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An Investigation into Sorghum Based Ogi (Ogi-Baba) Storage Characteristics

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Abstract: The storage characteristics of uncooked Ogi-baba (Sorghum based cereal breakfast) after drying for some time at an elevated temperature of 130ºC was the main objective of this experimental work. The experiment also aimed at checking the influence of accelerated drying on the quality and storage life span of the product. The performance was accessed using some organoleptic (odour, colour and fungi invasion count) characteristics at a weekly interval for four weeks by 10 human subjects – confirmed medically fit in their use of olfactory and visual organs. The experimental samples were opened to the atmosphere while the control is sealed immediately the dried product was cooled to room temperature. The 60 min heating was found to have the most stable colour and odour and this property is even more stablized when the product is sealed (as in the control sample). On the other hand, the 60min sample is most loaded with fungi as the experiment progresses but no fungi intestation when sealed, the 20 and 40 min samples (even when sealed) had fungi investation.

Key words: Cereal, elevated heating, ogi-baba, organoleptic, pap and porridge

INTRODUCTION

Ogi or pap is a local generic name for a semi solid food made from cereals (commonly Sorghum, Maize and Millet). It is also known as 'Eko', 'Agidi', 'Akamu', 'Koko' in Nigeria. The ones made specifically from Sorghum is referred to as Ogi-baba. The names are tribal names or the mode of its preparation or serving. The service could be very thick as in 'Agidi' - a gel like food with 12-15% dry-matter concentration, Nago (1992) and Hounhouigan (1994) or very watery as in 'Koko' – a porridge having 7 -10% dry-matter concentration. The third form is a semisolid gelatinized mass refered to a 'eko elewe', 'eko kolobo' in some western part of Nigeria, it is cut into water and sugar and/or milk added optionally. The porridge form is the preferred form for little baby being weaned. The amount of water in the preparation determines the final viscosity – as well as the malting process, Ashworth and Draper (1992). It is a staple food in most African country, Nago *et al.* (1998), with varying preparation methods and names. It is commonly used as weaning food for baby and young children, Faber (2001) and as a standard breakfast cereals for many homes. Apart from being used for human consumption, it has also serve as quick paper glue and free-range chicken feed supplement. It is often taken by Nursing mother as it stimulate or better to say encourage milk production. Personal observation shows that this is due to the fact that it has higher heat capacity than ordinary water while also supplying energy and nutrients. Medical personnel do recommend it for the same reason to sick people because it is light in the stomach and easy to digest.

Fortification is done either to improve the taste and acceptability enjoyed by commercial (baby weaning) products like Ceralac or for Nutritional purpose. Local fortification for taste include use of sugar, milk, chocolate, 'Kulikuli' (Ground Nut Cake), Fried beans (i.e. beans cake or 'Akara' or 'Kose'), fruits and seeds/berry often to dose the sour taste or enhance it. On laboratory scale, vanilla (Sanni *et al.*, 2001) and other artificial flavours are used.

Ogi generally have been implicated for kwashiorkor among infant (Akanbi *et al.*, 2003) and this has lead to many researcher attempt to fortify it to improve its nutritional value with plant protein sources: mellon (Osundahunsi and Aworh, 2003), okra (Akingbala *et al.*, 2005), cowpea (Sanni *et al.*, 2001, Egounlety *et al.*, 2002), soy bean (Nnam, 2000), and animal protein sources. Maize based Ogi have been reported to have better protein score than Sorghum based Ogi when fortified with cowpea or soy bean (Nnam, 2000). Fortification has been reported to improve protein from 1.4 % to 13 % in germinated and fortified preparation and increase lysine to more than 50% when cowpea is added (Egounlety *et al.*, 2002). It is commonly recommended to add palm oil to the weaning gruel to improve the Vitamin A content. Anglani (1998) did a good review on use of sorghum for human foods.

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Table 1: Some nutritional value of Sorghum (2). USDA SR20 tables gives an extensive information on units of measure and the bases of determining the component levels

	Component	Value		Component	Value
a	Water	9.2	m	Vit_C	0
b	Energ_Kcal	339	n	Thiamin	0.237
c	Protein	11.3	o	Riboflavin	0.142
d	Lipid_Tot	3.3	p	Niacin	2.927
e	Ash	1.57	q	Vit_B12	0
f	Carbohydrate	74.63	r	Vit_A_IU	0
g	Fiber_TD	6.3	s	Vit_A_RAE	0
h	Calcium	28	t	Retinol	0
i	Iron	4.4	u	FA_Sat	0.457
j	Phosphorus	287	v	FA_Mono	0.993
k	Potassium	350	w	FA_Poly	1.37
l	Sodium	6	x	Cholesterol	0

