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Physio-Chemical Properties of Malted Sorghum as Material For Mucamalt Using Cashew Apple Juice Extract As Vitamin C Fortifier

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Abstract: *The search for a local raw material for the production of beverages necessitated the harnessment of cashew extract. The beverage produced is 100% local contents with easy accessibility to the raw materials, reduced production cost and increased economic revenue of Nigeria. Thus the aim of this research was to harness our abundant natural resources endured by God. Sorghum has a wide range of colors. The best known are the white, yellow, brown and the red types. Although the red type was used because of her high extract yields. The optimization temperature come to play and it was discovered that the best and highest extract yields can only be obtained at temperature between 80 to 85^oC and the red sorghum meets this criterion. The influence of temperature, time and moisture on the enzyme activity and malting losses of germinated sorghum (Sorghum bicolor) were critically examined. The duration of germination and watering rate had the highest effect on enzyme activity and malting losses respectively. Vitamin C sourced from cashew apple fruits, the apple represents nearly 90% of the cashew (nut + apple). It is almost entirely edible, with pleasant flavor and aroma and high nutritive value, which is due mainly to high vitamin C and sugar contents. Sorghum used not as adjunct in this Mucamalt production but as main raw material along with Cashew Apple Extract, Vitamin C. However, the availability of the grain and seasonal cashew apple fruit (Between January to April) preservation poses a great problem to the brewing industry. The Mucamalt, a brand of malt drink was as a result of the well blended two local contents of red sorghum bicolor and red elongated cashew apple extract after careful selection through process optimization.*

Key words: *Apple juice, Cashew, Extract, Mucamalt, Nigeria and Sorghum.*

I. Introduction

Malt drink belongs to the category of brewed drinks that are considered non-alcoholic beverage drink, fortified with vitamin C and other minerals that are of benefit to human health. Production of this beverage varies from brewery to brewery in the composition of their ingredients but the basic ingredients remain the same. Through the physicochemical properties of carbohydrate malted sorghum which produces fermentable sugars from starch degradation was used and cashew apple fenny as vitamin C fortifier. Vitamins C, $B_{1,}$ B_2, B_3, B_4 and B_6 are options and apart from their importance to the body building effects, the producer of malt drink use them in their product to attract customers. There are two major sources of vitamin C namely; synthetic and natural types. The former apart from being more acidic ($_P$H 2.1-2.6) contains some chemicals that are used as additives in the course of producing them and such chemicals includes heavy metals and oxalic acid that are not friendly to our health while the later is hundred percent natural and is devoid of hazardous additives.

The advantages of sorghum over wheat or barley as major raw materials in brewing cannot be over-emphasized. The availability of the cashew apple with wider range, will in no small measure reduce the costs of production, and by extension bring the benefit of reduced costs to the consumers and is gluten-free as the product would not only be cheaper but also available. Physical and chemical characteristics of both malted and unmalted sorghum and cashew apple juice extracts were determined to evaluate their malting, extracting and brewing values. The compatibility of these two, malted sorghum and cashew juice for a large scale production will be determined and analysis against three other common malt drinks in the Nigerian market.

II. Research material and methodology

A. Sources of materials

Sorghum which is the major raw material and a source of carbohydrate were sourced at a local market around Airport Road, Lugbe area of Federal Capital Territory, Abuja, Nigeria. The Cashew being the source of Vitamin C for the fortification was sourced along Lemu road, Nigeria, the local rice used was gotten also in Bida, Nigeria and the research practical carried out at the National Cereal Research Institutes Badeggi, Niger State, Nigeria.

B. *Grain analysis*
The procedures for various tests carried out are described below

Malting

The grains was steeped in water, improved with hydrated lime which helped to reduce phenol content from germinated sorghum after the first 8hours the water was drained off and allowed to rest for 1hour, steeped again for another 4hours, the water drained again and rested for 30mins, soaked for another 4hours which completed the steeping process.

During the germination stage of malting, the formation of many enzymes is promoted and is dependent upon the moisture and oxygen content of the grain. The grains were germinated at a regulated temperature of between 20^{o}C to 25^{o}C for about 5 days. Within this period, the grains were turned twice per day and moisture contents noted and recorded. Plate I shows the terminated malting Sorghum.

Plate I: Terminated malting sorghum

Termination of germination

The process was then halted and the malt transferred to a kiln (dryer) at a steady temperature of between 55^{o}C to 60^{o}C to attain moisture content of 15%. Further reduction of moisture content to between 6 - 10% was obtained by raising the temperature of the dryer to 80^{o}C-85^{0}C (optimum temp.) for maximum extract yield and stable state for long storage purpose

Germinating capacity

At the germination temperatures of 20, 25, and 30°C used in the malting process of the cereal (sorghum), production of reducing sugars and that of free amino nitrogen (FAN) is the result. The germinating capacity of the sample = (a/500)x100 =(464/500) x 100 = 92.8% **=92.8%** Where: a = number of germinated sorghum after 96hrs.

