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Original article

IMPACT OF GRAIN BIOPOLYMER MODIFICATION ON TEXTURE AND ACCEPTABILITY OF TUWO: COMPARATIVE STUDY ON MODIFIED SORGHUM AND MILLET FLOURS

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ABSTRACT

Tuwo is a stiff porridge produced from cereal grains and consumed in different forms across Africa and Asia of which keeping quality is the most important quality factor. But the quality of *tuwo* produced and consumed all over is only a subjective. Therefore the desired final *tuwo* hardness determines the water: flour ratio to be mixed during preparation, taking into consideration the moisture loss during cooling and the subsequent texture modification. Modification of cereal biopolymer by pregelatinization and fermentation brings about changes in the crystalline structure of the biopolymer leading to other changes in the properties of their final products. However, research on the cooling behaviour of *tuwo* was not given enough attention probably because *tuwo* preparation is still a household process that is yet to be industrialized. In this work, modified sorghum and millet flours were produced and used to prepare *tuwo* and their cooling behaviour and hardening pattern were studied, and sensory evaluation conducted to determine their acceptability. The cooling rate of *tuwo* and index of hardness were found to be positively correlated and fit well ($r^2 > 0.9$) into a linear polynomial curve. Both pregelatinization and fermentation led to the production of *tuwo* with lower hardness at all temperatures compared to native flours of both millet and sorghum. At high temperatures however fermentative modification of the biopolymer gave *tuwo* with the least hardness (19mm penetration). The overall acceptability of modified sorghum and millet *tuwo* did not vary significantly ($P > 0.05$) from the control; also pregelatinization and fermentation did not significantly affect the acceptability of both the modified *tuwo* samples and the control indicating that modified cereal flours can be well accepted by the consumer.

Key words: Starch Modification, Hardness, Fermentation, Pregelatinization, Acceptability

