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Original Paper

Sugar Spectra of Syrups Produced from Different Tuber Starches via Crude Enzymes and Amyloglucosidase Sources

Okafor D.C.[1*], Agunwah I.M.[1], Ezegbe C.C.[2], Ekeoma C.L.[1] & Onuegbu N.C.[1]

[1] Department of Food Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria

[2] Department of Food Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University Awka, Anambra State, Nigeria

[*] Okafor D.C., Department of Food Science and Technology, Federal University of Technology, Owerri, P. M. B. 1526 Owerri, Imo State, Nigeria

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Abstract

Syrup production was done via enzyme hydrolysis. Enzymes used were crude enzymes from malted sorghum, wheat and millet and exogenous enzyme by name amyloglucosidase (AMG) which hydrolyzed Cassava (Manihot esculenta,), water yam (Dioscorea alata) and potato white (Ipomoea batatas L) starches. Syrup sugars were determined using high performance liquid chromatography (HPLC) and the sugar profile found are fructose; glucose, sucrose, maltose, D-xylose, and D-Raffinose which manifested as a result of the interaction between starches and enzymes. The sugar Fructose was in the range of 17.34 ± 0.651 g/l to 28.16 ± 0.982 g/l, Glucose sugar was in the range of 6.09 ± 0.165 g/l to 177.04 ± 1.229 g/l. The highest glucose yield (177.04 ± 1.229 g/l) was observed in Cassava starch reaction with the commercial enzyme –AMG. Sucrose content was in the range of 5.78 ± 0.180 g/l to 21.59 ± 0.536 g/l, Maltose (23.71 ± 0.125 g/l to 48.04 ± 0.125 g/l) was the most predominant sugar in all syrups gotten from the starch and crude enzymes interaction. The hydrolysis of starches using different enzyme sources yielded sugar spectra of different sugars concentrations with each starch source predisposed to the natural activity of the enzyme peculiar to their variety or cell structure. D-xylose and D-Raffinose were in the range of 0.004-0.225 g/l which is very small in quantity compared to other sugars seen while no D-stachyose was detected.

Keywords

Amyloglucosidase, Crude, Enzymes, Hydrolysis, Starches, Sugars

1. Introduction

Root and tuber crops are among the most important group of food crops in many tropical African countries. In Nigeria for instance, cassava (*Manihot esculenta*) is the most important of these crops in terms of total production, importance and economic value (Okoye et al., 2008). Cocoyam (*Colocasia esculenta*), which belongs to the Araceae family, ranks third after cassava and yam (Onyenweaku & Okoye, 2007). According to a report by Ogunniyi (2008), Nigeria is the world's largest producer of cocoyam, accounting for about 40% of total world output as recorded by the food and agriculture organization in 2007 (FAO, 2007). Despite this, Nigeria and other developing nations are beset by the problem of lack of proper storage facilities for these tubers and as such, a large number of these tubers in the order of millions of tons are destroyed through pest infestation, deterioration, physical damage to the tubers, pilfering etc. (Omemu et al., 2005). In order to recover the losses resulting from these wastages, it is important to expand the processing range of these tubers with particular focus on converting them into value-added products. One of the processing methods that can reduce wastage of these tubers is converting them into syrups for multipurpose usages and applications in food and beverage industries, as well as in the pharmaceutical industries. Again, with the demand on cane sugar as a result of increasing need by the teeming population and industries who seek to satisfy nutritional and commercial requirements, there is deficient supply of cane sugar as the quantity produced in the country cannot meet up with the increasing demand. Hence the need to source for alternative sources of sugar and this is what syrup production provides.

However, over the years, commercially produced enzymes have been used for syrup production which not only is expensive and not readily accessed or available in Nigeria and other tropical countries but also very difficult to preserve because they are heat labile. Hence this paper is geared towards producing syrup using an alternative source of enzyme other than the exogenous source. The main objectives of this paper is to produce sugar syrups by enzyme hydrolysis with exogenous and endogenous enzymes [amyloglucosidase (AMG) and crude enzymes from millet, sorghum and wheat respectively] and to determine the sugar spectra present in the syrups produced using high performance liquid chromatography (HPLC). The quality and state of this paper is new, different and interesting in that it will help us to ascertain the ability of tropical malted grains such as wheat, millet, and sorghum in hydrolyzing the starches extracted from tropical tubers and roots (cassava, water yam, and potato) and the extent of their hydrolysis as when compared to the action of the exogenous enzyme (Amyloglucosidase) hydrolysis on these starches. It will advance the knowledge of crude enzymes in the field of Food Science and Technology.

