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Research Article

Destroying the Myths in Cassava Utilization in Brewing

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ABSTRACT: *Cassava, a common tropical tuberous crop used mainly as a staple food in Africa, South America and part of Asia contains an appreciable content of Hydrogen cyanide (HCN). Its processing method as food releases a prussic odour associated with HCN. In this work efforts were made to reduce the level of HCN in the cassava chips to an acceptable level before being mashed with sorghum malt as an adjunct at various substitutions: 0%, 5%, 10% and 15% respectively. The resulting worts were analyzed for the original gravity, pH, viscosity and HCN content. When fermented with the yeast Saccharomyces cerevisiea to obtain liquors, their pH, alcohol content(v/v) and residual HCN, were analysed. Organoleptic tests were carried out with respect to colour, taste and general acceptability and analysed stastically with hedonic scale and ANOVA table at p≤0.05 to obtain an acceptable product using 0% cassava substitution as a reference point to obtain a product devoid of an objectionable odour.*

Keywords: M*alting, mashing, sorghum malt, HCN determination, saccharification*.

1. INTRODUCTION

Beer is an alcoholic beverage obtained from yeast fermentation of wort, a resultant product obtained from mashing of cereal malts. The cereals usually used in malt production are barley, sorghum, wheat etc but barley is much favored in the temperate region while sorghum is gaining much ground in African brews, especially South Africa and Nigeria, [1];[2]. Today, beer production involves the use of an adjunct to augment the carbohydrate yield needed in the wort using cheap carbohydrate source [3]. These carbohydrate sources include maize, sorghum, sugars, potatoes, cassava chips (tapioca), rye, oat and fruit cake [4]. By incorporating brewing adjunct during brewing, wort properties are modified deliberately and this in turn has a great influence on the final beer properties. For instance the body of the beer is improved and the total production cost is reduced. [5].

The adjunct utilization in brewing has gained much ground that the breweries are now working with adjunct addition at various ratio. Cassava, *Manihot esculenta*, is a woody shrub of the Euphorbiaceae, native to South America but extensively cultivated as an annual crop in tropical and sub-tropical regions for its edible starchy tuberous root, a major source of carbohydrate. It is the third largest source of carbohydrate for human food in the world. Africa is its largest center of production. [6].

1.1 Cassava in Brewing

There is no brewery in Nigeria today that uses cassava starch as an adjunct in brewing. However countries like Ghana, Mozambique and Zimbabwe have been able to produce beer and ale with different levels of substitution. In Nigeria today, the presence of HCN content in the cassava appears to induce fear to an average consumer and manufacturer [7], [8]. The cyanide occurrence in cassava poses no much problem in the final product if a proper processing method is used. The aim and objectives of this work is to demystify the danger people associate with HCN presence when used in brewing.

II. METHODOLOGY

2.1 Source of Materials

The major raw material used in these work are sorghum grain, four varieties namely Samsorgh 14, Samsorgh 17, Samsorgh 43 and Samsorgh 44 obtained from Cereal Research Section of Ahmadu Bello University, Zaria; Improved cassava chips from National Root Crop Research Institute, Umudike, Umuahia. Reagents and instruments for analysis were obtained from Department for Applied Microbiology and Brewing, ESUT, Enugu.

2.2 Malting

Floor malting method was used to obtain malt using the IOB method of analysis and method modified by the Germinative Capacity, Germinative Energy, Moisture Content and Root Lengths were also determined by IOB method.

2.3 Cassava Chips Processing

The cassava root (tubers) were peeled and sliced into chips, then sundried for 5 days, to obtain dry chips. The processed chips were obtained by soaking the sliced tubers in water for 24 hour with the water changed every 12 hour to avoid fermentation. The chips were then sundried for 5 days and crushed with the milling machine Buhler Miag sets 5 to obtain grist used for mashing.

