Moisture Composition and Evaluation of Solid State Crude Brown Sugars (Masarkwoilla) in Zaria Metropolis, Northern Nigeria

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Abstract:-**The attempt to develop brown sugar processing technology in Nigeria was initiated by the Federal Government in 1986 through the Federal Ministry of Industries. Meanwhile, brown sugar hardens during storage as a result of moisture loss into the atmosphere. In the light of this development, some local commercial crude brown sugars in a solid form known as "Masarkwoilla" within the Zaria Kaduna State of Nigeria were evaluated for moisture composition which is as well a function of their shelf lives.The samples A (Kwangilla) 18%, B (Sabo gari) 38%, C (Samaru) 55%, D (Tundun Wada) 65% and E (Zaria city) 86% were subjected to routine oven drying at 120^{o}C with an initial dose of 10g and 5min each to the final drying period of 60min (10min interval) with constant weight achievement.**

The ANOVA results disclose the disparities between the means of these sugar samples. Therefore, two independent samples T-test was conducted between two sugar samples at random in order to define the areas of significance as predicted by ANOVA.

The mean significant differences were observed with samples A & E, B & E, and C & E, while A & B, B & C, C & D, A & C, A& D, and B & D are not significantly different with each other. These imply that moisture contents of brown sugar needs to be standardized and maintained for longer shelf life and quality.

Brown sugar processing generally should be regulated and standardized such that moisture which plays a strong role in preserving the molasses and other components in inhibiting the attack of microorganisms and shelf life can be conditioned.

Key words**: brown sugar, solid state, moisture, microorganism, shelf life, Zaria**

I. INTRODUCTION

Sugar has been an important product with serious attention in this modern age. It has continued to be so important to humanity with diverse applications. The country's sugar manufacturing is only close to 7 percent of its demand. Northern parts of the country especially Katsina, Taraba, Kaduna, Kano, and Adamawa, has the potential to attract $24.88 million in profits. This has released the yearly sugar importation declaration of approximately one hundred million dollars, the highest import bill in sub-Saharan Africa [1]. Apart from crude oil, Nigeria has great potential to produce enough sugar that could earn the country a lot of foreign exchange if the resources are properly harnessed [2]. At present, the three factories using imported technology at Bacita, Numan, and Lafiagi produce only about I% of the national sugar requirement of about 1 million tons annually. The 99% shortfall is supplied largely through importation at huge foreign exchange cost to the national economy [3].

The level of sugar production in Nigeria may perhaps be related to the expected retardation in global utilization, which is invariably linked to the health consciousness of diabetes and obesity induced by excessive sugar intake. Nevertheless, there are concerns in support of the country increasing its sugar output. Meanwhile, it is obvious that the country's rising populace is expected to keep requesting for this product despite the health awareness in general. Hence, it is worth investing in sugar to secure the demand gap.

It is noteworthy that in some third world countries like Cuba, Brazil, Puerto-Rico, and India, the development of sugar processing technology at the intermediate level through indigenous effort has reached a tertiary stage [4]. It has been stated that the development of these technologies has been attracting enormous socio-economic benefits which have been continually justifying their existence and improvement in these countries [5]. In Nigeria, a study of the traditional sugar processing technique indicated that a product referred to as "Masarkwoilla" in Hausa dialect is processed from sugar cane mostly by rural farmers in several northern states such as Katsina, Kaduna and Niger State [6]. Basically, the product is a combination of sugar crystals and molasses. It is moist in its natural state due to the hygroscopic property of the molasses. There are extra molasses found in an unrefined brown sugar that retains slight nutritional significance and mineral compositions. The processing technology for the indigenous brown sugar plant is basically comprised of the following eight stages that include; weighing the harvested canes from the field, Juice extraction, clarifying or purification of the extracted juice by liming, heating and settling, evaporation, crystallization, centrifugation and drying [7]. The stabilizing nature of sugar is employed in many applications. Foods are protected from the invasion and activities of pathogenic microorganisms that could cause diseases. [8]. Microorganisms required moisture to mature as they attract water through the external region of their cells. When the activity of sugar within the food is increased to a definite amount, all water molecules are bound by the sugar. This interaction, however, inhibits the activity and development of microorganisms since the accessibility with water is blocked and water concentration drops. Addition of sugar to solution raises the osmotic pressure, thus negating the ability of microorganisms to mature [8]. Since the moisture content of this product is a direct function of the shelf life[9], research has established its vulnerability to microbial attack if the moisture content remained uncontrolled[6].

