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BACTERIOLOGICAL AND PHYSICOCHEMICAL EVALUATION OF SYRUPS PRODUCED FROM LOCAL STARCH SOURCES

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ABSTRACT

Investigations were carried out on the bacteriological and physicochemical status of locally prepared syrups from local raw materials. The syrups were produced, using acid hydrolysis, from starches obtained from *Colocasia esculenta, Zea mays* and *Manihot palmata*. The viable bacterial count gave low counts of *Leuconostoc mesenteroides*, *Bacillus subtilis* and *Lactobacillus* species. The dextrose equivalent was 83.12, 66.02 and 59.87 percent for *Zea mays, Manihot palmata* and *Colocasia esculenta* respectively. The titratable acidity was 0.02% for *Zea mays*, 0.02% for *Manihot palmata* and 0.01% for *Colocasia esculenta* while the cyanide content was 1.00ppm in *Manihot palmata* and absent in the other two starch sources. Generally the locally prepared syrups exhibited appreciable shelf life under the laboratory conditions.

KEY WORDS: Syrups, Acid hydrolysis, Dextrose equivalent, Cyanide,

INTRODUCTION

According to Birch (1970), syrups are thick sweet liquid consisting of concentrated solutions of nutritive saccharides in water and other solvents, which can be used as substitute for sugar in industrial and domestic applications.

The increase in pharmaceutical, food, soft drink and brewing industries in Nigeria has necessitated, in recent times, the use of large volumes of sugar either as sweeteners, adjuncts or extenders in the formulations of their products. Breweries for example, use between zero and 30% sugar in their formulations (Akobundu, 1988), while the level of sugar utilisation in the soft drink industry is even higher. The large quantity of sugar utilized by these industries has significantly increased its demand. Unfortunately the few sugar manufacturing industries in Nigeria cannot cope with this high demand. Therefore, a large tonnage of sugar is imported and this has really put pressure on the demand for foreign exchange, which is not easy to obtain in Nigeria.

In an attempt to reduce the demand for sugar by these industries, syrups are now used to supplement or as substitute. Sadly too, a significant proportion of the syrups required by these industries are still being imported even though the raw materials for their production are readily available locally. It has been reported that syrups with at least 20% dextrose equivalent could be made from converted starch from cereals (Welborn, 1991) and from non-cereal sources which are cheap and easily available (Khalid, 1982).

While the production of syrups from cereal such as maize, sorghum, millet, and guinea corn, has received considerable attention (French, 1975; Lees and Jackson, 1973; Levits *et al.*, 1996; Shaw and Taiwan, 1994; and Swain, 1976), there seem to be scanty information on the production of syrup from non-cereal starch sources (Akobundu, 1988; Petit and Pinilla, 1995; Edirisah-Aido, 1979), and none at all on the bacteriological quality of the syrups so produced. This work therefore is aimed at producing syrups from three local starch sources namely cassava, cocoyam and maize; and evaluating their physicochemical and bacteriological status to ascertain their suitability for consumption.

MATERIALS AND METHODS

Sample Collection

Manihot palmata, Colocasia esculenta and *Zea mays* were purchased locally from Etaha Itam market in Itu Local Government Area of Akwa Ibom State, Nigeria. The three crops were identified and authenticated by the Crop Science Department, Faculty of Agriculture, University of Uyo.

Extraction of Starch

Five kilograms each of the raw materials were washed in water and allowed to air-dry at room temperature. The cassava tubers and cocoyam corms were peeled, washed again with

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distilled water, grated with oven-sterilized hand grater, and steeped in sterile distilled water for 24 hours at room temperature under properly zealed sterile plastic containers. The maize grains were similarly steeped but wet-milled in rotary mill at 330 rpm. After milling the sample was homogenized in 1litre of sterile distilled water and sieved with a mesh of pore diameter 0.35μ. The filtrate was allowed to stand undisturbed for 2 hours for the starch to settle properly. Thereafter the supernatant was decanted and the starch formed was sun-dried for 2 days to get pulverized. The pulverized starches were sterilized by autoclaving at 121°C for 15 minutes and preserved in the desiccator until ready for use. Starches from cocoyam and scassava were similarly produced and treated.