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INTRODUCTION

Modification of cereal starches is done to alter their properties to make them more suitable for use in different food and non-food applications [1]. Several methods have been developed to produce modified starches with a variety of characteristics. All of these techniques alter the starch polymer, making it highly flexible and changing its physicochemical properties and structural attributes to increase its value for food and non-food industries [2]. Modifications of starch can be achieved by physical, chemical and enzymatic methods [3]. Physical methods involve the use of heat and moisture, while chemical modifications include etherification, esterification, crosslinking, hydrolysis and oxidation [4]. Commonly used modified starches in food applications include oxidised starches, cross-linked starches, starch phosphates, starch acetates and pregelatinized starches (PGS) [5]. Pregelatinized starches are native starches that are subjected to precooking followed by drying, resulting in complete granular fragmentation and the loss of birefringence [6]. Important properties of PGS in food processing include an increase in swelling capacity, solubility and cold-water dispersion. Furthermore, a greater weight of PGS is required to produce a given viscosity than the weight of native starch needed to get the same viscosity [7]. In the preparation of most cereal-based food systems, the starch-containing cereal was heated in the presence of water and cooled to a variable degree before consumption [6]. The unique character of many foods results from the changes that starch undergoes, especially when it is heated and subsequently cooled. Starches from different cereals vary widely in their gelatinization properties: wheat, barley, triticale and rye have similar gelatinization properties in which 50% of the granules lose their birefringence at 53°C; while the starch granules of maize, sorghum, and pearl millet gelatinize at 67°C during which 50% of the granules have gelatinized [8]. One of the largest uses of PGS is in instant pudding packaged powders that offer uniform powder consistency and reduced pudding preparation time [9]. When used in *tuwo* preparation, pregelatinized sorghum and millet biopolymer can impart beneficial changes in the physical and sensory attributes of the final *tuwo*. The quality and functionality of *tuwo* vary from one community to another, and even within a given community, quality and functionality may vary from one household to another [10]. Normally grains with floury or soft endosperm texture produce *tuwo* with sticky and mushy texture [11]. The most important qualities of *tuwo* desired by consumers are a thick and firm texture, non-stickiness and good keeping quality because *tuwo* is normally kept overnight, reheated in the morning and eaten as *dumame* [10]. *Tuwo* is a stiff porridge with neutral pH, produced mainly from cereal grains including Sorghum, Millet, Maize and Rice and also from some other small grains like Fonio [12]. Stiff porridges are consumed in almost all countries where coarse grains are cultivated for food, although with several variations in the details of the production procedure depending on the regional location and culture; and are known with different names like *sangati*, *ugali*, *umqo* and *tô* [13, 14]. The most important qualities of *tuwo* desired by consumers are a thick and firm texture, non-stickiness and keeping quality. In sorghum, the colour of the pericarp, presence or absence of testa, and the texture of the endosperm affect *tuwo* quality [15]. Certain cultivars of sorghum produce an acceptable *tuwo* when cooked in an acid medium but not in an alkaline medium. Porridge made in an acidic medium is generally firmer in texture and lighter in colour than that made in an alkaline medium [16]. Generally, white or yellow porridge is preferred. Some cultivars of sorghum produce fresh *tuwo* of acceptable eating quality but exhibit poor storage quality [17]. There is no gainsaying the importance of *Tuwo* in the diet of Nigerians of all socioeconomic status especially in the north. Nevertheless, the quality and functionality of' the *tuwo* produced and consumed nationwide is only a subjective judgment and varies from one community to another. Even within a given community, quality and functionality may vary from one household to another [11]. Laboratory evaluation of a range of *tuwo* samples produced using a similar set of grain indicated that grains with highly corneous endosperm and good dehulling qualities are suitable for the preparation of thick porridges [18]. *Tuwo* is normally served immediately after preparation as hot as it were, though it may be allowed to stay in the open dish or plate for some minutes under the prevailing ambient condition for the temperature to drop enough to be comfortably cut with the bare hand. This cooling process, as insignificant as it may seem, is an important aspect of consideration in *tuwo* processing as it determines the final eating texture of the product. Upon cooling the gelatinized starch of the *tuwo* undergo retrogradation and also losses moisture which reduces the stickiness of the product and increase the *tuwo* hardness. The desired final *tuwo* hardness determines the water: flour ratio to be mixed during production, taking into consideration the moisture loss during cooling and the subsequent texture modification. However, research on the cooling behaviour of *tuwo* was not given enough attention probably due to fact that *tuwo* preparation is still artisanal and yet to be industrialized. The aim of this work is therefore to study and compare how modification of sorghum and millet biopolymer by pregelatinization and by fermentation can influence the firmness and consistency of the *tuwo* regardless of the nature of the raw starch and to evaluate the consumer rating of the modified cereal biopolymer *tuwo*.

MATERIALS AND METHODS

Sorghum and Millet

Sorghum (Masakwa Variety) and Millet (Sosat C88) were obtained from Lake Chad Research Institute, Maiduguri.

Sample Formulation

A total of six (6) flour samples were formulated from sorghum and millet of which raw (unmodified) flour samples were the control against which pregelatinized grains flours and fermented grains flours were compared. The notation of the various flour formulations and their numberings are shown in Table 1. The notation is such that the first letter represents the Grain Type (S = Sorghum, Mi = Millet), the second letter represents the biopolymer modification method (C = Control, P = Pregelatinization, F = Fermentation), while the third letter N stands for normal *tuwo* preparation method. Thus sample MiFN, for example means the sample is of fermented millet grain flour used in normal *tuwo* preparation, SPN stands for sample of pregelatinized sorghum in normal *tuwo* preparation.

Table 1: Formulation Table

S/No.	Notation	Grain Type		Starch Modification Methods		
		Sorghum	Millet	Raw (Control)	Pregelatinized	Fermented
1	SCN	√	—	√	—	—
2	SPN	√	—	—	√	—
3	SFN	√	—	—	—	√
4	MiCN	—	√	√	—	—
5	MiPN	—	√	—	√	—
6	MiFN	—	√	—	—	√

Sample Preparation

Raw Grains Flour (Control Sample): Sorghum and millet grains were tempered with water using a quantity of 3 - 4% (v/w) followed by decortication of the grains in a commercial dehulling machine (previously cleaned), where the germs and hulls of the grains were removed. The decorticated grains were aspirated manually to remove adhering hulls and then ground into flour using a Laboratory Hammer mill. The sample flour thus obtained was dried to safe moisture content and then sieved using a standard sieve with 300µm aperture and then kept in airtight polythene bags until needed.