Ash present

2g of the milled sorghum sample was weighed and put in a porcelain glass the content is then placed in the Gallenkamp (furnace) at a temperature of 500^{o}C and for a period of 6hrs. The oven was turned off and allowed to cool down to 150^{o}C. The porcelain was then transferred to desiccators and allowed to rest for about 30mins, the weight was then taken as follow;

Percentage ash = (b-c) 10,000/(100 - w)a Where: a = weight of sorghum sample (2g)

b = weight of sample + porcelain

c = weight of ash + porcelain

Percentage = (43.974 – 43.9415){10,000/(100 – 7.6)2}

= {(0.00325)10,000}/(184.8) = 0.175

Malting loss: 1000 pieces of grains was counted and weighed, before and after malting, It was then compared as follow;

Percentage malting loss on dried basis is 100(TSW_1 – TSW_2)/TSW_1

Where: TSW_1 = thousand sorghum weight on dry basis

TSW_2 = thousand sorghum weight of polished malt

Percentage malting loss = {100(43.59 - 39.44)}/43.59 = 415/43.59 = 9.5%

C. *Cashew apple juice extraction*

The plunged cashew was carefully selected to remove the infected and damaged ones, average weight of the cashew taken along with the cashew nut and without the nut. About ten (10) samples were picked randomly and the following weights are obtained without the nuts. Average **weights of four**

types of cashew apple fruit: Red elongated = 82.88g, Red round = 63.8g, Yellow elongated =83.5g and Yellow round= 64.02g


Plate (a) Red round cashew apple fruit   Plate (b) Red elongated cashew apple fruit

Cashew Juice provides five times the Vitamin C of orange juice. In addition, Cashew Fruit Juice contains healthy ingredients, including Vitamins B_1, B_2, and B_3, calcium, and iron and beta carotene. The health benefits of the cashew drink include soothing sore throats and strengthening the immune system. The juice is full of Natural Vitamins and Minerals, and contains Disease Fighting Anti-Bacterial Agents.


Plate (c): Yellow elongated Cashew Apple Fruit   Plate (d): Yellow round Cashew Apple Fruit

D. *Cashew extract modification*.

Rice gruel is another clarifying agent for raw cashew apple juice which is another contribution of Indian research scientists. And of the three agents discussed, rice gruel happened to be the quickest way to obtain clear cashew apple juice - with the simplest of means: residual water from the cooking of rice. The clarified cashew apple juice can then be refrigerated and kept for good three days. Otherwise, if kept at room temperature (± 30^{o}C), it should be consumed within 24 hours, in order to prevent fermentation from occurring.

3g/litre,   4g/litre   5g/litre.

Plate II: Jars of Cashew with settlement of tannin content

In the above plate three small jars of 3litres, 4litres and 5litres respectively were used to determine the ideal rice gruel solution strength. Visual clarity and speed of tannin precipitation are key criteria in the selection of the solution strength.

E. Brewing process

2.5kg was weighed from the milled malt, along with 7litres of hot water, fed into cooking bowl, and 3.75grams of $CaCl_2$ and 3.75grams of brew plaster were added, the mixture were then heated to 50^{o}C, at this temperature enzymes; termamyl and fungamyl are added at 180mls and 90mls (quantity) respectively and allowed to rest. Without the protection of Calcium ions a-amylase is rapidly destroyed at normal mashing temperatures. When Calcium is present in sufficient amounts the enzyme is stable at above sparging temperatures, only then being finally destroyed in the Copper.

Alpha-amylase is used in ethanol production to break starches in grains into fermentable sugars. The first step in the production of high-fructose corn syrup is the treatment of cornstarch with alpha-amylase, producing shorter chains of sugars called oligosaccharides. An alpha-amylase called "Termamyl", sourced from *Bacillus licheniformis*, is also used in some detergents, especially dishwashing and starch-removing detergents. The natural enzyme produced in the wort that will cleave this link is limit dextrinase, but this is highly heat liable and is destroyed completely at mashing temperatures.

The use of additional enzymes is common throughout the brewing industry, and is greatly beneficial. It aids Mash Tun run off by reducing wort viscosity, also improving subsequent malt fine ability and filterability. Amylases are also used, typically where the use of adjuncts may dilute the availability of enzymes in the Mash Tun.

The infusion process mixes the malt with hot water to maintain a uniform temperature until starch conversion is complete and finally temperature is raised to 100^{o}C and boiled for 20mins vigorously. The Lauter tun, which separates the insoluble grain residues from the mash, cloth sieve was employed to do same, the separation and the finished product of mashing is grain slurry, called mash. Various other filter agents, such as polypropylene fibers can also be used. Some breweries use strain masters, which are a variation of lauter tuns. The spent grain obtained after the filtration which is spargled with water at 78^{o}C, can be sold as animal feed after drying and nourished with other vitamins. The product of the filtration is called wort, the $_{P}$H is taken as 5.4 The wort is transferred to another cooking put where it is boiled vigorously for about 2hours, the essence of the long boiling is to achieved the following; stops the starch -to-sugar conversion, sterilizes the wort, precipitates hydrolyzed proteins, concentrates the wort by evaporating excess water and effects chemical changes that affect end product flavor.