2.4 HCN Determination

Alkaline titration procedure as adopted by [9;10], was used. 10 gm of each of the ground samples were soaked in the mixture of 200ml of distilled water and 10 ml of orthophosphorus acid. The mixture was kept for 12 hours to release all the bonded cyanide and then distilled until 150 ml of the distillate was collected. 20 ml of the distillate was taken into a conical flask containing 40 ml of distilled water, 8 ml of ammonia solution, (6 moles) and 2 ml of potassium iodide 5% solution were added. The mixture was then titrated with Silver nitrate (0.02 moles) to faint and permanent turbidity. (1 ml of 0.02 M $AgNO_3$ = 1.08 mg HCN). Replicate determination were done for each of the samples.

2.5 Mashing Process

The mashing types used by infusion mashing techniques. The mixture of malts and adjuncts were in this order:

- First Mixture: Sample AT_1; 50 gm malt: 0gm adjunct.
- Second Mixture: Sample AT_2; 47.5 gm malt: 2.5 gm adjunct.
- Third Mixture: Sample AT_3; 45.0 gm malt: 5.0 gm adjunct.
- Fourth Mixture: Sample AT_4; 42.5 gm malt: 7.5 gm adjunct.

The mixtures were added into the mashing flask containing 360 ml of water and 2 ml of thermamyl (α-amylase), 2 ml of neutrase (Protein enzyme), 2 ml of ultraflo (β-glucanase) and 0.5 gm of cerezyme as exogenous enzymes. The content of the flask was stirred properly and covered with foil and placed in a water-bath at 30°C. The temperature was raised to 40-45°C and maintained for 30 mins for protein degradation and B-glucan degradation. This followed by a gradual increase to be 60-62°C and maintained at rest for 1 hour for B-amylase activities. The temperature was later increased to 70-72°C for α-amylase activities for 10-20 mins before the mash was tested for saccharification using Iodine solution. The temperature was increased to 80°C for mashing off [11]. These were repeated for all the mixtures until they were completed.

2.6 Filtration of Wort

The saccharified mash was filtered using muslin cloth to obtain the wort and spent grain.

2.7 Wort Analyses

2.7.1 Original Gravity

The original gravity was determined with saccharometer in 100 ml measuring cylinder containing wort filled to the brim and the original gravity recorded in degree Plato [12].

2.7.2 pH

pH Hand meter was used to determine the pH of Viscosity of wort was obtained.

2.7.3 Wort Viscosity

The wort recovered from original gravity above was used to determine the viscosity. The modified method using burette was used. 50 ml of water was in burette was discharged and the time for discharge noted. The same was repeated for the wort and time of discharge noted. The viscosity of wort was obtained using the formula:

$$\frac{n_1}{n_2} = \frac{t_1 P_1}{t_2 P_2}$$

n_1 = coefficient of viscosity of water=1.00 cp
n_2 =coefficient of viscosity of wort.
t_1 =time of flow of water in secs
t_2 =time of flow of wort in secs
P_1 =density of water =100
P_2 =density of wort from OG of wort

2.8 Wort Boiling

This was carried out with hops. The hops used were in pellets and 2 gm was used. The wort was poured into 500 ml conical flask and boiled for 30-40 minutes.

2.9 Wort Cooling

Cooling was done with a bowl of water until a temperature of 25°C was obtained.

2.10 Wort Fermentation

The cooled and aerated wort was now ready for fermentation and its gravity adjusted with saccharometer. A reconstituted strain of yeast *Sacchromyces cerevisea* was used to pitch the hopped wort (10 ml/L). The pitched wort was left to ferment for 7days for primary fermentation. Thereafter, the yeast was skimmed off and the green liquor left to stay in the refrigerator for 14 days for maturation or secondary fermentation. The liquor was then filtered through a filter paper to obtain a bright clear liquor. Then can be used for organoleptic tests.

2.11 Beer Analysis

The final gravity of the beer alcohol content was taken using saccharometer and the formula.