Pregelatinized Grains Flours: Three kilograms of decorticated and aspirated sorghum and millet grains were separately introduced into a basin containing two litres each of boiling water. The grains were then gently stirred to achieve even distribution of the grains in the water. The water was first brought to boil before adding the grains to maintain constant temperature for uniform thermal treatment. The grains were then allowed to stay in the boiling water for 10 minutes for complete gelatinization of the starch granules. The grains were then decanted and dried in a solar dryer. The dried grains were then milled in a laboratory hammer mill and sieved through a standard sieve with 300µm aperture and then kept in airtight polythene bags until needed.

Fermentation-Modified Grains Flour: Natural fermentation was carried out at the prevailing ambient temperature for 36 hours for both sorghum and millet. Fermentation water was being discarded after every 12 hours to avoid undesirable microbial succession and the development of putrid odour. The fermented grains were decanted and then spread on a canvass material for drying. The dried grains were then ground into flour using a Laboratory Hammer mill. The fermented flour thus obtained was sieved through a standard sieve with 300µm aperture and then kept in airtight polythene bags until needed.

***Tuwo* Preparation:** *Tuwo* was prepared by traditional method as described in literature [19]. The overall ratio of flour to water used was 1:3.5 (w/v). Some cold slurry of the flour was first prepared by mixing 20% of the desired quantity of flour (1 kg) with 25% of the desired quantity of water (3.5 l). This was followed by bringing 60% of the water into boiling and the cold slurry initially prepared was added to this boiling water coupled with vigorous stirring, using a wooden stirrer to form a consistent gruel. The remaining quantity of the flour (80% of the desired total) was then added incrementally to the boiling gruel with continuous stirring to avoid lumps formation and to ensure a homogenous gel is obtained. The remaining quantity of water (15% of the desired total) was finally added to the formed gel, covered properly without stirring, and allowed to cook for about 5 - 7 min, after which it was stirred vigorously to ensure smoothness of the gel. The final product obtained is the desired *tuwo*.

Determination of Cooling Rate of *Tuwo*: 10 equal quantities (30g) of each *tuwo* sample were taken immediately after preparation with the aid of a stainless-steel die to obtain a uniform sample size and surface area. The die was lined with vegetable oil to avoid the sticking of the *tuwo* sample on the inner surface of the die. The samples were kept in covered sample holders at room temperature (34 ± 1^0c). Successive temperatures of the tuwo samples were recorded with a thermometer at intervals of 10 minutes for the first six readings and then twenty minutes subsequently until a constant temperature is attained.

Determination of Index of Hardness: Index of hardness was estimated from the depth of penetration data (recorded as mm of penetration) obtained by Hand Penetrometer while maintaining a constant force of penetration [20, 21]. Ten equal quantities of each *tuwo* sample were taken immediately after preparation with the aid of a stainless-steel die to obtain a uniform sample size and surface area. The die was lined with vegetable oil to avoid the sticking of the *tuwo* sample on the inner surface of the die. The samples were kept in covered sample holders at room temperature (34 ± 1^oC). Successive temperatures and hardness were measured using a thermometer and a Hand Penetrometer respectively at 10 minutes intervals for the first one hour and 30 minutes intervals subsequently until constant temperature and hardness were recorded. The drop in temperature and increase in hardness with time were recorded as cooling behaviour.

Sensory Evaluation: A group of twelve people generally familiar with *tuwo* were trained for the sensory evaluation as described by [22]. A seven point hedonic scale was used to rank the degree of like and dislike of the *tuwo* samples by the twelve semi-trained panellists. Point seven represented like extremely and point one represented dislike extremely. Samples were coded with random numbers and presented to the assessors.

Data Analyses

The correlation of the *tuwo* temperature and index of hardness data to determine the effects of the two grain types and the two modification methods on the cooling behaviour of the *tuwo* samples were carried out by multiple regression analysis and curve fitting, while the sensory evaluation results were analysed by 3-way analysis of Variance (ANOVA) and mean separation carried out by the Tukey-Kramer honestly significant difference (hsd) all using MATLAB statistical software [MATLAB 7.12.0 (R2011a)]

RESULTS

Cooling Behaviour of *Tuwo*

Table 2 below shows the temperature readings (^0C) with time for the various *tuwo* Samples, while table 3 shows the penetrometer readings in mm as index of hardness of *tuwo* samples. These two sets of data were correlated and the product-moment correlation coefficients were shown in table 4. A predictable relation between *tuwo* temperature and its hardness with time was thus established with a strong positive correlation between the two recorded sets of data.