Source: USDA SR20

Preparation process for Maize based Ogi applies to the Sorghum based Ogi as well. Preparation involves steeping (soaking before wet milling), soaking in cold water for 3 to 5 days and changing the water every day until it has frothy top or smell alcohol. Normally by fourth day spoilage would have started with off-odour (Teniola and Odunfa, 2002). The major culprit was identified to be Brevibacteria spp. (Teniola and Odunfa, 2002). Another preparation method is the use of hot water (close to boiling) for soaking for 24 hours approximately. The third method common in Benin, (Nago *et al*., 1998) involve actual cooking in boiling water for 10 min then steeped at ambient temperature for 12-48 h. Other researchers (Nago *et al*., 1998), (Akinrele, 1970) reported these differences broadly as Cold procedure, 'Fon' method and 'Goun' procedure. About 40% of total proteins are lost during the manufacture of Ogi (Nago *et al*., 1998) using the 'Goun' method, but the digestibility of the residual proteins increased by 20% with 50% of both macro-mineral and micro-mineral elements gone (on the minimum). Temperature and polysaccharides excretion during fermentation can have serious influence on the final viscosity (Abiodun *et al*., 2002).

Production is still traditional and in batches and at a very small-scale level especially by the house wife for home consumption. For a commercial producer, the cleaned grain, free of dirt and other impurities, is steeped in earthenware, plastic or enamel pots for 1-3 days. During this period fermentation do occur, prolonged steeping will only lead to depletion of the carbohydrates and spoilage as mentioned earlier. The water is removed or reduced and wet-ground. In an urban settings, powered grinding machines are used but in a rural environments, pestle and mortar or stone grinder or grinding wheel are often used – personal study, (Banigo and Muller, 1972). Use of hot water accelerates the softening process and reduces aflatoxin B1 (Adegoke *et al*., 1994). Investigation however proves that the Ogi prepared like that will fail to rise when being cooked. This is often undesirable for a commercial seller of cooked Ogi. The grounding could be very smooth requiring no sieving. The traditional method of grinding is obviously going to be coarse but this also allows the preparation of coarse type of pap and smooth one that may or may not requires sieving. The grounded mixture is allowed to settle in a bowl made up of inert material (to the mixture) –commonly a clay pot or plastic bucket. The water is changed once every day other wise the whole mixture will get spoiled as fermentation still continues as earlier mentioned.

Sorghum according to USDA (2007), have the nutritional value as shown in Table 1. The fermentation involve in making Ogi normally alter the standardized nutritional values (Akinrele, 1996, Nago *et al*., 1998), but fermentation also have its own good influence too. By enzymatic activities of the fermenting agents (Lactic acid bacterial and yeasts), many complex substances are broken down to an easily digestible nutrient (Omemua *et al*., 2007).

The problem: Storage or shelf life of Ogi is often less than ten days except when refrigerated. Refrigeration is a good option in an environment where electricity is available most of the times and the family can afford the bill. It also preserves the freshness of the Ogi – fermentation ceases at low temperature. Another possible solution is Instant Ogi using the flowchart proposed by Banigo *et al*. (1974) for Maize but modification or use of preservative is generally unwanted for most food (IFC, 2007) people prefer the natural flavour. Apart from cost, comparable breakfast food like Custard, Oatmeal does not enjoy the same popularity and patronage accorded Ogi in many developing and underdeveloped nations.

Objective: It is desired to find out the storage behaviour of Sorghum based Ogi by drying at an elevated temperature. We plan to achieve this objective by heating at a fixed high temperature of 130ºC and assessing the product using organoleptic methods.

MATERIALS AND METHODS

Materials required: The materials used include Sorghum (Red variety), an electric Oven, aluminum foil, chemical balance, sieve (to remove dust), Polythene bags, Plastic buckets, Microscope, Slide, Scapular, Petri Dish with cover and Milling machine (plate type).

