International Journal of Biochemistry Research & Review
3(3): 200-205, 2013

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Effects of Variations of the Ration of Sorghum Malt with Sweet Potato Flour on the Quality of Glucose Syrup Produced Through Enzyme Conversion Activity of Sorghum Malt

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Authors' contributions

This work was carried out in collaboration between all authors. Author OOJD designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author OOP managed the analyses of the study. Both authors read and approved the final manuscript.

Research Article

Received 25th September 2012
Accepted 23rd March 2013
Published 15th May 2013

ABSTRACT

The chemical parameters of glucose syrup produced from five different weight ratios of sorghum malt and sweet potato flour using sorghum malt as a source of enzyme hydrolysis were studied. There were variations in the chemical parameters of the samples as a result of the different weight ratios of sorghum malt and sweet potato flour used. The moisture content ranged from 5.33 – 8.26%, ash content 0.010 – 0.040%, the dextrose equivalent 37.00 – 39.33%, the acid content 0.02 – 0.09%, the pH 5.4 – 5.8, and the brix value 82 – 86%. Significant differences were observed between the parameters (except the brix value) of the samples. All the samples had chemical parameters (except acid content of GA and dextrose equivalent of GB and GD) whose values were within the glucose syrup specifications set by the Standard Organisation of Nigeria (SON) as 18% maximum for moisture content, 0.3% maximum for acid content, (38 – 42)% for dextrose equivalent, (4.0 – 6.0) for pH and 82% minimum for brix value. Only the sample (Glucose Syrup E) with the lowest ratio (1:4) of sorghum malt to sweet potato flour had the most desirous qualities having the lowest moisture content, lowest ash content, lowest acid

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content, good brix value and good pH.

Keywords: Brix; enzyme hydrolysis; glucose syrup; sorghum malt; sweet potato.

1. INTRODUCTION

Glucose syrup is a concentrated aqueous solution of glucose, maltose and other nutritive oligosaccharides obtained from edible starch; it is therefore, the most viable substitute for sugar. Glucose or dextrose sugar is found in nature in honey and in a wide variety of fruits. It is less sweet than sucrose (cane or beet sugar) [1] and also less soluble in water, however, when used in combination with sucrose, the resulting sweetness is often greater than expected. It can be used along with a variety of dry solid substances without affecting other parameters like sweetness, ash content and acidity [2]. This advantage has enabled its widespread use in a range of industries for products like confectionery, jams, jellies and canned fruit, bakery products, pharmaceuticals, leather products, liquors and brewery product [3].

Glucose syrup is obtained commercially by hydrolyzing starch derived from cereals, roots and tuber crops such as wheat, barley, maize, rice, sorghum, white or sweet potatoes, cassava, sago palm and waxy maize [4]. The three methods for starch hydrolysis which are used for commercial production of glucose are, acid hydrolysis developed by Kirchoff in 1811, partial acid hydrolysis followed by an enzyme conversion or a complete enzyme hydrolysis [5]. Acidification, which involves the conversion of starch into glucose syrup by acid hydrolysis is being utilized by many factories (especially, the sugar confectionery industry) because of some advantages of this process which include, short hydrolysis time, technical set-up simplicity and low raw material cost [6]. Acid hydrolysis had widespread use in the past and is now widely replaced by enzymatic process as the former required the use of corrosion resistant materials, gave rise to high colour and residual salt content (i.e. after neutralization), needed more energy for heating and was relatively difficult to control [4]. Enzyme hydrolysis involves the use of various types of enzymes such as alpha-amylase, glucoamylase and pullulanase. In the acid-enzyme process, the starch slurry is treated by acidification, neutralization and filtration as in acid hydrolysis process and then is fed into the enzyme converter [7].

Although, glucose syrup is not abundantly produced in Nigeria, but most of Nigerian industries make use of it in their manufacturing operations [8]. The bulk of the syrup used is however imported. The high cost of importing it into the country has led to the adoption of locally available raw materials for its production, and in an attempt to expand existing market for cassava, and existing Vietnamese technology for the production of glucose syrup was adopted and modified to enable its production from cassava flour and rice malt [9]. The main aim of the study was to provide a supply of locally produced glucose syrup to substitute for the imported ones.

This research therefore focuses on the production of glucose syrup using different weight ratios of sorghum malt and sweet potato flour (which are cheap food materials within the southwestern part of the country) and evaluating the quality parameters of the syrups produced.

2. MATERIALS AND METHODS

The major raw materials used were sweet potato roots and white sorghum grains. The sweet potato (*Ipomoea batatas*) roots and sorghum grains used for the production of sweet potato flour and sorghum malt were obtained from Kuto market in Abeokuta, Ogun State and identified by a botanist in U.I. Ibadan, Oyo state Nigeria.

2.1 Preparation of Sorghum Malt

Sorghum grains were sorted, cleaned and soaked in clean water for 24hours; during this period, the water was changed every 8h. The water was drained and the soaked grains were left in the container for 48h (grains were watered two times each day). The sorghum malt preparation was done according to the methods described by [9].

2.2 Production of Sweet Potato Flour

Freshly harvested sweet potato roots were selected, washed, sliced, dried and milled. The flour production was done according to the methods described by [10].

2.3 Production of Glucose Syrup from Sweet Potato Flour using Sorghum Malt as a Source of Enzyme Conversion

The procedure for glucose syrup production as explained by the methods of [9] was followed. Five different samples of glucose syrup were produced by varying the weight ratios of sorghum malt, sweet potato flour, water, and sodium meta-bisulphite. The five samples, Glucose syrup A – E, were represented as GA, GB, GC, GD and GE respectively. Table 1 shows the proportion of sorghum malt, sweet potato flour, water and sodium meta-bisulphite used for the five different samples.

