Effect Of Processing Methods on the Quality Characteristics of Ogi From two Varieties of Millet

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Abstract
Ogi was produced from two varieties of millet (finger and pear millet) using three processing methods: dry milling, soaking and dry milling; and the traditional soaking, wet milling and wet sieving processes. Evaluation of physiochemical, functional, pasting, proximate and sensory properties of millet ogi samples was by standard analytical methods. Finger and pearl millet ogi had pH, total titratable acidity and viscosity of 4.22 - 5.29 and 3.88 – 5.32, 0.39 – 0.58 and 0.28 – 0.79 % Lactic acid and 138.40 – 145.80 and 8.36 – 11.81 Pa.s respectively. Bulk density, water absorption capacity and swelling power of the finger and pearl millet ogi ranged from 1.73 - 2.00 and 1.82 – 1.88 (g/ml), 1.80 – 2.00 and 1.50 – 1.80 g/g and 0.02 – 0.31 and 0.03 – 0.17 g/g respectively. Proximate composition varied respectively, from 2.75 – 7.50, 3.20 - 4.10, 6.16 - 9.71, 2.73 - 5.65, 1.57 - 3.96 and 70.28 - 79.85% for moisture, fat, protein, crude fibre, ash and carbohydrate for finger millet and 3.50 - 11.00, 6.00 - 9.10, 6.29 - 12.39, 2.08 - 3.15, 0.42 – 1.49 and 72.07 - 73.04% for pearl millet. Pasting properties for finger millet ogi ranged from 272.62 - 310.84, 131.04 - 202.87, 117.93 - 131.59 and 249.53 - 331.56 RVU for peak, trough, setback and final viscosities respectively while pearl millet ogi had values of 182.42 - 310.84, 23.55 - 121.34, 28.25 - 126.41 and 52.33 - 247.76 RVU. Pasting temperature and time were 80.05 - 93.70 and 78.19 - 81.10°C; and 5.08 - 5.69 and 4.07 - 4.26 min for finger and pearl millet ogi. Samples had varying degrees of likeness for the sensory attributes. Protein and energy ratios signified that 100 g of the millet ogi would meet >80 and >100% of infant protein and energy requirement respectively. The results are significant as a guide in utilizing millet as raw material for good quality ogi production.

Key words: *Ogi, finger and pearl millet, physicochemical, functional, pasting, proximate and sensory characteristics*

1. Introduction

Millet is a small-seeded grain often regarded as minor cereals belonging to the family *Poaceae* (*Gramineae*). (Zhu, 2014; Shobana *et al*., 2013). Millets are important source of nutrients and an indispensable food for millions of people in developing countries such as Africa (Mridula & Sharma, 2015). Millets are excellent source of carbohydrate (60 – 70%), rich in protein (1.5 – 5.5%), calcium, dietary fibre and polyphenols and contains other nutrients: fat, minerals like, manganese, phosphorus and iron Millet proteins are good source of essential amino acids, except lysine and threonine but are relatively high in Sulphur containing amino acids methionine and cysteine (Singh *et al*., 2012). According to Abah *et al.*, (2020), millet has different varieties: pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), kodo millet (*Paspalum setaceum*), proso millet (*Penicum miliaceum*), foxtail millet (*Setaria italic*), little millet (*Panicum sumatrense*), and barnyard millet (*Echinochloa utilis*). The cultivars are distinguished based on some morphological characteristics such as colour and grain shapes. The colour vary from brown, light brown to white. The white cultivars find useful application in the the baking industry, the brown and light brown types are useful for porridge while the brown cultivar is used in beer brewing (Abah *et al*., 2020). Finger millet (*Eleusine coracana* L.) is spherical in shape and can range from white to light brown or black in colour (Taylor & Emmambux 2008). Pearl millet has ovoid shape and may be creamy, pale yellow, brown, greyish brown, brown, slate blue, purple or purple black in colour. The most common is the slate grey colour (Tara *et al*., 2017). They are gluten-free grain with low-glycemic index with nutritional and nutraceutical advantages, that are commonly used in the preparation of a common infant complementary food called ogi.

Ogi is a wet starchy extract from cereal grains used majorly as an indigenous complementary food in Nigeria, when prepared as thin cereal gruel. It is also consumed by all classes of individual either as breakfast with some protein sources like beans pudding or cake or as snake food when made into a stiff gel called *akidi*. The wide range of acceptability was found to be attributed to its sensory qualities such as taste and mouth feel (John & Osita, 2012). It is commonly known as *pap* and called *Akamu* in South, *Ogi* in West and *Koko* in North. The preparation of millet ogi involves steeping clean grains in water at room temperature for 2 – 3 days, decanting of the steep water, washing with clean water, wet milling and sieving through a mesh, sedimentation of extracted starch, decanting and expression of excess water using a cotton bag.