In order to upgrade the quality standard of the product produced by the small scale rural farmers and support the production effort of the few giant sugar industries, a task force was commissioned by the Federal Government of Nigeria to design, fabricate and commission a prototype brown sugar processing plant. The country's Research Institute on cereals, located in Badeggi, Niger State was given the national mandate to coordinate and ensure the setting up of the plant at its Headquarters in Badeggi in 1987[6]. In line with this mandate, the model brown sugar processing plant with the capacity of 1814.37kg per day cane processing was completed and commissioned in the Institute in 1988[6].

Since then quite a few researches work which intended to advance the operation of the plant is still ongoing. Thus the objective of this paper is to ascertain and evaluate the moisture compositions with the commercial brown sugar in Zaria metropolis the Kaduna State of Nigeria.

II. EXPERIMENTAL

The locally made brown sugars used for this work were purchased at kwangilla (A), sabo gari(B), samaru(C), tundun wada(D) and zaria city(E) within Zaria Kaduna State in Northern Nigeria. The samples were ground into powder exposing the surface areas.

Moisture contents were determined using Genlab MINO/75/F/DIG oven dryer according to A.O.A.C 17^{th} edition, 2000 Official Method 968.11at $102^{o}C$ for 5min, 10min,20min,30min, 40min, 50min and 60min,

III. RESULTS AND DISCUSSION

Table 1. Moisture content evaluation using a routine oven drying method

	C_1 (g)	Co (g)	C1+Co (g). 0min	5Min		10Min		20Min		30Min		40Min		50Min		60Min	
				Total (g)	Net (g)	Total (g)	Net (g)	Total (g)	Net (g)	Total (g)	Net (g)	Total (g)	Net (g)	Total (g)	Net (g)	Total (g)	Net (g)
A	10.0	46.5	56.5	52.4	5.9	52.1	5.6	49.2	2.7	47.6	1.1	47.6	1.1	47.6	1.1	47.6	1.1
B	10.0	52.9	62.9	60.7	7.8	60.3	7.4	58.2	5.3	55.5	2.6	54.7	1.8	54.2	1.3	54.2	1.3
C	10.0	48.9	58.9	54.7	5.8	54.4	5.5	52.5	3.6	50.6	1.7	49.4	0.5	49.1	0.2	49.1	0.2
D	10.0	51.7	61.7	58.5	6.8	58.2	6.5	57.5	5.8	57.2	5.5	56.7	5.0	56.3	4.6	56.3	4.6
E	10.0	48.6	58.6	57.5	8.9	57.3	8.7	56.8	8.2	56.5	7.9	56.2	7.6	55.6	7.0	55.6	7.0

Table II. Percent moisture loss of the Samples after 60min of constant weight.

CBS Sample	Moisture loss (%)
A	18
B	38
C	55
D	65
E	86

Where CBS denotes the crude brown sugar from five commercial sources within Zaria metropolis;

Kwangilla (A)
Sabo gari (B)
Samaru (C),
Tundun wada (D) and
Zaria city (E))

Table III. ANOVA for the Moisture contents of the brown sugar samples

ANOVA: Single Factor								
DESCRIPTION					Alpha	0.05		
Groups	Count	Sum	Mean	Variance	SS	Std Err	Lower	Upper
A	8	28.6	3.575	10.865	76.055	0.985975	1.243539	5.906461
B	8	37.5	4.6875	11.61268	81.28875	0.985975	2.356039	7.018961
C	8	27.5	3.4375	12.21982	85.53875	0.985975	1.106039	5.768961
D	8	48.8	6.1	3.145714	22.02	0.985975	3.768539	8.431461
E	8	65.3	8.1625	1.042679	7.29875	0.985975	5.831039	10.49396
ANOVA								
Sources	SS	df	MS	F	P value	F crit	RMSSE	Omega Sq
Between Groups	124.7665	4	31.19163	4.010661	0.008816	2.641465	0.708048	0.2314
Within Groups	272.20125	35	7.777179					
Total	396.96775	39	10.17866					