2. Materials and Methods

2.1 Raw Material Collection

The cassava (*Manihot exculenta*) tuber known as TME 419, yam (*Dioscorea alata*) tuber commonly known as water yam, and potato white (*Ipomoea batatas L*), white colored sorghum (*Sorghum vulgare*)

with varietal name fara-fara, millet *(Pennisetum glaneum*) known as Ex - Borno and *wheat (Triticum eastivum)* Ex - Jos used were gotten from the Department of Crop Science Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. The equipment and some chemicals used for this research were all of analytical standards gotten from the department of food science and technology, Federal University of Technology Owerri, Imo state and the International Institute of Tropical Agriculture (IITA) Ibadan, Oyo state, Nigeria. The exogenous enzyme amyloglucosidase used was gotten from Novo Nordisk of Denmark. The solvents used for HPLC analysis are HPLC grade and are gotten from E-Merck (Darmstadt, Germany). Other chemicals are also of analytical grade and are gotten from Sigma Aldrich (Steinheim, Germany).

2.2 Preparation of Starch

The method described by Ige and Akintunde (1981) was used. Starch extraction was carried out from the fresh cassava tubers. The tubers were washed, peeled and milled into slurry. The slurry was properly stirred and allowed to settle for about 6 hours. After settling of the cassava slurry, a heterogeneous mixture was observed, the top part o of the mixture was a transparent liquid and the bottom part was a white thick liquid which is starch. The supernatant was decanted and the sediment which contains the starch was filtered with muslin cloth and oven-dried at 45-55 ℃ for 30 minutes to produce the dry starch, which was later milled to produce a fine powder. This procedure was followed in preparing starch from potato roots and water yam tubers

2.3 Production of Crude Enzymes

By malting the grains [Fara fara *(sorghum vulgare*, a variety of guinea corn*)* Ex -Borno *(Pennisetum glaneum* a variety of millet*)* and Ex -jos *(Triticum eastivum* a variety of wheat*)*], enzymes were developed in them. These enzymes are crude enzymes. The malting was prepared according to the method described by Subramanian et al. (1992). The grains were carefully sorted to separate dirt, stones and other contaminants. The cleaned grains were soaked in water at a grain to water ratio of 1:3 The grains were washed and soaked/steeped separately in portable water for 24 hours and the water were changed every 6 hours interval to undergo air rest of 10 mins. They were spread on a jute bag in a room for the commencement and completion of sprouting at an ambient temperature (35 ℃). 250 ml of water for every 500 g of grain was sprinkled every 6hours interval on the grains to enhance sprouting (Figure 1). It was germinated for 24 hours before the emergence of grain rootlets after which they were dried in an oven at 45 ℃ to stop the germination. Dry milling was done using a machine and was sieved to a fineness of flour using a 5.3 um aperture size sieve to get the malted cereal which contains the crude enzymes developed during malting of the grains.