Steeping or soaking is a very important step in ogi preparation. During this soaking stage, in addition to softening of the grains for milling, fermentation by microorganisms to take place for the production of the various components responsible for the ogi taste and flavour. The sedimentation period also allows for further fermentation and development of the sensory properties of the ogi. The ogi slurry is turned into pap by addition of boiling water with continuous stirring to obtain a lump free gelatinized pap (Obinna-Echem, 2017). Ogi slurry is often stored submerged in water that is decanted and replaced with clean water daily. This however does not give a good storage stability. The wet milling method has also been implicated in the loss of some nutrients, during the sieving process most soluble vitamins and some minerals are leached into the water. This may also be the case at storage during the daily decanting of water.

This has led to the consideration of other processing methods such as the dry milling of un-soaked grains, drying milling of grains after soaking and drying. Hence, the objective of this study was to determine the effect of processing methods on the quality of millet ogi.

2. Materials and methods

2.1 Millet Samples

Two varieties of millet: pearl millet (*Pennisetum glaucum* L. R. Br.) and finger millet (*Eleusine coracana*) was obtained from Mile III Market in Port Harcourt, Rivers State, Nigeria.

2.2 Chemical Reagents

All chemical reagents for the experiment were of analytical grade, obtained from the Biochemistry Laboratory, Department of Food Science and Technology, Rivers State University, Port Harcourt, Rivers State, Nigeria.

2.3 Preparation of Millet Ogi Samples

There different preparation method was used in preparation of the millet ogi. First was the conventional method where 500 of the millet after, cleaning to remove extraneous matters, washing with clean water was steeped in excess water for 24 h. Thereafter, the grains were washed, wet milled and sieved with water using a muslin cloth. The pomace was discarded and the extract allowed to sediment. After 18 - 24 h of sedimentation, the water was decanted, the slurry was transferred into a cotton bag and more water expressed to have the ogi cake from the conventional wet milling process. The second method was the dry milling without soaking. The millet after cleaning was washed, dried at 50^{o}C for 18 h, dry milled and sieved with 250µm sieve size to obtain fine powder. The third method was the dry milling after soaking. The grains were soaked in water for 24 h, washed, dried at 50^{o}C for 18 h, dry milled and sieved with 250µm sieve size to obtain fine powder.

2.4 Determination of pH, Titratable acidity and Viscosity of the millet ogi

pH, titratable acidity (as % lactic acid) and viscosity was determined using AOAC, (2012) standard method. The samples (2 g) was homogenized in 20 mL of distilled water and filtered into a beaker. The pH meter (Jenco 6177) after calibration and stabilization with standard buffer of pH 4.0 and 7.0, was used to determine the sample pH. Thereafter, 3 drops of phenolphthalein were added as the indicator and the mixture was titrated against 0.1 M NaOH. Acidity was expressed as % lactic acid with each ml of the 0.1 M NaOH equivalent to 0.09 of lactic acid. Viscosity of the 10 g of Ogi slurry in 100 mL of distilled water was determined using Rotary Viscometer (NDJ-85, China).

2.4 Determination of the Proximate Composition and Energy value of the millet ogi samples

The moisture, crude protein, crude fibre, crude fat and total ash contents of samples were analysed using the method described by Association of Official Analytical Chemists (AOAC, 2012). Moisture was obtained gravimetrically after drying to a constant weight at 70^{o}C in a hot air oven (DHG 9140A). Fat was determined using soxhlet extraction method with ethyl ether. Kjeldahl method and a nitrogen conversion factor of 6.25 was used for crude protein determination. Ash content was determined gravimetrically after the incineration of the samples in a muffle Furnace (Model SXL) at 550^{o}C for 2 h. Enzymatic gravimetric method was utilized in the determination of crude fibre. Carbohydrate was calculated by difference {100 - (Crude protein + crude fibre + ash + fat)}. Energy values were obtained using Atwater factor of 4 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat.

2.5 Determination of the functional properties of the millet Ogi

2.5.1. Water Absorption Capacity

The method described by Elkhalifa *et al.*, (2005) was used to determine the water absorption capacity of the millet ogi samples. To 1 g of sample in a pre-weighed 15 mL centrifuge tubes, was added 10 ml of distilled water and thoroughly wetted using a vortex for 2 min. After 30 min of standing at room temperature the sample was centrifuged at 3000 rpm for 25 min at 20^{o}C. The supernatant was decanted and the centrifuge tube containing sediment weighed. Water absorption capacity (grams of water per gram of sample) was calculated by dividing the weight of sediment by the sample weight.