Preparation of Syrup

Five hundred grams each of the sterile powdery starch from the different sources were mixed separately with 1.5 litres of 0.1M HCl in a 2-litre glass trough and allowed to stand for 3 hours to form slurry. The slurry was blended by heating at 100°C in a water bath with conunuous stirring. The blended slurry was further autoclaved at 120°C for 30 minutes and allowed to cool for 45 minutes for conversion to high sugar solution.

At the end of conversion, 50% (v/v) of 0.1M Na_2CO_3 was added to the resulting solution and the pH adjusted to 5.0 using 0.1M HCl. Thereafter the sugar solution was decolorized with 30.0 g of carbon black and allowed to stand for 2 hours to complete the decolorization process. Finally, the solution was aseptically filtered with sterile Whatman No.1 filter paper. The filtrate was concentrated to about 70% solid by heating in a water bath maintained at 80°C. The resulting viscous sweet slurry was the syrup.

Sensory Evaluation

A six-man panel from Departments of Microbiology and Brewing Science, University of Uyo, was set up to evaluate the sweetness, colour, flavour and texture of the syrups.

Bacteriological Analysis

Viable bacterial counts were carried out on nutrient agar (Oxoid, England), MRS agar and Tomato juice agar, using pour plate technique described by Madigan *et al.*, (1997), on serially diluted syrup samples. The bacterial isolates were identified based on cultural morphological and biochemical characteristics, assisted by the identification scheme of Buchanan and Gibbons, (1974).

Physico-chemical Analysis

Measurement of pH was taken with pH meter (Griffin, England) at 4°C. Anthrone method (AOAC, 1970) was used for the determination of total sugar. In this method the concentration of total sugar was read off from a standard glucose curve at 620 nm. The sulphated and chloride ash were determined by method of AOAC, (1984). The method of AOAC (1985) was adopted for dextrose equivalent, cyanide content, sulphur dioxide, dry substance, and titratable acidity.

RESULTS

Acid hydrolysis of the local starches extracted from cocoyam, cassava and maize

Table 1: Sensory evaluation of locally produced syrup

	Source of the Syrup		
Parameter	**Cassava**	**Cocoyam**	**Maize**
Sweetness	+	+++	++
Colour	Light brown	Dark brown	Light brown
Flavour	Fruity	Fruity	Fruity
Appearance	Clear	Clear	Clear
Texture	Viscous	Viscous	Viscous
RANKING	4	6	5

+ : Sweet ++: Sweeter +++: Sweetest

4 Fair 5: Good 6: Very good

Table 2: Incidence of different types of bacteria isolated from locally produced syrups

Sample	Viable Count (cfu/ml)[a]		
	L. mesenteroides	*Lactobacillus* sp	*B. subtilis*
Maize syrup	1.4×10^2 ± 0.03	1.0×10^2 ± 0.40	1.2×10^2 ± 0.30
Cocoyam syrup	1.0×10^2 ± 0.60	1.2×10^2 ± 0.30	1.0×10^2 ± 0.10
Cassava syrup	1.3×10^2 ± 0.20	1.3×10^2 ± 0.10	1.4×10^2 ± 0.20

[a]Values are mean ± standard deviation of three replications.

