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Changes in the functional and pasting characteristics of sweet potato *(Ipomoea batatas)* during fermentation

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ABSTRACT

Sweet potato flours were produced following fermentation of peeled and unpeeled potato in natural anaerobic condition and corn steep water. These samples include two unfermented control samples (PUF: peeled and UUF: unpeeled), two samples (UNF: peeled and PNF: unpeeled) produced from natural fermentation process and lastly, two samples (PCF: peeled and UCF: unpeeled) fermented with corn steep water. The effect of different fermentation process on the functional and pasting properties of the potato flours were investigated. From the results, it was observed that fermentation of peeled potato with corn steep water decreased (0.67 g/ml) the bulk density. The high-water absorption (210%) of unpeeled natural fermented potato flour indicates an increase in water holding ability of the degraded non- starchy carbohydrate components of the potatoes after fermentation. In addition to peeling, fermentation with corn steep water enhanced the water uptake which results to lower wettability time (34 sec). Hence, the flours could be utilized effectively in bakery and weaning foods. Pasting Properties were significantly different ($P< 0.05$). The peak viscosity ranged from 2081.00 cP to 4652.00 cP with highest in UCF. The highest breakdown viscosity (2080 cP) occurred after fermentation with corn steep water (UCF) suggesting the fragile nature of the granule after fermentation. Hence this flour can serve as emulsion stabilizer. The final viscosity which was highest in UCF indicates higher rate of re-association of the granule during cooling of the paste. From the pasting analysis, the unpeeled potato fermented with corn steep water had an improved pasting property due to the high degradation of the cellular carbohydrate which enhances water intake and swelling of the starch granule.

Keywords: *Degradation, Fermentation, Starch, Pasting, Potato, Properties, Viscosity*.

INTRODUCTION

The functionality of sweet potato *(Ipomoea batatas* when used as tuber, flour, flakes or puree (paste) influences its applications and value-added products. Nigeria is among major producer of sweet potato (along with China, USA and Tanzania) with annual production capacity of 4 million tons (FAOSTAT, 2016). Sweet potato is the seventh largest food crop, grown in tropical, subtropical, and warm temperate regions. In addition, sweet potatoes are rich in dietary fibre, minerals, vitamins, and bioactive compounds such as phenolic acids and anthocyanins which also contribute to the colour of the flesh. Depending on the cooking methods, peeling or unpeeling could improve bioactive components (Chandrasekara and Kumar, 2016). Sweet potato can be eaten in peeled or unpeeled form after subjecting it to different cooking techniques such as boiling, steaming, frying, roasting and baking. Yet with all these potentials, much are still lost through post-harvest storage and processing to less shelf-stable products. With starch as the predominating component of sweet potato in addition to 30% non-starch carbohydrate, their application for food and industrial purposes is based on the modification of physicochemical and functional properties of starch (Tortoe *et al.*, 2017; Yuliana *et al*., 2018 and Kwon *et al*., 2019). The starch impacts the functionality which affects its end uses. The alteration of native starch matrix within the cellular structure highly contributes to starch functionality, cooking and rheological behavior. More especially, heating (gelatinization) moist-starchy material is a well-known process that disrupt starch native structure (Yassaroh *et al.*, 2019). In addition to modification of physicochemical properties, changes in potato starch could improve digestibility (Zhang *et al*., 2020). Moreover, the abundant pectin substances in the middle lamella and the cellular wall of the potato cell facilitate the modulation of the textural properties of the starch under physical heat treatment *i.e.*, cooking, and widen its applicability as a thickening or gelling agent in the food technology sector (BeMiller, 2011).

Fermentation as a beneficial food processing and preservation technique has the potentials in the degradation of cellular structures. During fermentation, the degradation of material through microbial-enzymatic process results in the formation of lower molecular weight material with higher solubility. Apart from the chemical (nutritional impact) and physically transformation of biomaterial during fermentation, organoleptic qualities are also enhanced. Fermentation process which occur either under natural conditions or with starter cultures affects the sensory, physicochemical and nutritional quality of the fermented products. To encourage the sustainability of fermentation process and technology, cultures from conventional process waste could be utilised. Thereby ensuring that the process is adequate for food security. Sweet potato flour fermented with mixed cultures as starter culture was reported to possess the best attribute in terms of texture, flavor and consistence of stiff porridge (Ajayi *et al.,* 2016).