%Alcohol= OG – F.G x 0.129
where O.G= Original Gravity
F.G= Final Gravity

2.11.1 pH of Beer

As in the pH determination for wort was done using pH - Hand meter

2.11.2 HCN: Determination

As in wort analysis.

2.12 Sensory Evaluation

9-Point Hedonic Scale was used for the four samples of sorghum liquor produced from different adjunct substitution. ANOVA table was used to obtain the level of significance between the liquor with no cassava adjunct and those with different levels of substitution at $P \leq 0.5$ for colour, taste, odour/flavour and general acceptability.

III. RESULTS AND DISCUSSION

Table 1: Grain Analysis of Four Varieties of Sorghum

Varieties	Germinative Capacity (GC%)	Germinative Energy (GE%)	Moisture Content (%)	Root Length (cm)
Samsorgh 14	94	96	54	3.34
Samsorgh 17	96	96	52	3.16
Samsorgh 43	91	95	53	3.02

Samsorgh 44	92	95	52	2.94

Table 2: HCN Content of Raw Samples and Processed Samples

Raw Material	**HCN of Raw Samples (mg/100)**	**HCN of Processed Samples**
Cassava chips	95.58	94.61
Samsorgh 14	92.99	103.27
Samsorgh 17	95.58	105.19
Samsorgh 43	95.58	99.47
Samsorgh 44	97.85	105.73

Table 3: Wort Analysis of Sorghum 14 and Adjunct

Sample	**OG (oP)**	**Viscosity (cP)**	**HCN Conc. (mg/100)**	**pH**
AT_1	1035	1.859	0	5.8
AT_2	1033	1.593	0	5.8
AT_3	1032	1.421	0	5.8
AT_4	1030	1.274	0	5.8

Key:

AT_1= 50 mg Samsorgh 14 + 0 adjunct
AT_2 = 47.5 mg Samsorgh 14 + 2.5 gm adjunct
AT_3 = 45.0 mg Samsorgh 14 + 5.0 gm adjunct
AT_4 = 47.5 mg Samsorgh 14 + 7.5 gm adjunct

Table 4: Wort Analysis of Samsorgh 17 and Adjunct

Sample	**OG (^{0}P)**	**Viscosity (cP)**	**HCN Conc. (mg/100)**	**pH**
BT_1	1036	1.659	0	5.9
BT_2	1030	1.226	0	5.8
BT_3	1033	1.094	0	5.8
BT_4	1032	1.054	0	5.8

Key:

BT_1= 50 mg Samsorgh 17 + 0 adjunct
BT_2 = 47.5 mg Samsorgh 17 + 2.5 gm adjunct
BT_3 = 45.0 mg Samsorgh 17 + 5.0 gm adjunct
BT_4 = 47.5 mg Samsorgh 17 + 7.5 gm adjunct

Table 5: Wort Analysis of Samsorgh 43 and Adjunct

Sample	**OG (^{0}P)**	**Viscosity (cP)**	**HCN Conc. (mg/100)**	**pH**
CT_1	1033	1.072	0	6.0
CT_2	1032	1.054	0	6.0

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CT_3	1032	1.040	0	5.9
CT_4	1030	1.016	0	5.9

Key:

CT_1= 50 mg Samsorgh 43 + 0 adjunct
CT_2 = 47.5 mg Samsorgh 43 + 2.5 gm adjunct
CT_3 = 45.0 mg Samsorgh 43 + 5.0 gm adjunct
CT_4 = 47.5 mg Samsorgh 43 + 7.5 gm adjunct

Table 6: Wort Analysis of Samsorgh 44 and Adjunct

Sample	OG (^{0}P)	Viscosity (cP)	HCN Conc. (mg/100)	pH
DT_1	1032	1.070	0	5.8
DT_2	1032	1.047	0	5.8
DT_3	1030	1.045	0	5.8
DT_4	1032	1.044	0	5.8

Key:

DT_1= 50 mg Samsorgh 44 + 0 adjunct
DT_2 = 47.5 mg Samsorgh 44 + 2.5 gm adjunct
DT_3 = 45.0 mg Samsorgh 44 + 5.0 gm adjunct
DT_4 = 47.5 mg Samsorgh 44 + 7.5 gm adjunct