Table 2: Temperature Readings (°C) with Time for Various *tuwo* Samples

Grain	Flour	Cooling Time in Minutes									
		0	10	20	30	40	50	70	90	110	130
Sorghum	Raw (Control)	82.5	73	64.5	61.5	54.5	51.5	41.5	34	33.5	33
	Pregelatinized	82	72.5	66	59.5	54.5	47	42.5	35	34.5	33.5
	Fermented	81.5	72.5	65.5	59.5	54.5	50.5	44.5	36	33.5	33
Millet	Raw (Control)	80	72.5	66.5	61	56.5	50.5	44.5	36	34.5	33.5
	Pregelatinized	81.5	71	67	62	56.5	50	44.5	38	33	33.5
	Fermented	80	72	66.5	60	55.5	50	45	36	34.5	34

Values are means of two readings

Table 3: Penetrometer Readings in mm as Index of Hardness of *tuwo* Samples

Grain	Flour	Cooling Time in Minutes									
		0	10	20	30	40	50	70	90	110	130
Sorghum	Raw (Control)	15.1	14.8	12.1	10.1	9.8	8.5	7	5.5	5	4.9
	Pregelatinized	15.9	15.4	14.3	12.4	10.2	9.5	7.5	5.4	5	4.9
	Fermented	13.9	13.1	11.5	10.15	9.4	8.9	6.7	5.5	5.1	4.8
Millet	Raw (Control)	18.5	17.1	15.3	13.5	11.5	10.1	8.1	6.6	6.2	6.2
	Pregelatinized	12.9	12.5	10.9	9.2	8.6	7.9	6.1	5	4.8	4.8
	Fermented	18.7	17.1	15.6	14	11.5	10.1	7.4	6.4	6.1	6

Values are means of two readings

As the temperature of the samples decreases with time so also, the penetrometer reading, as index of hardness, decreases with time. But the index of hardness is the extent of the penetration of the penetrometer spindle into the *tuwo* sample meaning that the harder the sample the less the penetration. Therefore the positive correlation observed between decreasing temperature and decreasing index of hardness means a negative correlation between the temperature drop and actual hardness of the sample.

Table 4: Product-Moment Correlation Coefficients (r) of Temperature and Index of Hardness

	1	2	3	4	5	6	7	8	9	10	11	12
SCN(P)	1											
SCN(T)	0.992	1										
MiCN(P)	0.973	0.994	1									
MiCN(T)	0.977	0.993	0.993	1								
SPN(P)	0.977	0.997	0.998	0.998	1							
SPN(T)	0.987	0.997	0.993	0.998	0.997	1						
MiPN(P)	0.969	0.989	0.993	0.993	0.994	0.991	1					
MiPN(T)	0.977	0.991	0.989	0.998	0.995	0.997	0.985	1				
SFN(P)	0.962	0.985	0.992	0.997	0.996	0.991	0.991	0.993	1			
SFN(T)	0.989	0.997	0.989	0.997	0.994	0.999	0.986	0.997	0.988	1		
MiFN(P)	0.953	0.976	0.983	0.994	0.989	0.986	0.984	0.991	0.998	0.984	1	
MiFN(T)	0.982	0.996	0.994	0.998	0.997	0.999	0.989	0.999	0.992	0.998	0.988	1

(T) = Temperature Reading (P) = Penetrometer Reading

Curve Fitting [Index of Hardness (mm) Against Temperature (°C)]

A strong correlation was established between the index of hardness and temperature and a linear polynomial curve was fitted to enable the prediction of hardness at any given temperature. The slope of the curve β and the intercept ε were evaluated, while r-square indicated the goodness of fit of the data to the curve. These constants were presented in Table 5. The values of r-square for all the samples approached zero indicating that curves were all well fitted to the data.