In this study, the changes on the functional and pasting properties of flour from peeled and unpeeled potato tuber fermented with or without corn steep water were evaluated and compared with unfermented potato.

MATERIALS AND METHODS

Source of Raw Materials:

The cream sweet potato tubers (3kg) were purchased from Eke market Ekwulobia, Aguata L.G.A Anambra state, Nigeria.

Fermentation of Potato Tuber:

The potato flour was produced using the method of Yuliana *et al*., (2018) with some modifications. To obtain the potato flours, potato tubers measuring 3 kg were washed and divided into 6 portions. The six portions represents six samples, namely; Unpeeled-unfermented sweet potato flour (UUF), Peeled unfermented potato flour (PUF), Unpeeled natural-fermented potato flour (UNF), Peeled natural-fermented potato (PNF), Unpeeled corn steep water fermented potato flour (UCF) and Peeled, corn steep water fermented potato flour. To produce the unpeeled (UUF) and peeled unfermented (PUF) samples, one portion was either peeled or unpeeled followed by slicing into 10 mm width chips. The sliced chips were dried in cabinet drier at 60 ^{0}C. To produce the natural fermented flours (UNF and PNF), another two portions (peeled and unpeeled) of sliced potato were immersed into a 5 L tap water in a plastic container and then enclosed for 72 h natural fermentation. Similar to the natural fermented potato, corn-steep water fermented potato flours (UCF and PCF) were prepared by immersing peeled or unpeeled potato chips into 5 L corn steep water (water obtained from 72 h steeping of corn used in making *ogi;* a fermented corn product) enclosed in a plastic container and allowed for 72 h fermentation. At the end of the fermentation period, all fermented samples were washed with water and dried in a cabinet drier at 60 ^{0}C. All the dried chips were milled into powder using attrition mill and sieved to obtain flour using 250 µm sieve. The resultant flours were packaged in a polythene bag, sealed and kept for further analysis.

Functional Properties

Swelling Index:

The swelling index was determined by the method described by Okaka and Potter (1977). Graduated cylinder (100 ml) was filled with the sample to 10 ml mark. The distilled water was added to give a total volume of 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and left to stand for a further 8 min. The volume occupied by the sample was taken after 8 min.

Swelling index = final vol. of suspension-initial vol. of suspension

Initial volume used

Bulk Density:

The method of Konak *et al.* (2002) as reported by Ngoma *et al*., 2019 was modified and used. Twenty grams (20 g) of the samples were weighed into 100 ml graduated cylinder and the cylinder was tapped until the contents were tightly packed and the final volumes used to calculate the bulk density.

$$\text{Bulk Density (g/ml)} = \frac{\text{Mass of sample}}{\text{Volume of sample after tapping}}$$

Water and Oil Absorption:

The method described by Onwuka (2005) was used to determine the water and oil absorption capacity. One gram (1 g) of the flour samples were poured into a centrifuge tubes and 10 ml of distilled water or oil (for determination of oil absorption capacity) was added. The centrifuge tubes containing the samples were shaken with the hand and allowed to stand at room temperature (25 ^{0}C) for 30 min. It was centrifuged for 30 min at 5000 X g. The excess water or oil was decanted by inverting the tubes.

$$\text{Water Absorption (\%)} = \frac{\text{ml of water absorbed x 100}}{\text{Weight of sample}}$$

$$\text{Oil Absorption (\%)} = \frac{\text{ml of oil absorbed x 100}}{\text{Weight of sample}}$$

Gelatinization Temperature:

To determine the gelatinization temperature, the method of Shinde (2001) was used as reported by Chandra and Smasher (2013). One-gram flour sample was weighed accurately in triplicate and transferred to 20 ml screw capped tubes. Ten ml of water was added to each sample. The samples were heated slowly in a water bath until they formed a solid gel. At the completion of gel formation, the respective temperature (^0C) was measured and taken as gelatinization temperature.