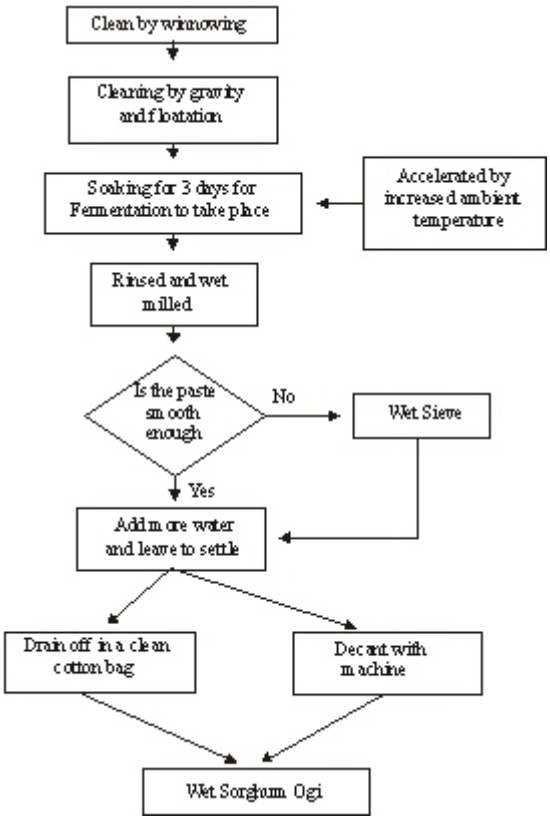

Fig. 1: Flow chart used in producing the Sorghum based Ogi. It is the wet form that was used for this experiment.

Sample production and preparation process: Fig. 1 is the flow chart commonly employed in traditional Sorghum Ogi preparation in many part of Nigeria – this method was adapted in this research work. The Sorghum was first cleaned by winnowing to remove chaffs and other light contaminants. It is then poured in a bowl of water so that the bad seed can float and be skimmed off. The same water was then used for cleaning. Soaking was done for three days to allow fermentation to take place. The fermentation process time is reduced by processing in a warm environment. Longer duration will produce too much fermented products and spoilage can start as well. The soaked grain is then rinsed and wet milled to smooth paste. Sieving will be needed especially if the milling plates are worn out, although some local food preparations use the coarse form. Much water is added to the slurry formed and allowed to settle. For an accelerated result, a decanting machine may be employed. In a local production process, the slurry is put in a (white) sack and hanged to allow the water to drain out. At this stage, the Ogi is ready for consumption or storage.

The experimental process of drying at 130 °C:

Experimental Design: There were three treatments, ten replicates, totaling 30 samples. The first treatment involves heating the slurry at 130ºC for 20minutes, the second was for 40 minutes and the third was done at 60minutes.

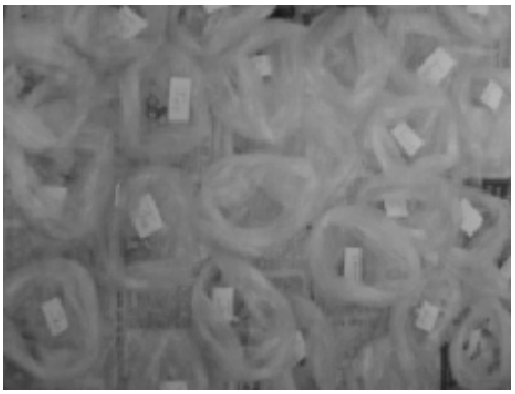

Fig. 2: Sample in polythene bags open to the atmosphere forms the Experiment

Fig. 3: Sample in sealed polyethylene bag act as the Control

The 130ºC was selected to ensure an accelerated removal of the water / moisture and the short duration is to prevent cooking or boiling or roasting. The slurry was spread as thin as possible to ensure even heating.

The sample was divided into fifteen parts - into an aluminum foil. They were then grouped into three groups and heated as early described.

Moisture Determination process: This was done on the dry basis i.e. this formula was used for each sample after oven drying them and allowing them to stabilize at room temperature;

$$M.C_{ab} = \frac{M.C_{wb} \times 100}{100 - M.C_{wb}}$$

where

$$M.C_{wb} = \frac{W_m}{W_o} \times 100$$

$M.C_{wb}$ = Moisture content, wet basis (%)
W_m =Weight of moisture in the product (kg)
W_o = Initial weight of fresh product (kg)

Storage methodology: After the oven drying process, each treatment was further grouped into 2 (15 each). One group was placed in sealed polythene bag (high density polythene) Fig. 3 and the other set in an unsealed bags

and left in the open air (Fig. 2). They were left like this for the next four weeks while assessments were done on them. The sealed sample acted as control.