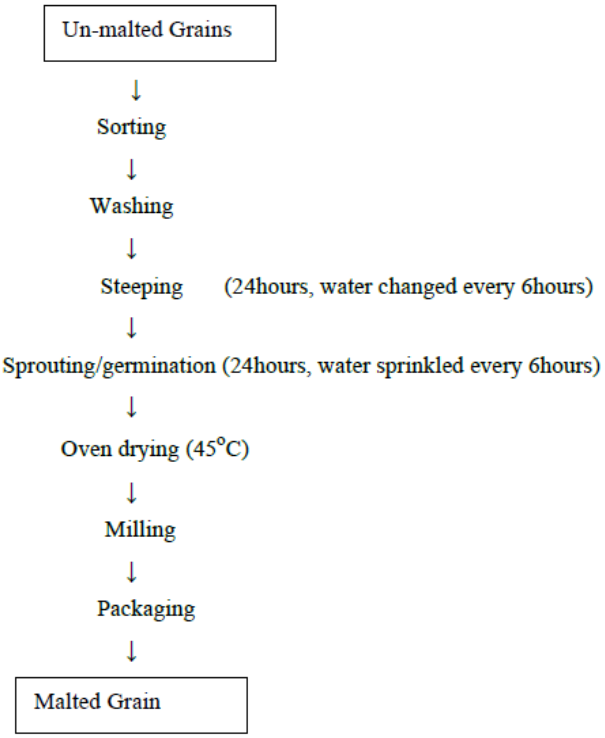

Figure 1. Flow Diagram for Production of Malted Grains (Wheat, Millet and Sorghum)

2.4 Procedure for Syrup Production Using Exogenous Enzyme Application (Amyloglucosidase)

The method described by Osuji and Anih (2011) and Okafor et al. (2018) was used. The mash water to be used for the syrup production was prepared to a pH of 11 with aid of calcium hydroxide. 20 grams of the starch samples were weighed respectively into clean pots. Slurry was made by adding 250 ml of the mash water respectively into the weighed starches. The temperature of the slurries was raised to 45 ℃, after which 20 grams of the amylogucosidase enzyme was added to each of the slurries, the slurries were stirred and maintained at that temperature for 20 minutes. Temperature was raised to 55 ℃, they were stirred and allowed to rest for 10 minutes. Iodine tests were carried out by adding 2 drops of iodine to a few drops of the samples on a ceramic tile. The temperature of the slurries was raised to 65 ℃ and maintained for 1 hour. Another iodine tests were carried out. Temperatures were further raised to 90-93 ℃ and maintained for another 1 hour. The slurries were then boiled for 5 minutes, after which iodine tests were carried out. The samples were then cooled to 60 ℃ by placing them in an ice water bath. The pH of the samples was checked. After hydrolysis, the liquors were boiled for 10 minutes to denature enzymes. The converted slurries were then filtered across a double-layered muslin cloth. The samples were then evaporated and concentrated through evaporation using a water bath, and then packaged.

2.5 Procedure for Syrup Production Using Crude Enzyme Application from Malted Cereals

The method described by Okafor et al (2018 and 2019) was used. The mash water to be used for the syrup production was prepared to a pH of 11 with aid of calcium hydroxide. 20 grams of the starch samples were weighed respectively into clean pots. Slurry was made by adding 250ml of the mash

water respectively into the starches. The temperature of the slurries was raised to 45 ℃, after which 3 grams of the malted grains respectively was added to each of the slurries, the slurries were stirred and maintained at that temperature for 20 minutes. Temperature was raised to 55^{o}C**,** they were stirred and allowed to rest for 10 minutes. Iodine tests were carried out by adding 2 drops of iodine to a few drops of the samples on a ceramic tile. The temperature of the slurry was raised to 65 ℃ and maintained for 1 hour. Another set of iodine test were carried out. Temperatures were further raised to 90-93 ℃ and maintained for another 1 hour. The slurries were then boiled for 5 minutes, after which iodine tests were carried out. The samples were then cooled to 60 ℃ by placing them in an ice water bath. The pH of the samples was checked, after hydrolysis, the liquors were boiled for 10 minutes to denature enzymes. The converted slurries were then filtered across a double-layered muslin cloth. The samples were then evaporated and concentrated through evaporation using a water bath, and then packaged. This same procedure was repeated for 6, 9, 12, 15 and 20 grams of the malted cereals respectively on each of the three starches.

2.6 Determination of Brix Level

The apparent Brix was determined using a portable digital handheld refractometer (VBR32T Bellingham and Stanley UK Brix/ATC 0-32%). The digital refractometer was cleaned with a clean wiper and standardized with distilled water at 20 ℃ until the brix value reads zero. Two drops of syrup sample at 20 ℃ was dropped on the lens (sensitive surface) of the refractometer and measured. The syrups with the highest brix level were chosen for the sugar spectra analysis using high performance liquid chromatography.