Table IV. T-Test two Independent Samples (A and B)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
A	8	3.575	10.865						
B	8	4.6875	11.61268						
Pooled			11.23884	0.331848					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.676218906	0.663696129	14	0.258833	1.76131			no	0.174654
Two Tail	1.676218906	0.663696129	14	0.517666	2.144787	-4.70763	2.482632	no	0.174654
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.676218906	0.663696129	13.98453	0.258839	1.76131			no	0.174748
Two Tail	1.676218906	0.663696129	13.98453	0.517678	2.144787	-4.70763	2.482632	no	0.174748

Table V. T-Test two Independent Sample (B and C)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
B	8	4.6875	11.61268						
C	8	3.4375	12.21982						
Pooled			11.91625	0.36211					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.725996089	0.724219486	14	0.24043	1.76131			no	0.190029
Two Tail	1.725996089	0.724219486	14	0.480859	2.144787	- 2.45189	4.951893	no	0.190029
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.725996089	0.724219486	13.99092	0.240433	1.76131			no	0.190088
Two Tail	1.725996089	0.724219486	13.99092	0.480867	2.144787	- 2.45189	4.951893	no	0.190088

Table VI. T-Test two Independent Samples (C and D)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
C	8	3.4375	12.21982						
D	8	6.1	3.145714						
Pooled			7.682768	0.960574					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.385890315	1.921147707	14	0.037656	1.76131			yes	0.456759
Two Tail	1.385890315	1.921147707	14	0.075312	2.144787	- 5.63494	0.309939	no	0.456759
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.385890315	1.921147707	10.37999	0.04129	1.812461			yes	0.512155
Two Tail	1.385890315	1.921147707	10.37999	0.082581	2.228139	- 5.75046	0.425456	no	0.512155

Table VII. T-Test two Independent Samples (A and C)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
A	8	3.575	10.865						
C	8	3.4375	12.21982						
Pooled			11.54241	0.040472					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.698706178	0.080943957	14	0.468316	1.76131			no	0.021628
Two Tail	1.698706178	0.080943957	14	0.936632	2.144787	- 3.50586	3.780862	no	0.021628
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.698706178	0.080943957	13.95194	0.468318	1.76131			no	0.021665
Two Tail	1.698706178	0.080943957	13.95194	0.936636	2.144787	- 3.50586	3.780862	no	0.021665

Table VIII. T-Test two Independent Samples (A and D)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
A	8	3.575	10.865						
D	8	6.1	3.145714						
Pooled			7.005357	0.953995					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.323381761	1.90799063	14	0.038557	1.76131			yes	0.454278
Two Tail	1.323381761	1.90799063	14	0.077115	2.144787	- 5.36337	0.313372	no	0.454278
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.323381761	1.90799063	10.73988	0.041734	1.795885			yes	0.503144
Two Tail	1.323381761	1.90799063	10.73988	0.083468	2.200985	- 5.43774	0.387744	no	0.503144

Table IX. T-Test two Independent Sample (A and E)

SUMMARY			Hyp Mean Diff	0				
Groups	Count	Mean	Variance	Cohen d				
A	8	3.575	10.865					
E	8	8.1625	1.042679					
Pooled			5.953839	1.880085				
T TEST: Equal Variances				Alpha	0.05			
	std err	t-stat	df	p-value	t-crit	lower	upper	sig
One Tail	1.220024517	3.760170338	14	0.001055	1.76131			yes
Two Tail	1.220024517	3.760170338	14	0.002111	2.144787	- 7.20419	- 1.97081	yes
T TEST: Unequal Variances				Alpha	0.05			
	std err	t-stat	df	p-value	t-crit	lower	upper	sig
One Tail	1.220024517	3.760170338	8.331274	0.002575	1.859548			yes
Two Tail	1.220024517	3.760170338	8.331274	0.005151	2.306004	- 7.40088	- 1.77412	yes