Table 1. Glucose syrup specification

Parameters	Units	Values
Brix	%	82 min.
Dextrose Equivalent	%	38 – 42
pH		4.0 – 6.0
Ash Content	%	0.03 max.
Acid Content	%	0.3 max.
Moisture content	%	18 max.

Source: [11]

Table 2. Proportions of sorghum malt, sweet potato flour, water and sodium meta-bisulphite used for the five samples

Samples	Sorghum malt (g)	Sweet potato flour (g)	Water (litres)	Sodium meta-bisulphite (g)	Ratio of SM to SPF
Glucose syrup A	100	750	0.625	6.25	1:7.50
Glucose syrup B	95	625	0.594	5.94	1:6.58
Glucose syrup C	80	500	0.500	5.00	1:6.25
Glucose syrup D	75	375	0.470	4.70	1:5.00
Glucose syrup E	62.5	250	0.391	3.91	1:4.00

SM: Sorghum malt
SPF: Sweet Potato Flour

2.4 Moisture Content Determination

The moisture contents of the five samples GA, GB, GC, GD and GE were determined according to the moisture content determination method described by [12] and [13].

2.5 Ash Content Determination

The ash contents of the five samples GA, GB, GC, GD and GE were determined according to the ash content determination method described by [13].

2.6 Dextrose Equivalent Determination

The dextrose equivalent of the five samples GA, GB, GC, GD and GE were determined according to the dextrose equivalent determination method described by [13].

2.7 Acid Content Determination

The acid contents of the five samples GA, GB, GC, GD and GE were determined according to the acid content determination method described by [13].

2.8 pH Determination

The pH of the five samples GA, GB, GC, GD and GE were determined according to the pH determination method described by [13].

2.9 Brix Value (Sugar Concentration) Determination

The brix value of the five samples GA, GB, GC, GD and GE were determined according to the brix value determination method described by [13].

3. RESULTS AND DISCUSSION

The result showed that significant differences existed between moisture content, ash content, dextrose equivalent, pH as well as acid content of the five samples; except in the brix values, where no significant difference was noticed. All the analyses were conducted in triplicate and mean $\pm$ standard deviations ($p<0.05$) of the three values were reported.

Table 3. Physicochemical parameters of five different glucose syrups produced by varying the weight ratios of sorghum malt and sweet potato flour

Samples	Moisture content (%)	Ash content (%)	DE (%)	Acid content (%)	pH	Brix (%)
GA	8.26±0.04[a]	0.04±0.02[C]	38±0[bc]	0.09±0[cd]	5.6±0[c]	86
GB	7.57±0.01[b]	0.03±0.03[bc]	37±0[a]	0.08±0[d]	5.4±0[a]	84
GC	7.46±0.01[c]	0.025±0[b]	39.33±0[d]	0.07±0.03[bc]	5.5±0[b]	84
GD	6.28±0.01[d]	0.02±0[ab]	37.67±0[ab]	0.04±0[b]	5.8±0[d]	82
GE	5.33±0.01[e]	0.01±0.01[a]	38.67±0[cd]	0.02±0[a]	5.7±0[e]	82

Values are expressed as means of triplicate determinations ± Standard deviation
GA, GB, GC, GD and GE represent Glucose syrup A, Glucose syrup B, Glucose syrup C, Glucose syrup D and Glucose syrup E respectively.

GE had the lowest moisture content of 5.33% while GA had the highest moisture content of 8.26%. The moisture contents of the five samples decreased from GA – GE as a result of decrease in weights of sorghum malt and sweet potato flour used [8]. However, the moisture contents (Table 3) of all the samples were within the limits of SON glucose syrup specification (as shown in Table 1) for moisture content which is 18% maximum. Also, the ash content of the samples decreased from GA – GE as a result of decrease in weights of sorghum malt and sweet potato flour used [14]. GE had the lowest ash content of 0.01%, while GA was the highest with 0.04%. All the values (except for GA) were within the (0.03% maximum) SON ash content specification for glucose syrup. All the values (except for GB and GD) were within the dextrose equivalent specification for glucose syrup which is 38 – 42%. Moreover, the acid contents of the samples decreased from GA – GE respectively due to decrease in weight of sorghum malt and sweet potato flour used for their production [15]. However, only GE had the lowest acid, ash and moisture contents coupled with desirable proportions of brix value and pH. The high acid contents of GA, GB, GC and GD could have resulted from the weight ratio of the sorghum malt and sweet potato flour used for their production [9]. Therefore, a suitable weight ratio for sorghum malt/ sweet potato flour (Table 2) would be slightly less than 1:4 [16]. The pH values of all the weight ratios also fall within the SON specification (4.0 – 6.0). There were no significant differences between the brix values of all the weight ratios used for the production of the five glucose syrup GA – GE. All the samples displayed brix values that were within the acceptable limits [17,18].

4. CONCLUSION

The weight ratios of sorghum malt/ sweet potato flour used in production of the five samples of glucose syrup exhibited acceptable parameters except for acid contents. The only weight ratio of sorghum malt/ sweet potato flour acceptable for all the parameters is 1:4 (Table 2). Therefore, a weight ratio of sorghum malt/ sweet potato flour that will be suitable to produce acceptable glucose syrup within the specification of SON should not be more than 1:4.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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