2.5.2. Bulk Density

Bulk density determination was by the method described by Kaur *et al.*, (2007). The samples 2.5 g was filled gently into a 10 ml graduated cylinders, the bottom of the cylinders was tapped gently on a laboratory bench until there was no more diminution of sample level at the 10 ml mark. The volume occupied by the sample was noted and the bulk density (g/ml) was expressed as weight of sample (g) divided by volume of sample (ml).

2.5.3. Swelling Power and Solubility Determination

Swelling power and solubility was determined according to the method described Aidoo *et a*l., (2022). The sample (1g) was mixed with 10 mL of distilled water in a centrifuge tube and heated to 85^{o}C and held for 30 min with continuous shaking. The heated suspension was centrifuged at 1000 x g for 15 min. Swelling capacity (g/g) was calculated by dividing the sediment weight with the sample weight. The soluble component in the supernatant after evaporation of water was used in the computation of solubility (%) by dividing the soluble component weight with the sample weight multiplied by 100.

2.6 Pasting properties

Pasting properties of the "Ogi" samples were determined using a Rapid Visco Analyzer (Model RVA-4; New Port Scientific Pty. Ltd, Warriewood, Australia). Three grammes (3g) of the flour samples were weighed into a dried empty canister; 25ml of distilled water was dispensed into the canister containing the sample. The mixture was thoroughly stirred and the canister was fitted into the RVA as per manufacturer's instructions. The slurry was heated from 50 to 90^{o}C with a holding time of 2mins followed by cooling to 50^{o}C with 2mins holding time. The rate of heating and cooling were at a constant rate of 11.25^{o}C min^{-1}. The pasting profile were determined with the aid of Thermocline for windows software connected to a computer.

2.7 Sensory Evaluation

Ogi porridge was prepared as described by Obinna-Echem, (2017) with some modifications. Briefly, the ogi powder was reconstituted to slurry with water (2:0.5 w/v) and made into porridge by the addition of equal amount of boiling water with continuous stirring until a lump free porridge was obtained. Twenty member panelists made up of staff and students of the Department of Food Science and Technology, Rivers State University who are regular consumers of ogi were selected for the sensory evaluation. The samples were evaluated for colour, aroma, taste, sourness, mouthful (smoothness) and overall acceptability. Each attribute was rated on a 9-point hedonic scale where: 1 = dislike extremely, 2 = dislike very much, 3 = dislike slightly, 4 = dislike moderately, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = liked very much, 9 = liked extremely (Iwe, 2010).

2.8 Statistical Analysis

Data obtained for all the analysis carried out was subjected to statistical analysis using minitab (Release 18.1) statistical software English (Minitab Ltd. Conventry, UK). Statistical differences and relationship among variables were evaluated by analysis of variance under general linear model and Turkey pairwise comparison at 95% confidence level.

3. Results and Discussion

3.1 Effect of Processing Methods on the Physicochemical Properties of two Varieties of Millet Ogi

The physicochemical properties of the millet ogi from the two varieties are shown in Table 1. For the finger millet ogi, pH, TTA and viscosity ranged from 4.22 - 5.29, 0.39 – 0.58 % Lactic acid and 138.40 – 145.80 p.sc respectively 3.88 – 5.32, 0.28 – 0.79 % Lactic acid and 8.36 – 11.81 P.sc respectively for the pearl millet ogi. There were significant (P<0.05) differences between the control samples produced using the conventional soaking, wet milling and wet sieving method and the other methods. The conventional ogi for both varieties had significantly (P<0.05) the lowest pH and the highest TTA. The decrease in pH and increase in TTA of the conventional ogi is attributed to the fermentation process during the soaking and sedimentation steps. The result of the samples that were soaked before drying and dry milling and the control indicated that the activities of the fermenting microorganisms was more at the sedimentation period. The souring or acidification of ogi is an important and desirable quality attribute responsible for product stability and flavour development of ogi (Bolaji *et al*., 2014). The viscosity of the pearl millet ogi was significantly (P<0.05) lower than that of the finger millet. The viscosity of the control for finger millet was the highest while there was no significant difference (P>0.05) in the viscosity of the pearl millet ogi. Viscosity is the resistance to flow, it is often referred to as thickness of a fluid. The values obtained are higher than the report of 1.79 Pa.s by Bolaji *et al*.,(2014) for ogi from maize at 80^0C. Lower viscosity is good for a nutrient dense yet less viscous porridge for infant feeding and the production of ogi from pearl millet will be desirable for such in line with its low viscosity.