Adjuncts such as, (267grams of sugar), caramel are added to increased the gravity of wort and black coloration of the final product malt. The caramels required or added depend on individual brewery. The mixture was allowed to settle and cooled down until there was a clear filtrate and sludge. Carefully, the filtrate is removed and wahtmann filter paper is used to filter the filtrate to obtained clearer final product (malt). 400mls of the malt obtained was inoculated with 100mls of cashew extract of about 10% concentration. The inoculated malt was then transferred onto water bath under tight sealed and regulated at 70^{o}C for a period of 1hr, there was a coagulant formed at the bottom of the bottle, the malt was filtered to removed the sediment been formed at the bottom of the bottle and transferred again to the water bath for another 70^{o}C, this is done in order to sterilized the malt, for long live span and preservation.

Plate III: Milled Sorghum.

F. Check for saccharification

Some quantity of mash were taken and filtered using fine whatmann filter paper, time of filtration is noted, the filtrate is then transferred on to crucible and checked for saccharification by adding drop(s) of iodine solution. Filtration of the whole lots continues and the solute obtained is known as wort. After the first filtration, the substrate is further sparged (washed) with hot water at 78^{o}C to remove left over sugar or wort, this could also be describe as leaching out of aqueous extract from a mash filter.

G. Diastatic power using Windisch-Kolbach method

Diastatic power is a measure of how much starch-converting enzyme in any given malt contains and is measured in degrees Lintner. As a general rule of thumb, you want to make sure your mash averages 70 Linter or above. It is good to know that heat destroys diastatic power, if the temperature targeting is a bit off. The suggestion here is that the diastatic power be keep above 100. Forty five grams of milled malt was weighed, transferred into a beaker mixed with 180ml of distilled water at 40^{o}C, the beaker and its contents were then transferred to water bath maintained at the same temperature for an hour. The contents were made up to 295mls with distilled water of about 32^{o}C, room temperature. In addition 70, 15, 15mls of distilled water respectively were successfully used to sparge the contents and out of which 50mls is used for the analysis.Two conical flasks of 200mls were set aside, one for the experiment and the other as blank, into which 100mls of 2%(w/v) starch were added, after some minutes 5mls of acetate buffer solution were also added to the two separate samples, one was placed in the water bath at 20^{o}C for 20mins, with 5mls of malt extract introduced into the flask under continuous stirring, the mixture $_{P}$H 5.58 was obtained. The two flask volumes were then made up to 200mls with distilled water and mixed thoroughly, from each flask 50mls were pipette into an Erlenmeyer flask after which 25mls of 0.1N Iodine solution and 3mls of 1N NaOH were added and covered with lid glasses.

At about 15mins, the flask contents were acidified with 4.5mls of 1N H_2SO_4, the excess iodine is titrated with 0.1N Sodium thiosulphate.

H. Wort sterilization

Wort refers to the filtrate obtained from the filtered mash before and after sparging, this wort is boiled to sterilize the wort composition and to extract the desirable compounds their present. This boiling will last for between 1hour to 1.5hours when the adjuncts such as, sugar syrup, caramel, Cashew fruit juice extract, AMG/Hi-Tempase and fungamyl are added to achieve the following:

1. Homogenization of the caramel as colourant
2. Colour and Odour development
3. Concentration of wort
4. Sterilisation of wort
5. Drive off of the undesirable volatile gases such as DMS and H_2S
6. Sugar syrup to improve wort gravity
7. Termination of the carry-over enzymes from mash.
8. Precipitation of undesirable protein.
9. Concentrate of Cashew fruit juice is blended with the prepared wort.

I. Malt production

The whole content is further cooled down to temperature of between 4^{o}C and 6^{o}C and final filtration carried out to prepare the product for packaging in either bottle or can for proper storage. However the final analysis is done and regulated to conform to set standard which depends on the set standard of the brand brewery. Priming in the brewery industry is the addition of sugar to wort in the production of either beer or malt and vitamin c added also depend on individual brewery. The resulting malt after boil is cooled down to a very low temperature to allow other heavy particles to form sedimentation at the bottom of the containing vessel in form of slurry. It is then filter and the following parameters confirmed; pH, Gravity, Saccharification and colour.

Plate IV: Samples of Mucamalt

J. Percentage extract yield

Extract yield is an important economic factor in evaluating raw grain for malting and was determined; it is an indication on how much of the original grain comes into the extract. Fifty grams of the milled malt is weighed and poured in the beaker, 200ml of distilled water is added at 45^{o}C the contents is then transferred to hot plate regulated to 45^{o}C with stirring set at 100rpm and allowed for 30mins, after which the temperature is increased to 70^{o}C from 45^{o}C; 1min/1^{o}C for 25mins. 100mls of distilled water was later added at 70^{o}C this mixture (mash) was allowed to rest for an hour maintaining this temperature it was then cooled down to 20^{o}C with cold water. The total volume raise up to 450mls with distilled water stirred well and filtered using filter paper. The filtrate was transferred into measuring cylinder at 20^{o}C; the hydrometer was inserted and recorded reading taken.