Environmental Condition: The experiment was conducted at the Agricultural Engineering Department Laboratory, Ahmadu Bello University, Samaru- Zaria. Zaria is within the Northern Guinea Savannah zone of Nigeria, Latitude 11º 12′N and Longitude 7º 33′E, at an altitude of 610m above sea level. The climate is relatively dry, with a mean annual rainfall of 700-1400mm, occurring between the months of April and September. The dry season begins around the middle of October, with cold weather that ends in February. This is followed by relatively hot-dry weather from March to April just before the rain begins. The mean minimum daily temperature is from 14º C to 24 ºC during the cold season while the mean maximum daily temperature is from 19 ºC to 36ºC during the hot season. The Relative Humidity varies between 19 to 35% during the hot season, and 63 and 80% in the wet season (Akpa, 2002). The Relative humidity within the laboratory during the experiment ranges from 40-50% and the average room temperature was 21ºC.

Assessments methodology: The assessment selected were Organoleptic involving 10 human subjects with good visual and olfactory capabilities medically – they were tested to confirm these. The assessments were performed weekly for 4 weeks. The following were assessed; Stability indicated by Colour and Odour, and Fungi Invasion (observed under a microscope). The odour change is an indicator of bacteria infestation. The colour change may be due to bacteria or fungi invasion.

The colours were scaled as 1 – Faded, 2 –Light Dark Reddish Brown and 3 – Dark Reddish Brown.

The odour scaling was a comparison with the fresh one, 1–Very Pronounced, 2–Moderately pronounced, 3–Slightly Pronounced, 4–Very slightly Pronounced.

The fungi invasion was based on their negative nutritional value of their presence. It is scaled as follows using Food Science Department, Institute for Agriculture Research, Ahmadu Bello University Standard;

1→ + - very little growth, reduced nutritional value
2 → ++ - few growths, nutritional Value is almost gone
3→ +++ - very many growth, there is little or no nutritional value
4→ ++++ - Much growth, no nutritional value

Statistical test: Analysis of Variance (ANOVA), t-test and Levene's test were performed on the sample to see if the results are reliable.

RESULTS AND DISCUSSION

Table 2, 3 and 4 summarizes the result obtained in the cause of the experiment. While Table 5, 6 and 7 are

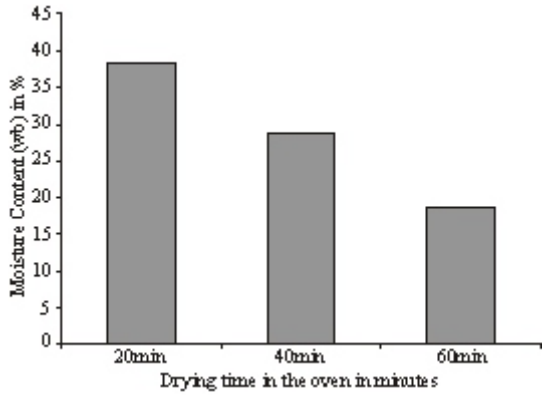

Fig. 4: Average moisture content of the samples

the statistical analysis performed on the result to verify the accuracy of the experiment and result. Fig. 4 shows the average final moisture content after the drying process was concluded. The 60 min period had the least moisture content as naturally expected? Drying at an elevated temperature of 130ºC for 60 min period is found to be more superior to that of 40 min, and the 20 min drying time is the least preferred.

From Table 2, the treatments all maintained their colour in the first week of the experiment but then begin to loose it, much rapidly for the experimental sample. The reason is attached to rate of re-hydration, those dried for 60 min are drier and hence have rapid moisture re-absorption rate than those at 20 min. This explains why the control samples retain their colour more readily at 60 min than at 20 min, the 20 min control samples have higher moisture content and thus have higher deteriorating rate than that of 40 min and 60 min. The rapid moisture re-absorption can be reduced by taking cue from commercial products like chocolate drinks - small packaging which exposed very little to atmosphere (moisture) at a time. This result is comparable to high temperature heating of Spaghetti (Dexter *et al*., 1981) in which the higher temperature enhanced the colour intensity and cooking when appropriately timed compared to the lower temperature heating.

From Table 3, all maintain stable odour in the first week of the experiment. In the last week the results were indistinguishable. For the control, there is an increasing difference as shown by the standard deviation (STD) column. The 60 min one retaining its odour quality longer. This confirms the earlier said statement that sealing and small packaging will improve the shelf life of dried Ogi.

From Table 4, there were no observable infestations in the first week both for experiment and control sample. For the experiment, there is progressive increase in infestation and is so rapid in the case of the 60 min drying time. We are yet to establish the reason for this behaviour. Theodore and Steven (1972) implicated moisture and re-hydration process as the likely hood reason for

Table 2: Average Colour Changes as observed by the 10 human subjects. The values are averages of the observation scaled

	Experiment				Control			
Week	20 min	40 min	60 min	STD	20 min	40 min	60 min	STD
Wk1	3	3	3	0.00	3	3	3	0.00
Wk2	2.4	2	2	0.23	3	3	3	0.00
Wk3	2	1.7	1.3	0.35	2.7	2.8	3	0.15
Wk4	1	1	1	0.00	2.2	2.5	2.8	0.30

1 for Faded colour,
2 for Light Dark Reddish Brown,
3 for Dark Reddish Brown.