Determination of Wettability Time:

Wettability of the flour samples was determined according the method described by Onwuka (2005). One (1) gram of each of the flour samples was weighed using an analytical balance and were each added into a 25 ml graduated measuring cylinder with a diameter of 1 cm. The finger was then placed over the open end of the cylinder, inverted and clamped at a height of 10 cm from the surface of a 600 ml beaker containing 500 ml of distilled water. The finger was then removed and the test sample was allowed to drop into the water surface. The time (sec) required for the sample to become completely wet was recorded as the wettability time.

Determination of the pasting properties of potato flour:

The pasting properties were determined using the RVA (Rapid Visco Analyser) super 4 model by Newport Scientific Australia according to the method of Adebowale *et al*., (2008) modified. This equipment is widely used in the starch industry and measures stirred viscosity of starch suspensions subjected to time/ temperature protocols. The potato flour weighing 3g solids content (dry basis) based on this formula (3gx 100/100-moisture content of the potato flour) were measured in the canisters and deionized water was added to the sample and mixture made up to 28g. The mixture was inserted into the RVA tower and then lowered into the system while rotating the canister at a speed of 160 rpm with continuous stirring of the content with a plastic paddle. A 13 min analysis protocol was used and it consists of heating the slurry from starting temperature of 50 °C to 95°C and then cooling back to 50 °C. Each of the sample was prepared and analyzed in triplicate and the results of pasting viscosities (peak, breakdown, setback and final), peak temperature and time were reported as mean values.

Statistical Analysis of Data:

All data reported are mean value and standard deviation of triplicate analysis. Data were analyzed using One-way ANOVA and mean separated with Tukey's HSD test to determine statistical significance ($P<0.05$) of data. The statistical analyses were carried out using IBM SPSS version 21 software.

RESULTS AND DISCUSSION

Functional Properties

Bulk Density:

The results of the functional properties of the flour from fermented and unfermented potato samples are shown in Table 1. The bulk density of the potato flours significantly ($P<0.05$) ranged from 0.67-0.77 g/ml. Lower bulk densities (0.69 and 0.67) were obtained from peeled corn steep water fermented potato (PCF) and unpeeled corn steep water fermented potato (UCF) while higher values (0.77 g/ml and 0.74 g/ml) were obtained from natural fermented potato flour. Similar value was recorded by Omoniyi *et al*. (2016) on fresh cream variety sweet potato while higher range of bulk densities (0.80-0.87g/ml) were reported by Ngoma *et al*., (2019) for different chemically pretreated potato. flour. Bulk density measures the heaviness of a flour sample. It is a property that determines the porosity of a product which influences the design of the packaging material and handling of flour (Ngoma *et al*., 2019). Flour with higher bulk density are less porous and contributes to additional weight during packaging

Table 1
The functional properties of fermented and unfermented sweet potato flour.

Samples	B.D (g/ml)	WAC (%)	OCA (%)	Wettability (sec)	G.T (^{0}C)	S. index (g/ml)
UUF	$0.71^c \pm 0.34$	$100.0^f \pm 0.92$	$110.0^f \pm 0.19$	$58.00^b \pm 0.27$	$58.00^b \pm 0.22$	$1.67^b \pm 0.01$
PUF	$0.70^c \pm 0.03$	$130.0^e \pm 0.15$	$120.0^e \pm 0.04$	$54.00^d \pm 0.14$	$59.00^a \pm 0.57$	$1.67^b \pm 0.21$
UNF	$0.77^a \pm 0.19$	$210.0^a \pm 0.18$	$200.0^a \pm 0.25$	$43.00^c \pm 0.08$	$59.00^a \pm 0.30$	$1.83^a \pm 0.17$
PNF	$0.74^b \pm 0.08$	$140.0^d \pm 0.33$	$180.0^b \pm 0.21$	$41.29^d \pm 0.29$	$58.00^b \pm 0.02$	$1.67^b \pm 0.02$
UCF	$0.69^d \pm 0.62$	$200.0^b \pm 0.20$	$160.0^c \pm 0.07$	$37.00^a \pm 0.53$	$59.00^a \pm 0.07$	$1.67^b \pm 0.41$
PCF	$0.67^e \pm 0.28$	$150.0^c \pm 0.42$	$140.0^d \pm 0.61$	$34.00^e \pm 0.37$	$59.00^a \pm 0.45$	$1.67^b \pm 0.13$