Specific gravity of wort = 1.033
From the Extract Table = 8. 29(g/100g)
Extract in g/100mL, E_w = 8.55
The extract yield on air-dry sorghum is $E_n = P(w+800)/(100-P)$% by wt
The extract yield on dry sorghum is $E_d = 100E_n/(100-w)$% by wt
En = 8.55(7.4 + 800)/(100 – 8.55)% by wt
= 6,903.27/91.45 = 75.49%

Ed = (100 x 75.49)/(100 - 7.4)%
= 7,439/92.6 = 81.52 %

K. Optimization process

Fractional conversion (or simply conversion) is a convenient variable often used in place of concentration in engineering work. The results will be presented in terms of both C_A and X_A.

$$C_A = \frac{NA}{V} = \frac{NAO\ (1-XA)}{V} = C_{AO}(1\text{-}XA)$$

And

$$-dC_A = C_{AO}dXA$$

$$\frac{dXA}{dt} = K(1 - XA)$$

Rearranging and integrating

$$\int \frac{dXA}{1-XA} = K\int dt$$

$$-\ln(1 - XA) = Kdt$$

L. Finishing

Two methods are applicable in the production of a finished product from the flavoring syrup. First, the syrup is diluted with water and the product is cooled, carbonated, and bottled. In the second method, precise amount of syrup is measured to each bottle, fills it with carbon dioxide. In either case, the sugar content will reduced in the finished beverage.

M. Product preservation/carbonation

Gases are used for preservation, ripening, spoilage prevention, freezing, chilling, carbonation, and many more applications. Carbonation is a phenomenon in which carbon dioxide gas is suspended in water, creating small bubbles. It can occur both naturally and artificially, as a result of the introduction of carbon dioxide to a liquid. This phenomenon is what makes soft drinks bubbly and fizzy, although the fizzy sensation is actually not caused by the bubbles themselves, but rather by the chemicals which make the bubbles. There are a number of reasons for people to use carbonation in the preparation of beverages. One thing about carbonation is that it drives out the oxygen, which can make a beverage shelf stable as long as it is sealed, keeping microbes which need oxygen to survive out.

N. Pasteurization

Pasteurization is a way of food preservation, it extend her longevity (shelve life) which keep it for longer use, and these could be carried out in different ways. Beverages or Beer pasteurization is the application of heat to the products to enhance its preservation by minimizing harmful micro-organisms. A prerequisite for perfect pasteurization is sufficient heating period at temperatures below 100^{o}C, the duration of which depends on the characteristic and the $_P$H value of the product to be treated. The product must be immediately cooled when heating were completed/finished to prevent any quality loss.

III. Results and discussion

Results of the analysis of the compositions of red Sorghum grains (%)

Embryo	5
Endosperm	88
Pericarp-testa	7
Husk	-
Starch	64%
Nitrogen	1.26^
Lipid/fat	12.5%
3-D-glucan	Negligible
Ash	0.175%
Starch gelatinization temperature	65^{o}C
Starch solubility in 100^{o}C water	Soluble
Amyl pectin	3.5%
Amylase	12.8%

The Percentage moisture content of dry sample of white and red before malting are 20% and 18.5% respectively and the corresponding value after malting are given 36.58% (white) and 33.85% (red). This shows that at same condition, red sample has high absorbing ability which could reduce the steeping period and save time. Ash present = 0.175

Germinating capacity is a good quality and attributes for the cereal because it implies that variation in temperature during the malting of sorghum, especially when malting temperature is difficult to control, and also reflecting temperature variations, which was still obtained as 92.8% and percentage malting loss = 9.5%.

The enzymes amyl pectin 3.5% and amylase 12.8% are supportive enzymes generated during malting and enhance in the breakdown of starch bond with the addition of termamyl and hi-tempase enzymes to achieve saccharification of the starch to simple sugar. The sorghum is a glucan free as also shown above which is an advantage over other carbohydrate producing grain and since some people are allergy to glucan thus limit the possible consumption to few but with this development sorghum is highly favor for the production of non-alcoholic drinks. Starch presence of 64% is not too bad but can be adjusted with some adjunct such as maize grit. Starch gelatinized at 65°C and soluble in water at 100°C**.** Also the Nitrogen present is 1.26^