Table 3: Physico-chemical analysis of the local syrups

Parameter	Syrup sample		
	Cassava	Cocoyam	Maize
pH	5.0	5.0	5.0
Titratable acidity (%)	0.02[a]	0.01	0.02
Sulphated ash (%)	0.36	0.31	0.46
Chloride ash (%)	0.04	0.07	0.07
SO_2 (ppm)	1.02	0.02	2.14
Total sugar (%)	14.38	15.72	16.83
Dextrose equivalent (%)	66.02	59.87	83.12
Cyanide (ppm)	1.00	Nil	Nil
Dry substance	70.40	70.00	70.00

[a]Values are mean from three replications

yielded high sugar syrups of varying degree of sweetness, texture, colour, appearance and flavour. The result of the sensory evaluation test is presented in Table 1. All the syrups had appreciable sweetness and flavour.

Table 2 shows the incidence of different bacteria isolated from the locally produced syrup. Based on morphological and biochemical characteristics, the isolates were identified as *Leuconostoc mesenteroides, Bacillus subtilis* and *Lactobacillus* species. The mean bacterial counts in all the samples was low.

The result of the physico-chemical analysis is presented in Table 3. Maize syrup had the highest dextrose equivalent (83.12%) and total sugar (16.83%). Cassava syrup had 66.02% dextrose equivalent and 14.38% total sugar while the cocoyam syrup had 59.87% and 15.72% dextrose equivalent respectively.

DISCUSSION

In this study, syrups produced from local starch sources exhibited varying degree of

sweetness. This may be due to the conversion of the starch to glucose by acid hydrolysis. Based on ranking, cocoyam syrup was adjudged the sweetest with rank 6 while cassava syrup had the least rank of 4. However because of low starch yield and the difficulty associated with extracting starch from cocoyam head, it might not be economically expedient to produce syrup from this source.

All the syrups were found to contain low counts of bacteria. This might be due to high sugar content in the syrup which tied up moisture that could have been available for bacterial growth and proliferation. It is possible that the high osmotic pressure exerted by the sugar on non-osmotolerant bacteria must have plasmolysed their cells. However, the few bacterial isolates were non-human pathogens, showing that the syrups were bacteriologically stable and safe for consumption.

This study also revealed that the maize syrup had the highest dextrose equivalent, followed by cassava syrup, while the cocoyam syrup had the least. Similar observation was made by Akobundu (1988), who reported dextrose equivalent of 47%, 46% and 45% respectively, for maize, cassava and cocoyam. However, the dextrose equivalent recorded in this study was 36.12%, 20.02% and 14.87% higher than those earlier reported for maize, cassava and cocoyam respectively. This variation might be due to differences in the crop varieties used, and in the rate of degradation between cereal and non-cereal starches during hydrolysis. Furthermore, a certain degree of polycondensation might have taken place and some of the yield of dextrose might have been lost owing to the acidity and high temperature required for the conversion. Wiseman (1975), reported that cereal starches are completely degraded on hydrolysis with dilute acid thereby increasing the dextrose equivalent in cereal syrups.

Cyanide is known to be cytotoxic. It inhibits the respiratory chain at the level of cytochrome oxidase and is implicated in chronic degeneration neuropathy and goitre formation by altering the regulatory mechanism of the thyroid and the peripheral metabolism and excretion of thyroid hormones. But the cyanide content in this locally produced cassava syrup was very low compared to the lethal level of 35 mg/100 mg observed by Oke (1969). Acid hydrolysis of cassava starch might have converted hydrogen cyanide to less toxic hydrocyanic acid. Similarly, the presence of SO_2 in low concentration served as preservative and contributed to improved stability of the syrups.

In conclusion, the results of this investigation show that high sugar syrups with acceptable physico-chemical and bacteriological status could be produced from local cereals, roots and tubers for brewing, bottling, food and pharmaceutical industries. However the major problems facing production of syrup from novel raw materials are unacceptability of the syrup for consumption owing to lack of public confidence in the product, shortage of raw materials and poor colour of the product. Many consumers of syrups still prefer those from conventional sources. But with proper education and public awareness campaign, this problem shall be solved. The problem of shortage of raw materials can be solved by increased agricultural production of starch- producing crops, while modern equipment and proper production environment are essential for the production of syrups with acceptable colour and appearance.

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