Table 3: Average Odour Changes as observed by the 10 human subjects. The Odour scaling was a comparison with the freshly made sample

	Experiment				Control			
Week	20 min	40 min	60 min	STD	20 min	40 min	60 min	STD
wk1	4	4	4	0.00	4	4	4	0.00
wk2	2.6	2.2	2	0.31	4	4	4	0.00
wk3	1.7	1.2	1	0.36	3.7	4	4	0.17
wk4	1	1	1	0.00	2.9	3.7	3.9	0.53

1 – Very Pronounced,
2 – Moderately pronounced,
3 – Slightly Pronounced,
4 – Very slightly Pronounced.

Table 4: Average Observed Fungi Infestation. The number of plus indicates the relative amount of fungi colony found in the samples

	Experiment			Control		
Week	sample dried for 20 min	sample dried for 40 min	sample dried for 60 min	sample dried for 20 min	sample dried for 40 min	sample dried for 60 min
week 1	N.S	N.S	N.S	N.S	N.S	N.S
week 2	+	+	++	N.S	N.S	N.S
week 3	++	+++	+++	+	N.S	N.S
week 4	+++	++++	++++	+	+	N.S

N.S implies not significant

Table 5: Group Statistics. The SD and SEM indicates that the sample size used is adequate enough

		N	Mean	SD	SEM
T=20 min	Experiment	5	42.2920	.7590	.3394
	Control	5	34.0073	2.4639	1.1019
T=40min	Experiment	5	29.6912	1.7837	.7977
	Control	5	27.8765	1.9234	.8602
T=60min	Experiment	5	18.0719	2.4877	1.1126
	Control	5	19.1327	1.4959	.6690

SD = Standard Deviation
SEM = Standard Error Mean

Table 6: Independent Sample Test Using SPSS v10. The p values in the Levene's Test column shows that the samples used all have equal variance in their respective group

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
T=20 min	Equal variances assumed	2.205	.176*	7.185	8	.000*	8.2847	1.1530	5.6259	10.9435
	Equal variances not assumed			7.185	4.752	.001*	8.2847	1.1530	5.2738	11.2956
T=40min	Equal variances assumed	.010	.923*	1.547	8	.160*	1.8147	1.1731	-.8905	4.5199
	Equal variances not assumed			1.547	7.955	.161*	1.8147	1.1731	-.8932	4.5226
T=60min	Equal variances assumed	.887	.374*	-.817	8	.437*	-1.0608	1.2982	-4.0545	1.9328
	Equal variances not assumed			-.817	6.558	.443*	-1.0608	1.2982	-4.1730	2.0513

* (p>0.05)

such anomaly. In the control sample, the level of moisture seems to be responsible for the little infestation observed in the 20 min sample.

Table 5 shows the group statistics for the 20, 40 and 60 minutes drying period. The statistical results indicate that the sample size used is adequate. From Table 6, it can be seen that the results are acceptable for the three timing used since all are statistically insignificant – p values greater than 0.05. Table 7 shows that internal variation in experimental setup is not really much.

Table 7: ANOVA Table showing the internal variation between experimental groups and within the experimental groups

		Sum of Squares	df	Mean Square	F	Sig.
T=20 min	Between Groups	171.590	1	171.590	51.630	.000
	Within Groups	26.587	8	3.323		
	Total	198.177	9			
T=40min	Between Groups	8.233	1	8.233	2.393	.160
	Within Groups	27.524	8	3.440		
	Total	35.757	9			
T=60min	Between Groups	2.813	1	2.813	.668	.437
	Within Groups	33.706	8	4.213		
	Total	36.520	9			

CONCLUSION AND RECOMMENDATION

The accelerated heating of Sorghum Slurry prepared using the traditional processing method outline in this write up has some positive implications. Overall, it is better to heat for longer duration, with some burning expected. A programmed heating process /pattern may prevent this burning or roasting as the timing get more prolonged. In order word, programmed heating of Ogi should be investigated. Another one is to heat at much more elevated temperature at a very short duration using blast of controlled/ stabilized heated air (turbulent and non turbulent mode) perhaps using the same process for powder milk production.

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