Table 1 Extract yields

S/No	Temp. °C	Moist 1st 1hr	Moist 2nd 1hr	Moist 3rd 1hr	Moist 4th 1hr	Total % Moisture Loss	%Moisture content	Gewichts-verhaltnis S_L 20/20C %Extract yields	Gewicht % g in 100ml bei s20
1.	40 R							1.0108	2.73
	W							1.094	2.41
2.	45 R							1.012	3.15
	W							1.011	2.85
3.	50 R	8.43	6.2	4.59	2.41	21.63	12.22	1.014	3.57
	W	8.16	6.15	4.13	2.3	20.74	15.84	1.013	3.20
4.	55 R	8.74	6.81	5.0	3.17	23.72	10.13	1.017	4.33
	W	8.84	6.97	5.25	3.60	24.66	11.92	1.015	3.83
5.	60 R	9.07	7.59	4.37	3.64	24.67	9.18	1.020	5.08
	W	8.46	7.38	4.33	3.49	23.66	12.92	1.018	4.58
6.	65 R	8.47	7.43	5.03	3.50	24.43	9.42	1.023	5.83
	W	8.35	7.29	4.99	3.29	23.92	12.66	1.020	5.08
7.	70 R	10.1	8.45	7.76		26.32	7.53	1.025	6.32
	W	10.0	8.21	7.43		25.66	10.92	1.023	5.83
8.	75 R	12.1	8.55	6.31		24.93	8.92	1.030	7.56
	W	12.1	8.86	6.72		27.68	8.90	1.025	6.32
9.	80 R	13.1	9.82	2.70		25.57	8.28	1.033	8.29
	W	13.5	9.89	2.98		26.32	10.26	1.030	7.56
10.	85 R	13.2	10.21	3.30		26.71	7.14	1.033	8.29
	W	13.6	10.45	4.05		28.10	8.48	1.030	7.56
11.	90 R							1.029	7.43
	W							1.024	6.10
12.	95R							1.024	6.12
	W							1.022	5.67
13.	100R							1.023	5.89
	W							1.018	4.53

Table 2 Extract yields at varying temperature

S/NO.	Temp. T(°C)	Extract yield (From Table)	Fraction (Xa)	(1-Xa)	-ln (1-Xa)
1.	40 R	2.73	0.273	0.727	0.319
	W	2.41	0.241	0.759	0.276
2.	45 R	3.15	0.315	0.685	0.378
	W	2.85	0.285	0.715	0.335
3.	50 R	3.57	0.357	0.643	0.442
	W	3.20	0.320	0.680	0.386
4.	55 R	4.33	0.433	0.567	0.567
	W	3.73	0.373	0.627	0.467
5.	60 R	5.08	0.508	0.492	0.709
	W	4.58	0.458	0.542	0.612
6.	65 R	5.83	0.583	0.417	0.875
	W	5.08	0.508	0.492	0.709
7.	70 R	6.32	0.632	0.368	1.000
	W	5.83	0.583	0.417	0.875
8.	75 R	7.56	0.756	0.244	1.411

	W	6.32	0.632	0.368	1.000
9.	80 R	8.29	0.829	0.171	1.766
	W	7.56	0.756	0.244	1.411
10.	85 R	8.29	0.829	0.171	1.766
	W	7.56	0.756	0.244	1.411
11.	90 R	7.43	0.743	0.243	1.415
	W	6.10	0.612	0.388	1.577
12.	95 R	6.12	0.612	0.388	0.947
	W	5.67	0.567	0.433	0.837
13	100 R	5.89	0.589	0.411	0.889
	W	4.53	0.453	0.547	0.603

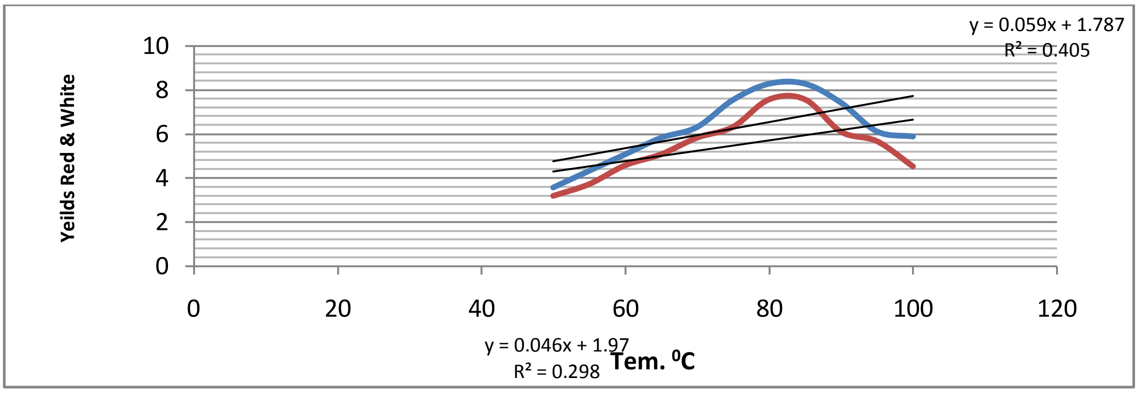

Figure 1: Graph of Extract yields against Temperature (^oC)

Y = 0.059x + 1.787 R^2 = 0.405, R = 0.636
Y = 0.046x + 1.97 R^2 = 0.298, R = 0.547