Table 5: Table of Constants for the Linear Regression Curves

Grain	Flour	B	E	r^2	Adjusted r^2
Sorghum	Raw (Control)	0.2197	-2.5650	0.9845	0.9806
	Pregelatinized	0.2013	-0.5645	0.9934	0.9918
	Fermented	0.2774	-3.1660	0.9762	0.9703
Millet	Raw (Control)	0.2060	-1.1390	0.9710	0.9637
	Pregelatinized	0.1933	-1.1510	0.9575	0.9469
	Fermented	0.2946	-4.3540	0.9772	0.9715

The constants evaluated from the curves were used to predict the index of hardness between 30 to 80°C to observe the effects of grain type and modification methods on the hardening pattern of *tuwo*.

Regression Lines from the Predicted Values of Temperature and Index of Hardness: Figures 1 and 2 show the regression lines of the index of hardness against temperature for the control, pregelatinized and fermented samples of *tuwo* from sorghum and millet respectively.

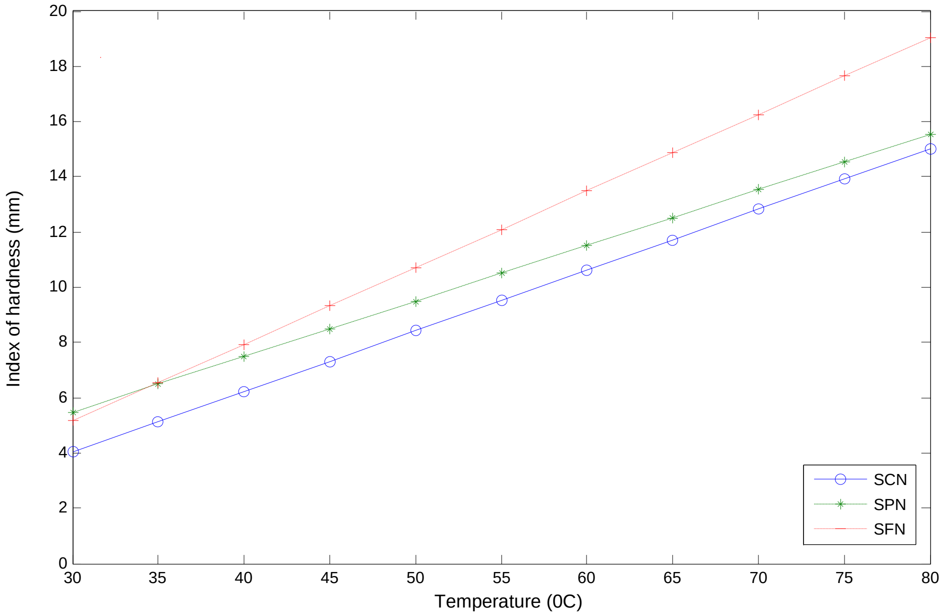

Fig. 1: Regression Lines Showing the Effects of pregelatinization and fermentation on the Hardening pattern of Sorghum *Tuwo*