2.7 Determination of Sugar Spectra with High Perfomance Liquid Chromatography Using Refractive Index Detector (Hplc-Ri)

Determination and quantification of specific sugars was performed according to method of Zielinski et al. (2014) using HPLC with Refractive Index detector (Waters e2695, USA; 2414 RI Detector) with Sugar Analysis 300 x4.6mm column. The analysis was performed at 35 ℃ with a flow rate of 1 ml min-1using isocratic elution with 75% acetonitrile (AcN): 25% water (H_2O) mixture as a mobile phase. All samples were centrifuged at 4,000 rpm for 10 min (Hermle Labnet Z323) and the supernatant was filtered through a 0.22 μm PES membrane (Sartorius Stedim Biotech, Germany). Then the filtrate was diluted 10 times before direct injection into the HPLC. The sugars seen and detected were recorded.

2.8 Statistical Analysis

Data were expressed as mean ± standard deviation (SD) from two parallel measurements. The analysis of variance (ANOVA) and least significant difference (LSD) were performed with the SPSS 20.0 software (SPSS Inc.) significance difference was defined at $\Theta = 0.05$.

3. Results and Discussion

3.1 Brix Reading of Syrups Produced with Crude Enzymes

Increase in the brix level of the syrups confirms that there was an interaction between the starches and enzymes. From the refractometer readings at different concentration for each of the crude enzyme used,

it was observed that the potato white starch with millet crude enzyme at all concentrations gave the highest brix level (Table 1). All other starch sources (cassava and water yam starches) on the millet crude enzyme gave their highest degree brix at 15 grams concentration. When sorghum crude enzyme was used in the hydrolysis, cassava starch was the only starch that gave a reading of 3.0 ^{0}BX at 0gram concentration of the crude enzyme as against all starch sources that gave zero reading at the 0gram concentration of the sorghum crude enzyme. Cassava had degree brix level of 3.0 without any enzyme treatment this can be attributed to the variety used and other substances in the multi component matrix in which the starch occurs naturally as the gelatinized starch has lost its crystallinity thereby accelerating its hydrolysis. Also, since this variety TME 419 gives higher tonnage yield and higher starch content as opposed to other cassava varieties which are lower in starch content, it is possible that some hydrolysis took place by inherent enzyme in the peel as starch extraction processes took place (Tester et al., 2004). Cassava, water yam and potato white starches gave their highest brix level of 16.0, 13.5 and 15.0 respectively at the 15 grams concentration of the sorghum crude enzyme treatments (Table 1). For wheat enzyme treatments, potato white starch set the pace at all concentrations of the crude enzyme giving its highest degree brix level at 15 grams concentration of the crude enzyme. All starch sources when treated with different crude enzymes gave their best/highest degree brix readings at 15 grams concentration of the crude enzyme (Table 1). As a result of the high brix level at this concentration, only syrups produced at the 15 gram concentration of the crude enzyme was subjected to sugar spectra analysis using HPLC.

Table 1. Brix Reading of Syrups Produced with Crude Enzyme Application at Different Concentrations for Different Starch Sources

Sources of Enzymes	Sources of carbohydrates	Quantity of crude enzymes applied (Grams)						
		0.0	3.0	6.0	9.0	12.0	15.0	20.0
Millet	Cassava starch	0.0	7.0	9.0	12.0	13.6	15.40	15.30
	Water yam starch	0.0	9.5	11.3	12.5	13.5	15.0	14.8
	Potato white starch	0.0	10.5	11.8	13.8	15.5	18.5	18.0
Sorghum	Cassava starch	3.0	9.5	11.9	13.5	14.5	16.0	15.8
	Water yam starch	0.0	7.4	8.1	10.5	11.7	13.5	13.10
	Potato white starch	0.0	8.5	9.8	11.5	13.7	15.0	14.8
Wheat	Cassava starch	0.0	6.3	8.5	10.7	12.6	14.7	14.0
	Water yam starch	0.0	8.5	9.8	10.6	11.3	12.8	12.4
	Potato white starch	0.0	11.3	12.6	15.0	19.0	25.0	24.8