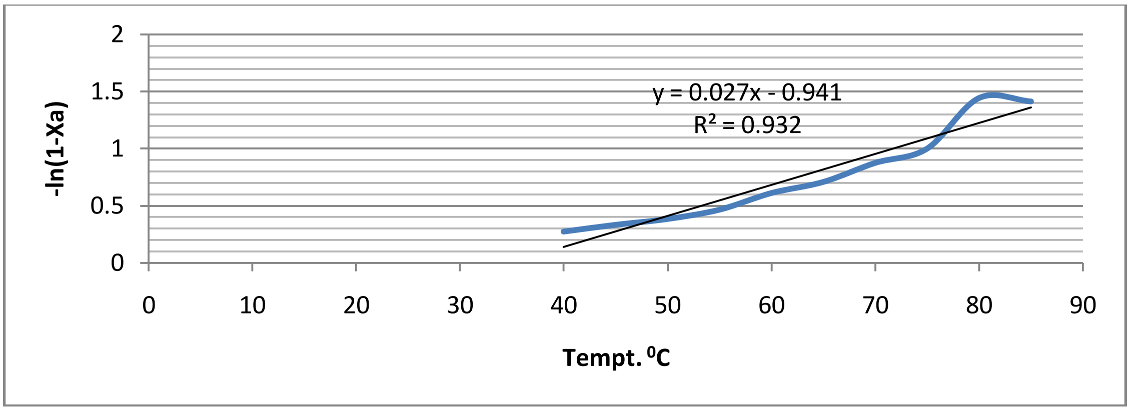

Figure 2 Graph of -ln(1-Xa) against Tempt. (^0C): White sample a (1st Order Kinetic)
y = 0.027x - 0.941, R^2 = 0.932, R= 0.965

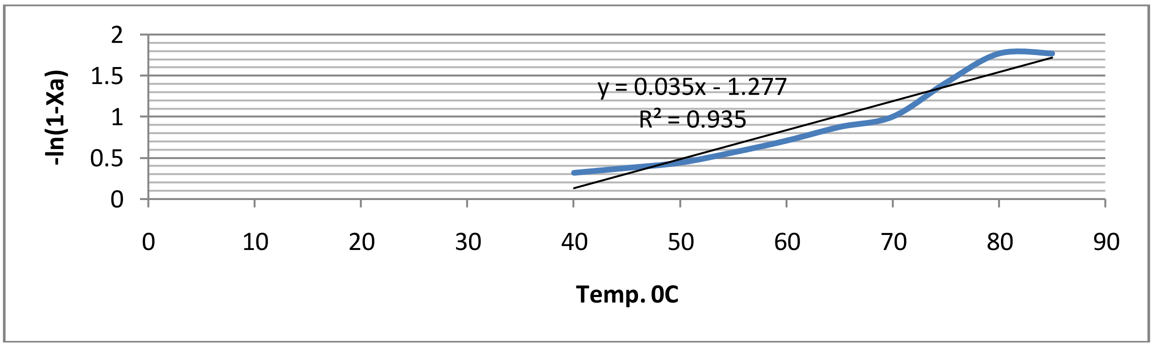

Figure 3 Graph of: -ln(1-Xa) against Tempt. (^0C): Red sample a (1st Order Kinetic)

y=0.035x-1.277, R^2 = 0.935, R = 0.967

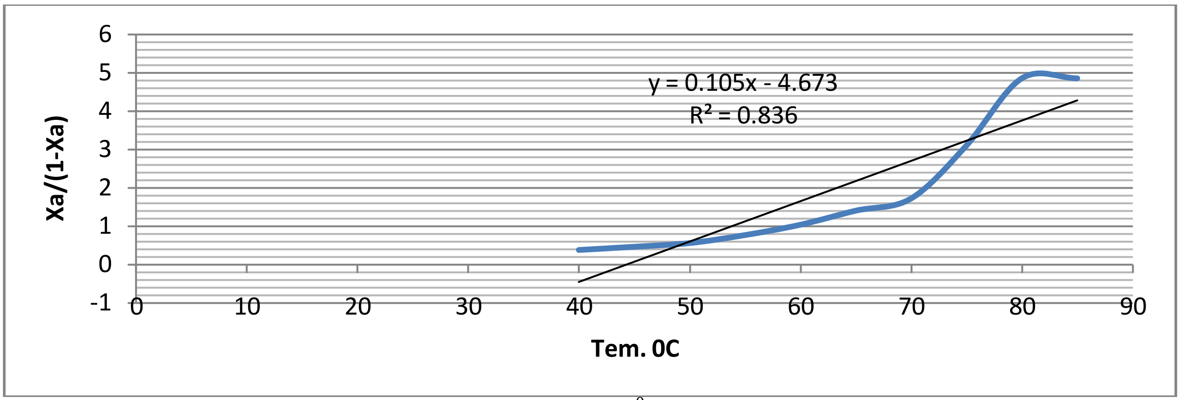

Figure 4: Graph of Xa/(1-Xa) against Tempt. (^{0}C) Red sample b (2nd Order Kinetic)
y=0.105x-4.673 = R^2 = 0.836, R = 0.914