Table X. T- Test two Independent Samples (B and D)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
B	8	4.6875	11.61268						
D	8	6.1	3.145714						
Pooled			7.379196	0.519977					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.358233819	1.03995349	14	0.157995	1.76131			no	0.267788
Two Tail	1.358233819	1.03995349	14	0.315989	2.144787	- 4.32562	1.500622	no	0.267788
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.358233819	1.03995349	10.53315	0.160822	1.795885			no	0.305148
Two Tail	1.358233819	1.03995349	10.53315	0.321644	2.200985	- 4.40195	1.576952	no	0.305148

Table XI. T-Test two Independent Samples (B and E)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
B	8	4.6875	11.61268						
E	8	8.1625	1.042679						
Pooled			6.327679	1.381442					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.25774387	2.76288367	14	0.007627	1.76131			yes	0.594017
Two Tail	1.25774387	2.76288367	14	0.015254	2.144787	-6.17259	-0.77741	yes	0.594017
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.25774387	2.76288367	8.246978	0.011934	1.859548			yes	0.693315
Two Tail	1.25774387	2.76288367	8.246978	0.023867	2.306004	-6.37536	-0.57464	yes	0.693315

Table XII. T-Test two Independent Samples (C and E)

SUMMARY			Hyp Mean Diff	0					
Groups	Count	Mean	Variance	Cohen d					
C	8	3.4375	12.21982						
E	8	8.1625	1.042679						
Pooled			6.63125	1.834865					
T TEST: Equal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.287560678	3.669729963	14	0.001262	1.76131			yes	0.700211
Two Tail	1.287560678	3.669729963	14	0.002524	2.144787	-7.48654	-1.96346	yes	0.700211
T TEST: Unequal Variances				Alpha	0.05				
	std err	t-stat	df	p-value	t-crit	lower	upper	sig	effect r
One Tail	1.287560678	3.669729963	8.185941	0.003033	1.859548			yes	0.788636
Two Tail	1.287560678	3.669729963	8.185941	0.006066	2.306004	-7.69412	-1.75588	yes	0.788636

IV. DISCUSSION

Table l shows the total net weights of each of the sample by routine oven drying method by 17th AOAC 2000 official method. Table ll clearly reveals the % loss in moisture having sample A as the least and sample E as the highest. This means the moisture contents in the samples from these different sources are not uniform and are significantly different from each other.

Table lll is the ANOVA table which discloses the disparities of the moisture compositions between the four crude brown sugar samples

Practically, this means that the four groups are not all equal in the amount of moisture present in each of them. At least one or more of their means is/are different. This development necessitated the use of two independent sample t-tests to determine the actual differences within these samples.

With this two tailed and two independent sample t-test, significance differences were observed with sample A&E [t_{crit} (2.31) < t_{stat} (3.76)], B&E [t_{crit} (2.31) < t_{stat} (2.76)] and C&E [t_{crit} (2.31) < t_{stat} (3.67)] while samples A&B [t_{crit} (2.14) > t_{stat} (0.66)], B&C [t_{crit} (2.14) > t_{stat} (0.72)],C&D [t_{crit} (2.23) > t_{stat} (1.92)], A&C [t_{crit} (2.14) > t_{stat} (0.08)],A&D [t_{crit} (2.20) > t_{stat} (1.91)] and B&D [t_{crit} (2.20) > t_{stat} (1.01)] are not significantly different from each other.

V. CONCLUSION

For Nigeria to be a serious player in the production of brown sugar, technical knowledge, conditions, and awareness are very germane.

This will support its production and give extensions towards brown sugar value additions with positive economic impacts.

This paper has succeeded in revealing moisture as one of the technical factors to be considered in the production and conservation of brown sugar. Brown sugar that has hardened can be made soft again by adding a new source of moisture for the molasses, or by heating and remelting the molasses. Storing brown sugar in a freezer will prevent moisture from escaping and molasses from crystallizing, allowing for a much longer shelf life.

Meanwhile, believing that the country has the capacity to actualize the production of brown sugar as an alternative to white (bleached) sugar, there must be enforcement of standards with respect to moisture as a parameter. In addition, with the right investment policies in brown sugar production with the Federal Government, the country would definitely enrich and empower her masses and becoming a key player of this commodity in the global market.

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