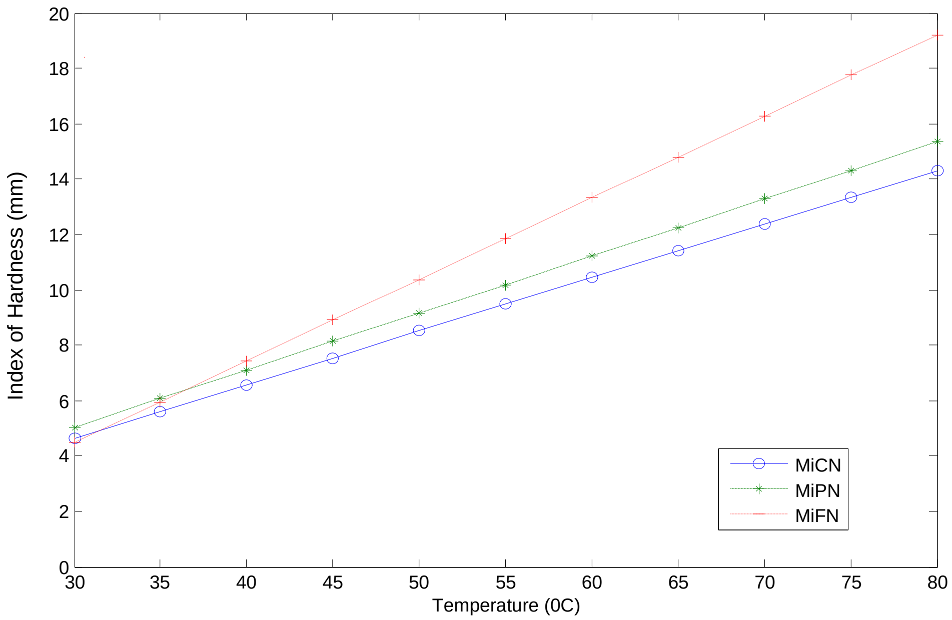

Fig. 2: Regression Lines Showing the Effects of pregelatinization and fermentation on the Hardening pattern of Millet *Tuwo*

Sensory Properties of *Tuwo*

The results of the sensory evaluation of the samples are presented in Table 4 below, which are an indication of consumer acceptance of the product.

Table 4: Sensory Evaluation scores of *Tuwo* Samples

Attribute	Sorghum			Millet		
	Native	Pregelatinized	Fermented	Native	Pregelatinized	Fermented
Colour	4.83 ± 1.64^{bdg}	3.42 ± 1.62^{bdg}	4.58 ± 1.68^{bdg}	4.17 ± 2.12^{bdg}	3.17 ± 1.59^{bdg}	4.33 ± 1.16^{bdg}
Aroma	4.75 ± 1.22^{adg}	4.33 ± 1.44^{adg}	3.92 ± 1.68^{adg}	4.92 ± 1.88^{adg}	3.42 ± 1.24^{adg}	4.58 ± 1.17^{adg}
Taste	4.75 ± 0.75^{bdg}	4.0 ± 1.48^{beg}	4.42 ± 1.68^{bfg}	4.08 ± 2.23^{bdg}	2.67 ± 1.56^{beg}	4.42 ± 1.17^{bfg}
Texture	4.67 ± 1.44^{bdg}	4.08 ± 2.07^{beg}	4.33 ± 1.56^{bfg}	4.58 ± 2.02^{cdg}	2.17 ± 1.27^{ceg}	4.17 ± 1.75^{cfg}
Overall Acceptability	5.0 ± 0.74^{bdg}	4.25 ± 1.36^{bdg}	4.58 ± 1.56^{bdg}	4.67 ± 1.72^{bdg}	2.58 ± 1.44^{bdg}	4.83 ± 1.03^{bdg}

Mean values in the same row with different superscript differ significantly ($p < 0.05$)

DISCUSSION

Cooling Behaviour of *Tuwo*

The penetrometer readings recorded was observed to vary in inverse proportion to the cooling time until a constant value was attained. Upon correlation, these two sets of data were found to correlate well and the product-moment correlation coefficients were shown in table 4. A predictable relation between *tuwo* temperature and its hardness with time was thus established with a strong positive correlation between the two recorded sets of data. The temperature and index of hardness of the samples recorded with time all showed positive correlation. That means as the temperature of the samples decreases with time so does the index of hardness. But the index of hardness is the extent of the penetration of the spindle into the *tuwo* sample meaning that the harder the sample the less the penetration. Therefore the positive correlation observed between decreasing temperature and decreasing index of hardness means a negative correlation between the temperature drop and actual hardness of the sample. This predictable relation can be used in product formulation, standardisation and in process design. As *tuwo* was subjected to the natural cooling process, moisture was being lost to the environment as starch retrogradation also takes place causing an increase in the forces of attraction between the molecules leading to increase in hardness with time. This is attributable to several factors [23]; at lower temperatures, the forces of attraction between the molecules are higher than at elevated temperatures leading to harder texture. Starch retrogradation as an inherent property of plant starches also lead to harder textures at lower temperatures. It was observed that immediately after the *tuwo* was removed from the heat source, hardening of the *tuwo* texture sets in as the temperature drops. The relationship between temperature drop and hardening of *tuwo* is critical in the study of keeping quality of the product. *Tuwo* from the fermented grain samples tend to lose temperature faster than the one from native unmodified *tuwo* (control sample). This may be due to the starch modification during fermentation which reduces the flour's bulk density and water absorption capacity [24], which implies that the *tuwo* from such flour exhibits a less dense cellular structure leading to higher surface area for energy and mass transfer. The hardness of cereal flour meals is attributable to the inherent associative forces within the starch molecules such as amylose/amylopectin ratio, and the level of chemical transformation during *tuwo* preparation [25]. It was reported that higher amylose content and longer amylopectin chains could contribute to the hardness of a food gel from maize and that flour preparation methods could affect the inherent associative forces within the starch molecules [23] and by extension that of the food prepared from such flour.