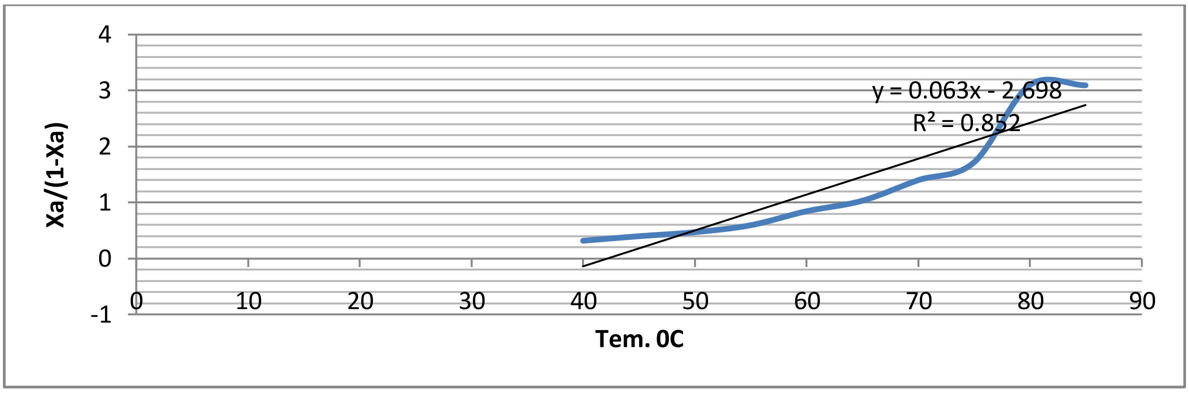

Figure 5: Graph of Xa/(1-Xa) against Tempt. (^{0}C) White sample b (2nd Order Kinetic)
y=0.063x- 2.698 = R^2 = 0.852, R = 0.923

Optimization process was employed to test among the available factors and variables to arrived at the best and applicable method in achieving the set objective, first order rate of reaction was employed and this was tested below:

Table 3 First and Second Order Kinetics for Extract yields

S/NO.	Temperature (^{o}C)	Fraction (Xa)	(1-Xa)	-ln(1-Xa)	Xa/(1-Xa)
1.	40	0.273	0.727	0.319	0.376
		0.241	0.759	0.276	0.318
2.	45	0.315	0.685	0.378	0.460
		0.285	0.715	0.335	0.399
3.	50	0.357	0.643	0.442	0.555
		0.320	0.680	0.386	0.471
4.	55	0.433	0.567	0.567	0.764
		0.373	0.627	0.467	0.595
5.	60	0.508	0.492	0.709	1.033
		0.458	0.542	0.612	0.845
6.	65	0.583	0.417	0.875	1.400
		0.508	0.492	0.709	1.033
7.	70	0.632	0.368	1.000	1.717
		0.583	0.417	0.875	1.400
8.	75	0.756	0.244	1.411	3.098
		0.632	0.368	1.000	1.717
9.	80	0.829	0.171	1.766	4.848
		0.756	0.244	1.411	3.098
10.	85	0.829	0.171	1.766	4.848
		0.756	0.244	1.411	3.098

11.	90	0.743	0.243	1.415	3.058
		0.612	0.388	1.277	1.277
12.	95	0.612	0.388	0.947	1.577
		0.567	0.433	0.837	1.309
13	100	0.589	0.411	0.889	1.433
		0.453	0.547	0.603	0.828

And from the graphs Figure 2 and 3 it was observed that for both white and red sorghum tested for sample a the order of kinetic is with first order, while with second order was obtained for white and red samples of b in Figure 4 and 5. Therefore, from the tested orders it can stated that the extract yield was favored more with first order as the gradient is less or equal to 1 (0.87 =1).

Proximate compositions of red Sorghum malt grains (%)

Moisture content	7.7
Diastatic power ^{0}L (DP) b – amylase mainly	23.81
A-Amino nitrogen (mg/1)	32.3mg/l
Total soluble nitrogen (TSN) (%)	2.12
B-D- Glucan (%)	Negligible
Malting loss (%)	9.5
Density	0.66
Ash content	0.175%
Fat content	8.14%
Crude fiber	1.82
Starch	64%
Nitrogen	1.26
Crude protein	5.52

Gravity in brewing industry is the level of sugar present in the brewed wort or eventual products produced from such, either beer or malt. The pH which is the level of either acidity or alkalinity of any substance are very important as the body intake of either acid or alkaline are monitor and regulated, to avoid any excess take a disorder. The result of the wort and Mucamalt analyzed are presented below.