Mean values in the same column with the same superscripts are not significantly different@(P<0.05).
BD: Bulk density, WAC: Water absorption capacity, OCA: Oil absorption capacity, G.T: Gelatinisation temperature, S.index : Swelling index
UUF – Unpeeled, unfermented sweet potato
PUF – Peeled, unfermented potato
UNF – Unpeeled natural fermented potato
PNF – Peeled natural fermented potato
UCF – Unpeeled corn steep water fermented potato
PCF – Peeled, corn steep water fermented potato

Water Absorption Capacity (WAC):

The water absorption capacity of the flours was significant (P<0.05). It ranged from 100% in peeled unfermented potato (PUF) to 210% in UNF. The microbial degradation of the fibrous components of the unpeeled potato tubers during the natural fermentation seems to have facilitated the imbibition of water into the flour structures. Although WAC was calculated on percentage basis, but the values obtained if converted to ml/g would be similar to values (ml/g) reported by Ngoma *et al* (2019) on chemically treated white sweet potato. As fermentation decreases the fibrous components, the rate of water absorption would increase and more water will be entrapped within the material structure. Water absorption capacity is useful in improving yield, uniformity and shape to food products during processing (Osundahunsi *et al*., 2003).

Oil Absorption Capacity (OAC):

The oil absorption capacity of the flours differs significantly (P<0.05) due to the fermentation methods. It ranged from 110.00% (peeled unfermented potato flour) to 200.00% unpeeled natural fermented (UNF). Similarly, to water absorption capacity, natural fermentation contributed to an increase in OAC as more hydrophilic components were accessible to the oil. The flours from fermented potato can be an alternative where wheat flour is applied since the OAC values can be compared with wheat flour (146.00%) (Chandra and Samsher, 2013). Due to the high water and oil absorption capacity, flour from natural fermentation could be used as a binding agent. Flours of good oil absorption capacity are potentially useful in structural interaction in food specially in flavor retention, improvement of palatability and extension of shelf life particularly in bakery or meat products where fat absorption capacity is desired (Aremu *et al*., 2007).

Wettability Time:

Wettability time ranged from 34 sec to 58.00 sec. Peeling and fermentation enhances the water uptake and dispersibility which results to the lowest wettability time (34 sec) obtained after using corn steep water to ferment peeled potato. Probably, through peeling, some insoluble materials were reduced and the remaining insoluble material which may have adhered to the unpeeled potato were solubilised during fermentation to facilitate the flowability and surface wetting of material. The degree of wettability is determined by a force balance between adhesive and cohesive forces. This affirmed the lower wettability of the corn steep water fermented potato. In contrast, it was reported that ungerminated and fermented sorghum flour took longer time (84.9 sec) to wet in cold water than the germinated-fermented sorghum flour (71.10s). A result attributed to the changes (increase in total sugars) that took place during germination and fermentation of sorghum (Elkhalifa and Bernhardt, 2018). Generally, the determination of wettability time indicates the degree to which the flour is likely to possess instant characteristics during processing. The flour with the lowest time of wettability would dissolve faster in water faster and have a better texture in comminuted meats and baked products (Akinyede *et al.,* 2005).

Gelatinization Temperature:

Although the gelatinization temperature (58.00-59.00 ^{0}C) between fermented and unfermented potato flours varied with fermentation decreasing the gelatinization temperature but within fermented flours, fermentation process had no influence in the variation. Gelatinization temperature is the temperature at which gelatinization of starch take place (Sahay and Singh, 2006). The range obtained in the study relates with onset gelatinization temperature (51-63 ^{0}C) of South African *(Ndou)* sweet potato flour obtained with DSC (Ngoma *et al*., 2019).