3.2 Sugar Spectra of Syrups as a Result of Effect of Only Starch Source Interaction

For fructose, interaction between the starches showed that, water yam starch gave the highest mean yield of fructose (11.95 g/l) followed by cassava starch (7.55 g/l) while potato white starch gave the

least fructose yield (5.78 g/l) irrespective of the enzymes used. For glucose, cassava starch gave the highest mean yield of glucose (48.47 g/l) followed by potato white starch (9.69 g/l) with water yam starch giving the lowest yield (3.80 g/l). For sucrose, potato white starch gave the highest mean yield of sucrose (11.01 g/l), followed by water yam starch (6.41 g/l) with cassava starch given the least yield for sucrose (3.16 g/l). For maltose, potato white starch gave the highest mean yield of maltose (26.09 g/l), followed by water yam starch (20.05 g/l) with cassava starch given the least yield for maltose (17.14 g/l). For D-xylose, potato white starch gave the highest mean yield (0.0082 g/l), followed by water yam starch (0.0079 g/l) with cassava starch given the least mean yield for D-xylose (0.0047 g/l). For D-Raffinose, potato white starch gave the highest mean yield (0.1218 g/l), followed by cassava starch (0.0400 g/l), with water yam starch given the lowest mean yield for D-Raffinose (0.0198 g/l) shown in Table 2. Different sugars at variable concentrations indicated interaction that took place as a result of the inherent properties (genetic makeup) of the different starch sources

Table 2. Effect of Starch Source Interaction on Sugar Spectra in Grams per Liter (g/l)

Starch source	Fructose	Glucose	Sucrose	Maltose	D-xylose	D-Raffinose	D-stachyose
CS	7.5514	48.4675	3.1639	17.1416	0.0047	0.0400	0.0000
WYS	11.9484	3.8013	6.4148	20.0471	0.0079	0.0198	0.0000
PWS	5.7823	9.6994	11.0100	26.0931	0.0082	0.1218	0.0000

Means with different alphabet superscript along columns are significantly different ($p \geq 0.05$)

KEY: CS = cassava starch, WYS = water yam starch, PWS = potato white starch

3.3 Sugar Spectra from Enzyme Interaction Only

When the enzymes interaction only is considered without paying attention to the starch source, millet enzyme gave the highest total yield of fructose with mean yield of 14.76 g/l, followed by sorghum enzyme (8.76 g/l), wheat (5.14 g/l) and AMG enzyme with the lowest mean yield of 5.05 g/l. AMG enzyme gave the highest total yield of glucose (59.65 g/l) followed by millet enzyme (10.03 g/l), wheat (6.68 g/l) with sorghum enzyme with the lowest mean yield of 6.27 g/l. The wheat enzyme gave the highest total yield of sucrose (9.24 g/l), followed by millet enzyme (9.20 g/l), AMG (5.96 g/l) with sorghum enzyme giving the least yield (3.05 g/l). The wheat enzyme gave the highest total yield of maltose (28.53 g/l), followed by millet enzyme (20.37 g/l), sorghum (18.37 g/l) and AMG enzyme gave the lowest mean yield of 17.10 g/l. The AMG enzyme gave the highest total yield of D-xylose (0.0093 g/l), followed by wheat enzyme (0.0073 g/l), sorghum (0.0063 g/l) with millet enzyme being the lowest (0.0047 g/l). The millet enzyme gave the highest total mean yield of D-Raffinose (0.0830 g/l), followed by wheat enzyme (0.0830 g/l), AMG (0.0463) while sorghum enzyme gave the lowest mean yield of 0.0273 g/l (Table 3). The ability of this enzyme sources to liberate this sugar can be attributed to their diastatic power resulting from the amount of diastatic enzymes present in the malted grains which varies between the grains (John et al., 1998).

Table 3. Effect of Only Enzyme Interaction on the Sugar Spectra in Grams per Liter (g/l)

Enzyme source	Fructose	Glucose	Sucrose	Maltose	D-xylose	D-Raffinose	D-stachyose
AMG	5.0552	59.6484	5.9563	17.1053	0.0093	0.0463	0.000
Millet	14.7637	10.0264	9.2048	20.3677	0.0047	0.0853	0.000
Sorghum	8.7552	6.2730	3.0491	18.3693	0.0063	0.0273	0.000
Wheat	5.1354	6.6763	9.2414	28.5333	0.0073	0.0830	0.000