3.1 Beer Analysis

Table 7: Beer Analysis of Samsorgh 14 and Adjunct

Sample	OG(^{0}P)	Final Gravity (^{0}P)	Approximate Alcohol % (v/v)	HCN Conc. (mg/100)	pH
AT_1	1035	1003	4.2	0	4.6
AT_2	1033	1002	4.1	0	4.6
AT_3	1032	1002	4.0	0	4.6
AT_4	1030	1002	3.7	0	4.6

Table 8: Beer Analysis of Samsorgh 17 and Adjunct

Sample	OG(^{0P})	Final Gravity (^{0}P)	Approximate Alcohol % (v/v)	HCN Conc. (mg/100)	pH
BT_1	1036	1003	4.4	0	4.6
BT_2	1030	1002	4.1	0	4.7
BT_3	1033	1002	4.1	0	4.6
BT_4	1034	1002	4.2	0	4.6

Table 9: Beer Analysis of Samsorgh 43 and Adjunct

Sample	OG(^{0}P)	Final Gravity (^{0}P)	Approximate Alcohol % (v/v)	HCN Conc. (mg/100)	pH
CT_1	1033	1002	4.1	0	4.6
CT_2	1032	1002	4.0	0	4.6
CT_3	1032	1002	4.0	0	4.7
CT_4	1030	1002	3.7	0	4.6

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Table 10: Beer Analysis of Samsorgh 44 and Adjunct

Sample	**OG(^{0}P)**	**Final Gravity (^{0}P)**	**Approximate Alcohol % (v/v)**	**HCN Conc. (mg/100)**	**pH**
DT_1	1032	1002	4.0	0	4.6
DT_2	1032	1002	3.9	0	4.6
DT_3	1030	1002	3.7	0	4.6
DT_4	1032	1002	4.0	0	4.6

IV. DISCUSSION

The result of the grain in TABLE 1 shows that all the samples of Sorghum seeds obtained for the work (Samsorgh 14, 17, 43, 44) respectively were suitable for malting judging from their Germinative capacity (94-96%) and Germinative Energy (92-94%). Their root lengths (2.94-3.34 cm) were appreciable. On HCN Concentration of cassava chips, the processed chips have reduced HCN content 94.61 mg when compared to raw chips (95.58 mg/100g). For sorghum samples, there were reasonable increase in HCN contents between the raw samples of sorghum varieties and their malted samples. For instance Samsorgh 14 raw had 92.99 mg/100g while its malt had 103.27 mg/100gm. For cassava, the drying process under the sun reduces the HCN content while in the sorghum, the germination process induced HCN development in the radicle thereby increasing their concentration (2). The normal range of HCN in raw cassava is between 15-400 mg/100gm. However the FAO/WHO recommendation safe limit of HCN in human food is ≤ 50 mg/100mg.

When the malts were mashed at varying concentration of cassava chips (Processed) and later fermented into liquor, all gave 0 mg/100gm of HCN in both worts and their corresponding liquors. This shows that the wort boiling processes with hop is an effective way of removing HCN content in brewing.

It therefore explains why cassava ‘Foo Foo’ is free from danger of HCN when consumed or why garri which undergoes frying free from HCN effect in our daily food menu. The results therefore come from that beer produced with cassava adjuncts is free for consumption devoid of HCN contamination and this demystifies the fear or danger of cassava utilization in brewing.

The sensory evaluation revealed that Sample A has no significant difference at $P \leq 0.05$ with colour, taste, mouth-feed and general acceptability. The same results go for Sample C in all the attributes listed above. However Sample B and Sample D are significantly different in all the attributes evaluated.

Thus Sample A can be said to be as good as sample C in this project while Sample B and D have their attributes similar. Therefore, the use of Cassava as Adjunct in Beer Brewing has a prospect in Nigeria.

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