Swelling Index (S.I):

The peeled corn steep water fermented potato (PCF), peeled (natural) fermented sample (PNF), unpeeled unfermented potato (UUT), unpeeled corn steep-water fermented (UCF) and peeled unfermented potato flour samples all have the same swelling index. (1.67). The highest value of swelling index (1.83) was obtained for unpeeled natural fermented sample (UNF). The influence of the fermentation methods in altering the cellular carbohydrates might be responsible for the increase in swelling index. The presence of the natural fermenting microorganisms (enzymatic reactions) and chemical substances may have increased the degradation of cell wall materials of sample UNF and increased starch access to water, hence the high swelling index. Swelling power is an evidence of interaction between the starch granule amorphous and crystalline structures. Higher swelling power is being detected in short period (72 h) fermented flour due to the lesser structural rigidity which facilitates swelling when heated in excess water. However, swelling of fermented starchy material may reduce if fermentation is being prolonged (96 h) due to formation of dextrin from amylopectin degradation (Yuliana *et al.,* 2018). Swelling power may follow a difference trend due to varieties of starchy materials and fermentation conditions. Ajayi *et al.*, (2016) observed reduction in swelling capacity of sweet potato flour after 48 h fermentation.

Pasting Properties:

The pasting properties (parameter and profile) which shows changes in the viscosities, gelatinisation time and temperature as the potato flour suspension was heated and cooled using the Rapid Visco Analyser (RVA) is presented in Table 1 and Figure 1. The pasting profile in Figure 1 is typical of potato and characterized by high peak followed by major breakdown.

Peak Viscosity:

The peak viscosity increases due to fermentation (Table 2). Fermentation of the potato with corn steep water (UCF) was more effective in increasing the peak viscosity to 4652 cP from 2081 cP in unpeeled-unfermented potato (UUF). Probably, the fermented flour samples may have a lesser structural rigidity in comparison to initial unfermented sweet potato flour and would be easier to swell when heated in excess water (Yuliana *et al*., 2018). Earlier, UCF recorded the highest water absorption capacity. Higher water absorption capacity enables starch granules to swell into higher viscosity when heated due to higher accessibility of starch to water during gelatinisation. In the absence of fermentation, the rigid non-starchy carbohydrate in the potato could delay water absorption into the granule. Depending on the enzymatic activities, fermentation may increase (Yuliana *et al*., 2018) or decrease (Ajayi *et al*., 2018) peak viscosity. But in this study, due to the increase (100%) in peak viscosity following fermentation (degradation of the rigid non-starchy carbohydrates), the fermentation process is being recommended as a sustainable technology for the production of potato flour.

Table 2
Effect of fermentation process on the pasting properties of potato flour.

Sample	Pasting temp (0C)	Peak viscosity (cP)	Trough viscosity (cP)	Break down (cP)	Final viscosity (cP)	Setback viscosity (cP)	Peak time (min)
UUF	$80.65^a \pm 0.07$	$2197^e \pm 42.20$	$1053^e \pm 39.09$	$1144^f \pm 95.40$	$1335^d \pm 71.05$	$282^d \pm 86.33$	$4.33^a \pm 0.04$
PUF	$80.7^a \pm 0.15$	$2081^f \pm 69.13$	$893^f \pm 22.16$	$1188^e \pm 38.03$	$1119^e \pm 83.03$	$226^e \pm 24.09$	$4.4^a \pm 0.16$
UNF	$79.1^a \pm 0.04$	$3625^d \pm 33.01$	$1993^d \pm 76.08$	$1632^c \pm 43.18$	$2703^c \pm 52.14$	$710^c \pm 70.24$	$4.87^a \pm 0.09$
PNF	$80.7^a \pm 0.10$	$3903^c \pm 28.16$	$2334^c \pm 63.35$	$1569^d \pm 25.34$	$3129^c \pm 61.27$	$795^b \pm 21.03$	$4.87^a \pm 0.03$
UCF	$80.75^a \pm 0.03$	$4652^a \pm 84.23$	$2570^a \pm 41.26$	$2082^a \pm 58.09$	$3396^a \pm 39.25$	$821^a \pm 57.21$	$4.73^a \pm 0.02$
PCF	$80.7^a \pm 0.05$	$4340^b \pm 29.05$	$2413^b \pm 48.19$	$1927^b \pm 44.06$	$3206^b \pm 63.07$	$793^b \pm 59.04$	$4.67^a \pm 0.01$

Mean values in the same column with the same superscripts are not significantly different at (P<0.05).