KEY: AMG = Amyloglucosidase

3.4 Sugar Spectra as Shown by the Interaction of both Enzyme and Starch Sources

When the interaction of both enzyme and starch sources are considered together, the sugars spectra are affected. Water yam starch and millet gave the highest mean yield of fructose (28.16 g/l), followed by the interactive effect of cassava starch and sorghum with mean yield of 17.34 g/l while potato white starch and wheat gave the lowest yield (10.49 g/l). The interactive effect between cassava starch and AMG enzyme gave the highest mean yield of glucose (177.04 g/l), followed by that of potato white starch and wheat enzyme with mean yield of (17.11 g/l), with water yam starch and millet giving the lowest glucose yield of 6.09 g/l. The interactive effect between potato white starch and wheat gave the highest yield of sucrose (21.59 g/l), followed by the interaction of water yam starch and AMG enzyme with yield of 13.9 g/l whereas cassava starch and wheat gave the lowest yield of 4.12 g/l. The interaction between potato white starch and wheat enzyme gave the highest yield of maltose (48.04 g/l), followed by the interaction effect between water yam starch and sorghum enzyme yielding (32.30 g/l), with cassava starch and AMG enzyme giving the lowest maltose yield (24.56 g/l). The interactive effect between potato white starch and AMG enzyme gave the highest yield of D-xylose (0.018 g/l), followed by the interaction of water yam starch and wheat enzyme yielding (0.0127 g/l), with cassava starch on all enzyme sources giving the lowest yield of 0.0047 g/l. The interaction effect between cassava starch and AMG enzyme gave the highest mean of D-Raffinose yield (0.0920 g/l), followed by the interaction effect between water yam starch and sorghum enzyme with mean yield (0.0390 g/l), while potato white starch and wheat enzyme gave the lowest yield of 0.2250 g/l.

For fructose yield, there is no significant difference between cassava starch on wheat and water yam starch on AMG enzyme as, likewise no significant difference exists between water yam starch on wheat and potato white starch on sorghum. Other starch sources and enzymes are significantly different with respect to yield of fructose sugar.

For glucose yield, cassava starch on millet and water yam starch on wheat are not significantly different, also potato white starch on millet and sorghum are not significantly different but all other starch source on all other enzymes are significantly different with regards to the glucose yield. For sucrose yield, water yam starch on millet, sorghum and wheat enzyme are not significantly different. All other starches on all other enzyme sources are significantly different.

For maltose yield, all starch sources on all enzyme sources are not significantly different.

For D-xylose yield, cassava starch on AMG, millet, sorghum, and wheat enzymes are not significantly different, alongside water yam starch on AMG enzymes, and potato white starch on millet, sorghum and wheat while water yam starch on millet, sorghum, wheat and potato white starch on AMG are significantly different from all other starches on all other enzymes sources but are not significantly different in their yield of D-xylose.

For D-Raffinose yield, cassava starch on wheat and water yam starch on AMG are not significantly different. Cassava starch on sorghum and potato white starch on millet, sorghum and wheat are not significantly different. Cassava starch on millet and potato white starch on AMG are not significantly different. Potato white starch on millet and sorghum are not significantly different, but cassava starch on AMG and potato white starch on wheat are significantly different from among all the starch sources and enzymes as shown in Table 4. The discussions agree with the results of the study conducted by other researchers. In fact, Osuji and Okafor (2013), Okafor et al. (2019) have worked on Soymilk and revealed the existence of significant differences among the sugar content of soymilk after different enzyme treatment using HPLC. Among the sugars identified include glucose, fructose, maltose, Raffinose, Xylose and stachyose. The presence of stachyose as identified in their work can be attributed to the action of the cell wall degrading enzyme used as opposed to this research where stachyose was not identified because the hydrolysis was mainly as a result of Oligosaccharide degrading enzymes.

