
20mg of pulp	20	5.54	11.20	6.16
20mg of control	20	5.43	9.67	7.20
20mg of peel	30	5.06	16.10	4.00
20mg of pulp	30	5.56	10.04	6.98
20mg of control	30	5.47	9.01	7.56
20mg of peel	40	5.12	14.15	4.25
20mg of pulp	40	5.59	9.20	7.14
20mg of control	40	5.48	8.56	8.22
Mean	**30**	**5.36**	**11.99**	**6.14**

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