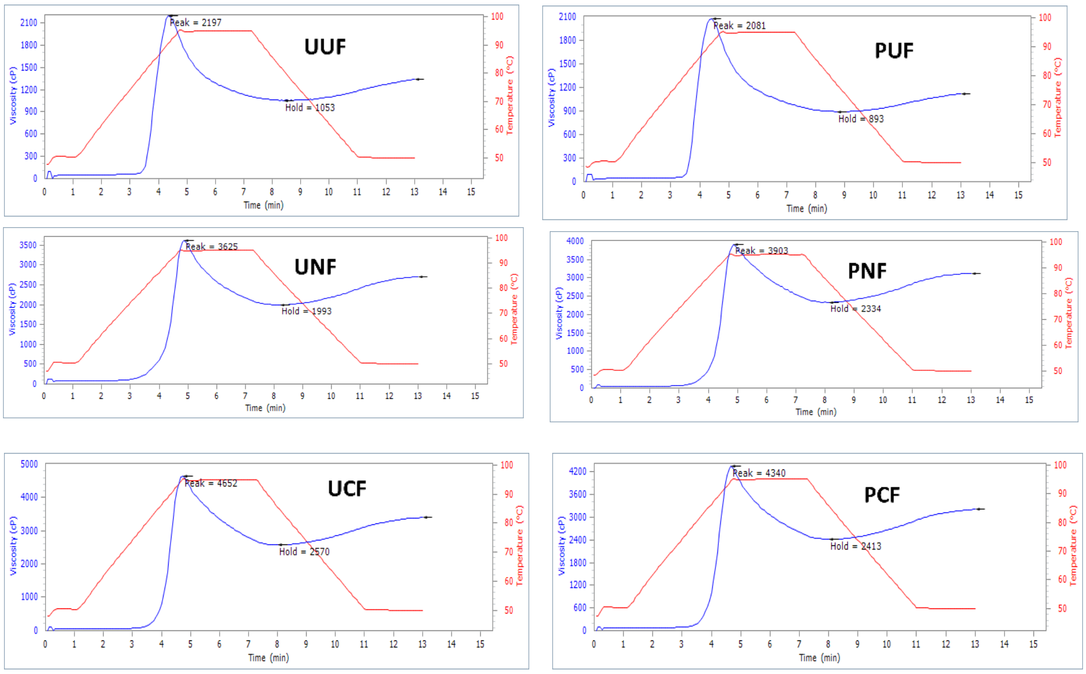

Fig. 1.Pasting curve of the fermented and unfermented potato

UUF – Unpeeled, unfermented sweet potato
PUF – Peeled, unfermented potato
UNF – Unpeeled natural fermented potato
PNF – Peeled natural fermented potato
UCF – Unpeeled corn steep water fermented potato
PCF – Peeled, corn steep water fermented potato

Breakdown Viscosity:

It is well known that the viscosity of starch suspension is affected by the magnitude of shear force. Thus, during mechanical shearing of the potato viscous paste, the disintegration of the swollen granules resulted in the breakdown (lowering) of viscosity. The breakdown viscosity of the potato paste followed this trend (UCF>PCF>UNF>PNF>PUF>UUF). This shows that UCF with the highest breakdown viscosity had paste which is more fragile to mechanical deformation. The stability of starch paste during cooking is much desired when starch is used as binding or thickening agent. Probably, these potato pastes (UCF, PCF, UNF, PNF) with high breakdown viscosity (low shear stability) would be required in non-Newtonian shear thinning food products such as tomato sauce (ketchup) where added starch thickeners with longest flow and shear thinning effect is desired (Juszczak *et al*., 2013). Non-waxy starches have been reported to stabilise oil in water (Kasprzak and Wolf, 2018). Still yet, starch material with low breakdown viscosity has some applications if the peak viscosity is low. It is most applicable in noodle production due to its heat and shear stability (Zhang *et al*., 2020).