Result of the Analyzed Wort

Original gravity	4.09
$_P$H reading	5.58
Colour of cold wort (EBC)	6.4
Odour	Aroma
Taste	Sweet
Turbidity (EBC)	Turbid

Result of the Analyzed Mucamalt

Energy	220kj/100ml
Carbohydrate	10.48g/100ml
Protein	0.25g/mg
Fat	0.02g/mg
Calcium	35g/100ml
Vitamins A	240lu/100ml
B_1	0.11mg/100ml
B_2	0.12mg/100ml
B_3	0.97mg/100ml
B_5	0.49mg/100ml
B_6	0.18mg/100ml
C	2.18mg/100ml

Optimum temperature for maximum extract yield of sorghum

Optimum temperature is the temperature at which high percent of extract can be achieved which is 80^{o}C and 85^{o}C; the percentage extract yield obtained is shown in the table above. Extract yield, is important in the determination of economic factors and evaluation of raw grain for malting and gotten thus: En = 75.49% and Ed = 81.52 %

Tannin, is a yellowish or brownish bitter-tasting organic substance present in barks of the cashew apple fruits which are carried along in the course of extraction and this must be remove through precipitation using rice gruel, local rice are used to avoid the chemical been used to polished these foreign types. The original gravity of 4.09 was obtained which is the level of the sugar content and eventually determine the quantity of sugar syrup to be added, $_{P}H$ = 5.58 and Taste is sweet.

The research results shows that favorably, Mucamalt produced with the vitamin C obtained from cashew apple fruits can best compare with the imported ascorbic acid and this can be seen from the analyzed three selected malts in the market. What is new here is the source of vitamin C and other vitamins which are essential to the body, and is has found in abundant in the source of vitamin used.

Analysis of the produced mucamalt and compared with three other malts variety in the market.

Ingredients	Mucamalt	Nasmalt	Hi-malt	Maltina
Energy	**220kj/100ml**	**206kj/100ml**	**218kj/100ml**	**227kj/100ml**
Carbohydrate	10.48g/100ml	10.52g/100ml	11.44g/100ml	12.8g/100ml
Protein	0.25g/mg	0.24g/mg	0.26g/mg	0.38g/mg
Fat	0.02g/mg	0.02 g/mg	0.01g/mg	0.09g/mg
Calcium	35g/100ml	36g/100ml	32g/100ml	53g/100ml
Vitamins A	240lu/100ml	321lu/100ml	242lu/100ml	245lu/100ml
B_1	0.11mg/100ml	0.14mg/100ml	0.12mg/100ml	0.13mg/100ml
B_2	0.12mg/100ml	0.13mg/100ml	0.13mg/100ml	0.15mg/100ml
B_3	**0.97mg/100ml**	**0.96mg/100ml**	**0. 94mg/100ml**	**0.98mg/100ml**
B_5	0.49mg/100ml	0.51mg/100ml	0.57mg/100ml	0.52mg/100ml
B_6	0.18mg/100ml	0.18mg/100ml	0.19mg/100ml	0.20mg/100ml
C	**2.18mg/100ml**	**1.84mg/100ml**	**2.32mg/100ml**	**2.57mg/100ml**

Though there are some variations in the quantity of other ingredients, such as fat, vitamin C, protein and calcium which is more noticeable compared to others. Thus it depends on the adaption of an individual brewery to regulate their vitamin C cropping in their products. And the objective here is to seek more alternative source of producing malt drinks which this work has effective addressed in the area of major raw material such as carbohydrate (starch) source: sorghum and vitamin C (cashew) source which are all local content and in effect has direct impact on the final cost of production.

Cashew apple juice extraction

The red elongated cashew average weight obtained without nuts = 82.88g, Physical and water content of the red elongated cashew apple: Ave. wt., 82.88g, $_{P}H$ 5.4, Juice cont. 62.05g, Substrate cont. 20.83g, Water cont. 74.87%.

Annual profits earnings calculation

From the grand total cost of N9, 345.45 to produced 206.2bottles, (8.6crates) while cost of producing a bottle stood at N45.32 and crate cost N1,087.73. Assumed 15% of the cost of production is used as handling and packaging charges, therefore, the cost per crate now will be N1, 250.89

Six (6) crates of Mucamalt will therefore be,

= N2, 021,638.38 and @ N157 to Dollar = $12,876.678

Supposed a crate of Mucamalt is sold for N1, 600 ($10.191) per crate

Therefore, 1,616.16 crates will cost (1,616.16 x 1,600)

= $16,470.42

Profit per brew on 160HL per day will be:

$(16,470.42 - 12,876.678) = $3,593.74

Annual profit at 329days per year = $3,593.74 x 329 = $1,182,340.46

IV. Conclusion

The results of the various analysis conducted shows favorably. Mucamalt produced with the vitamin c obtained from cashew apple fruits can compare with the imported ascorbic acid and this can be seen from the analyzed three selected malts in the market. What is new here is the source of vitamin c and other vitamins which are essential to the body, and is has found in abundant in the source of vitamin used. Though there are some variations in the quantity of other ingredients, such as fat, vitamin c, protein and calcium which is more noticeable compared to others, thus it depends on the adaption of an individual brewery to regulate their vitamin c cropping in their products. And the objective here is to seek alternative source of producing malt drinks which this work has effectively addressed, in the area of major raw material such as carbohydrate (starch) source: sorghum and vitamin c (cashew) source which are all local content and in effect has direct impact on the final cost of production.

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