Curve Fitting [Index of Hardness (mm) Against Temperature (°C)]

A strong correlation was established between the index of hardness and temperature and a linear polynomial curve was fitted to enable the prediction of hardness at any given temperature. The slope of the curve β and the intercept ε were evaluated, while r-square indicated the goodness of fit of the data to the curve. These constants were presented in Table 5. The values of r-square for all the samples approached zero indicating that curves were all well fitted to the data. This means that the values of hardness predicted from these constants will approximate closely to experimental data and can be used in process design and in product standardization.

Effects of Pregelatinization and Fermentation on Hardness: Figures 1 and 2 show the regression lines of the index of hardness against temperature for the control, pregelatinized and fermented samples of *tuwo* from sorghum and millet respectively.

Sensory Properties of *Tuwo*

The non-significant difference observed in colour ratings of sorghum (4.83) and millet (4.17) could be due to the fact that the dark colour of sorghum and millet *tuwo* is already acceptable to the native consumer by virtue of long cultural tradition. However, non-significant difference between the two samples in Pregelatinization and fermentation might be due to the reduced tannin contents in the fermented samples [26]. The aroma ratings of the two grain samples did not show any significant variations. This may be due the fact that *tuwo* aroma does not matter much to consumers since *tuwo* is normally eaten with soup. However, fermentation imparted an aroma that is rated lower in both the samples of sorghum (3.92) and millet (4.58) than that of the control (sorghum 4.75, millet 4.92) although the difference is not statistically significant at $P<0.05$. The taste ratings of sorghum (4.75) and millet (4.08) are not significantly different from each other, but pregelatinization has significantly reduced the taste ratings of both grains probably due to the loss of soluble substances without generating any taste inducing substances. Fermentation, on the other hand, has significantly reduced the taste ratings of sorghum but significantly increased that of millet, probably due to flavour modification induced by the fermentation process. The increased taste rating due to fermentation observed in millet but not in sorghum may be due to the higher amino acid quality of millet [27]; the interaction of which resulted in improved taste for the fermented millet *tuwo*. Both pregelatinization and fermentation have significantly reduced the texture ratings of the two samples. This may be due the distortion of the amylose: amylopectin ratios and the disruption of the cellular structure of the biopolymer [2] that led to softer texture that is preferred by consumers. On the overall, the acceptability of the sorghum and millet *tuwo* do not varies significantly. Pregelatinization and fermentation did not significantly affect the acceptability of the *tuwo* samples. This is an indication that improved cereal flours can be well accepted to the consumer.

CONCLUSION

The cooling rate of *tuwo* and index of hardness are positively correlated and fit well into a linear polynomial curve. The hardness of *tuwo* at any temperature can be estimated from the linear equation with good accuracy which may be important in product formulation and standardisation. The modification processes of both pregelatinization and fermentation led to the production of *tuwo* with lower hardness at all temperatures compared to native flour. At high temperatures however fermentative modification of the biopolymer gave *tuwo* with the least hardness. On sensory evaluation, colour and aroma ratings of sorghum and millet samples do not vary significantly. Likewise pregelatinization and fermentation did not significantly ($P<0.05$) affect the colour ratings though the ratings for both grains are slightly lower. Aroma ratings of the samples did not show any significant variation However, fermentation impart an aroma that is rated lower in both sorghum and millet than that of the control. The taste ratings of sorghum (4.75) and millet (4.08) are not significantly different from each other. Pregelatinization has significantly reduced the taste ratings of both the grains. Fermentation, on the other hand, has significantly reduced the taste ratings of sorghum but significantly increased that of millet. On the overall, the acceptability of the sorghum and millet *tuwo* did not vary significantly. Pregelatinization and fermentation did not significantly affect the acceptability of the *tuwo* samples. This is an indication that improved cereal flours can be well accepted to the consumer.

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