Setback:

On cooling the gelatinised paste from 95 ^{0}C to 50 ^{0}C, a rapid development of gel structures occurred on the fermented samples. The changes in the paste viscosity at this stage of cooling was measured as the setback viscosity. Irrespective of the type of fermentation, setback viscosity (793-795 cP) did not vary among peeled fermented flours. The low setback (226-282 cP) of the unfermented potato confirms with the report on low setback of native potato starch. It has been stated that higher setback viscosity is an indication of starch with higher rate of retrogradation (Tortoe *et al.,* 2017).

Final Viscosity:

The strong setback that occurred in the fermented samples irrespective of the mode of fermentation caused an increase in the final viscosity. A higher final viscosity was expected in the fermented samples considering their initial higher peak viscosity. The trend (UCF>PCF>UNF>PNF) in the final viscosity was similar to the peak viscosity. Fermentation which had caused an increase in the peak viscosity due to the ease in the disruption of the starch granule most likely influenced the increase in the final viscosity. The interaction of starch chains (amylose and amylopectin) in the paste during cooling results to a more ordered structure and increase in gel firmness termed retrogradation (Hoover *et al*., 2010). During cooling, the viscosity stability of the fermented potato flour paste from viscous paste to gel offers potentials to use the flour at a lower dosage rate in sauce.

Pasting (Gelatinization) Temperature and Time:

The fermentation processes have no significant difference in both the pasting (gelatinization) temperature and time. Gelatinization temperature is the temperature at which gelatinization of starch take place (Sahay and Singh, 1996). Surprisingly that irrespective of fermentation, the pasting temperature (80 ^{0}C) which did not vary, was higher than gelatinization temperature (58.00-59.00 ^{0}C) measured during the determination of the functional properties. The differences in the temperature values could be attributed to the differences in analytical methods. However, the pasting temperature (80 ^{0}C) and time (4 min) conforms with sweet potato varieties from Nigeria (Odedeji and Adeleke, 2010; Ajayi *et al*., 2018) and Indonesia (Rauf *et al*., 2018). The non-significance of gelatinization and pasting time, may indicate that the enzymatic activities occurring during the fermentation process did not affect the starch crystalline structure or possibly, less proportions of starch were affected due to the fermentation conditions. Therefore, the earlier changes observed in the pasting viscosities could be attributed to the degraded non-starchy components which enhanced water absorption by the granule during gelatinization.

CONCLUSION

The significant difference in majority of the functional properties such as bulk density, water absorption capacity and oil absorption capacity, wettability time has shown that some structural changes occurred in the cellular structure of the potato during the different fermentation processes. Since starch dominates peeled potato, changes in starch composition and structure may have affected all the functional properties of peeled fermented potato. Due to the high values of water absorption capacity, oil absorption capacity and swelling index of flour from natural fermentation of unpeeled potato is highly recommended for use in the baking industries.

The high peak viscosity of PCF and UCF which is related to starch swelling and water absorption on heating was influenced by degradation of cellular non-starchy carbohydrate components during fermentation. The carbohydrate degradation increases starch access to water during pasting which increases the swelling and viscosity of fermented flours at the pasting (gelatinization) temperature. Although the unfermented samples shows low peak viscosity, but the low breakdown viscosity is advantageous in noodle production that requires high mechanical stable starch granule. Although fermentation did not alter the pasting time and temperature but it could be economical to consider the production of fermented potato flour which yielded higher peak viscosity at gelatinization. Due to the high soluble fibre content from degraded potato carbohydrate after fermentation, the use of unpeeled -fermented potato flour would ease the effects of cardiovascular and gastrointestinal diseases.

With the improvement in the functional and pasting viscosities, fermentation of peeled or unpeeled potato tubers with corn-steep water could be a sustainable technology in the production of potato flour.

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