Table 4. The Sugar Spectra of the Interactive Effect of Enzymes and Starches (g/l)

Starch	Enzyme	Fructose	Glucose	Sucrose	Maltose	D-xylose	D-Raffinose	D-Stachyose
CS	AMG	$0.1270^{d} \pm 0.010$	$177.0383^{a} \pm 1.229$	$3.1607^{h} \pm 0.055$	$24.5643^{h} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0920^{d} \pm 0.004$	0.000
	Millet	$11.1170^{f} \pm 1.210$	$6.9790^{h} \pm 0.069$	$1.3996^{g} \pm 0.005$	$13.5533^{k} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0160^{b} \pm 0.004$	0.000
	Sorghum	$17.3413^{b} \pm 0.651$	$8.9627^{e} \pm 0.061$	$3.9877^{j} \pm 0.044$	$16.5993^{l} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0390^{e} \pm 0.004$	0.000
	Wheat	$1.6203^{c} \pm 0.451$	$0.8900^{i} \pm 0.014$	$4.1077^{e} \pm 0.105$	$13.8493^{i} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0130^{f} \pm 0.004$	0.000
WYS	AMG	$14.8217^{c} \pm 0.563$	$1.0910^{f} \pm 0.020$	$13.9087^{f} \pm 0.128$	$23.5833^{f} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0140^{f} \pm 0.004$	0.000
	Millet	$28.1590^{a} \pm 0.982$	$6.0930^{j} \pm 0.165$	$5.7837^{h} \pm 0.180$	$0.5873^{d} \pm 0.125$	$0.0047^{a} \pm 0.006$	$0.0150^{e} \pm 0.004$	0.000
	Sorghum	$1.5130^{j} \pm 0.265$	$5.9940^{g} \pm 0.025$	$3.9430^{h} \pm 0.128$	$32.3033^{j} \pm 0.125$	$0.0097^{a} \pm 0.006$	$0.0390^{e} \pm 0.004$	0.000
	Wheat	$3.3000^{h} \pm 0.159$	$2.0270^{h} \pm 0.097$	$2.0237^{i} \pm 0.103$	$23.7143^{g} \pm 0.125$	$0.0127^{a} \pm 0.006$	$0.0110^{e} \pm 0.004$	0.000
PWS	AMG	$0.2170^{g} \pm 0.003$	$0.8160^{c} \pm 0.075$	$0.7998^{b} \pm 0.004$	$3.1683^{a} \pm 0.125$	$0.0187^{a} \pm 0.006$	$0.0330^{b} \pm 0.004$	0.000
	Millet	$5.0150^{i} \pm 0.265$	$17.1120^{d} \pm 0.389$	$20.431^{c} \pm 0.527$	$46.9623^{c} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.2250^{a} \pm 0.004$	0.000
	Sorghum	$7.4113^{h} \pm 0.751$	$3.8623^{d} \pm 0.064$	$1.2167^{a} \pm 0.093$	$6.2053^{b} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.0040^{a} \pm 0.0040$	0.000
	Wheat	$10.4860^{d} \pm 0.854$	$17.1120^{b} \pm 0.389$	$21.5930^{d} \pm 0.536$	$48.0363^{e} \pm 0.125$	$0.0047^{b} \pm 0.006$	$0.2250^{c} \pm 0.004$	0.000
LSD		1.098	0.654	0.405	0.218	0.011	0.006	0.000

KEY: CS = cassava starch, WYS = water yam starch, PWS = potato white starch, AMG = Amyloglucosidase.

4. Conclusion

It is evident that enzyme hydrolysis by means of endogenous enzyme can hydrolyze starches to produce syrups. Sources of the starches hydrolyzed determines to a great extent the type of sugars to be produced in a hydrolysis, as the constituents enzymes developed in a particular malted grain and the cell structure of the starch source must be compatible to the intended end product (sugar) in that particular hydrolysis. The diastatic power of the grains developed during malting led to more production of maltose sugar by the crude enzymes. Food and beverage industries, institutions and, private investors should harness the opportunity of producing syrups from crude enzymes and choices as to what type of sugar they want to dominate the syrups affect their starch source and enzyme source. This can be achieved by choosing among the starches and enzymes that produce the best result for any particular sugar of interest. For a syrup rich in fructose water yam starch is the ideal starch and malted millet as source of enzyme, for a sucrose rich syrup, potato white starch is the ideal starch and malted wheat as the source of enzyme etc. This paper has established the fact that a particular sugar type can dominate all other sugars in syrup. This paper has provided alternatives on how a particular sugar can be obtained in syrup at different preferred or desired concentrations to meet consumer's preferences using crude enzymes.

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