Table 1. Effect of Processing Methods on the Physicochemical Properties of two Varieties of Millet Ogi

Varieties	Sample Codes	pH	TTA (%Lactic acid)	Viscosity (Pa.s)
Finger millet	**OFd**	$5.28^a \pm 0.03$	$0.39^c \pm 0.01$	$138.60^b \pm 0.14$
	OFs	$5.29^a \pm 0.01$	$0.39^c \pm 0.02$	$138.40^b \pm 0.29$
	OFw (Control)	$4.22^c \pm 0.01$	$0.58^b \pm 0.00$	$145.80^a \pm 0.71$
Pearl millet	**OPd**	$5.32^a \pm 0.02$	$0.28^d \pm 0.02$	$11.81^c \pm 2.51$
	OPs	$4.79^b \pm 0.01$	$0.59^b \pm 0.02$	$8.36^c \pm 0.13$
	OPw (Control)	$3.88^d \pm 0.01$	$0.79^a \pm 0.01$	$8.49^c \pm 0.01$

Values are means ± standard deviation of duplicate samples
Means that do not share a letter are significantly (p<0.05) different.
OFd = Ogi from dry milled finger millet

OFs = Ogi from soaked and dry milled finger millet
OFw = Ogi from soaked, wet milled and wet sieved finger millet
OPd = Ogi from dry milled pearl millet
OPs = Ogi from soaked and dry milled pearl millet
OPw = Ogi from soaked, wet milled and wet sieved pearl millet

3.2 Effect of Processing Methods on the Functional Properties of two Varieties of Millet Ogi
Table 2, shows the functional properties of the millet ogi samples. Functional properties are important physicochemical properties of foods, that describes how ingredients behaves during preparation and cooking, and reflects how they affect the finished product in terms of its sensory properties (Appearance, taste, texture, mouthfeels etc.) (Pawase *et al*., 2021). It may also affect the concentration of some nutrients.

The result for the bulk density respectively, varied from 1.73 - 2.00 and 1.82 – 1.88 (g/ml) for the finger and pearl millet ogi samples. There was no significant difference (P>0.05) in the bulk density of the samples except for the finger millet control sample with the least bulk density value. Bulk density has been reported to be a function of the starch content. The higher the starch content, the more likely the increase in bulk density (Iwe *et al.*, 2016). Low bulk density is a desirable factor in food formulation especially food with less retro degradation (Oladele &Aina, 2009) and for complementary foods like ogi that is usually diluted with excess water to reduce bulk. Although, high bulk density is a good physical attribute when determining the mixing quality of a particular matter (Chukwu *et al.*, 2018) and may imply nutrient concentration.

Water absorption capacity of the samples ranged from 1.80 – 2.00 and 1.50 – 1.80 g/g for the finger and pearl millet respectively. There was no significant difference (P>0.05) in the water absorption capacity of the samples irrespective of variety. Similar result was reported by Pawase *et al., (*2021) (1.54 - 1.86 g/g) for the water absorption capacity of different varieties of pearl millet. Water absorption is required in food formulations especially slurry based foods, and is important in consistency and bulking of food products (Iwe *et al.*, 2016). High water absorption is important for increased digestibility which is desirable for infants though; it easy absorption of water can lead to spoilage.

Swelling power of the samples varied significantly (P<0.05) and the values ranged from 0.02 – 0.31 and 0.03 – 0.17 g/g for the ogi from finger and pearl millet respectively. The control samples had the lowest swelling power. This result is comparable to the report (0.84 g/g) by Jude-Ojei *et al., (*2017). Swelling power of a food is an indication of the extent of associative forces within the granules (Adebowale *et al.*, 2012).

Table 2. Effect of Processing Methods on the Functional Properties of two Varieties of Millet Ogi

Varieties	Sample Codes	Bulk density (g/ml)	Water absorption Capacity (g/g)	Swelling power (g/g)
Finger millet	**OFd**	$1.95^{a}\pm0.05$	$1.80^{a}\pm0.28$	$0.11^{b}\pm0.02$
	OFs	$2.00^{a}\pm0.01$	$2.20^{a}\pm0.28$	$0.31^{a}\pm0.03$
	OFw (Control)	$1.73^{b}\pm0.11$	$2.00^{a}\pm0.00$	$0.02^{d}\pm0.00$
Pearl millet	**OPd**	$1.87^{a}\pm0.01$	$1.80^{a}\pm0.00$	$0.06^{d}\pm0.01$

OPs	$1.88^{a}\pm0.03$	$1.50^{a}\pm0.42$	$0.17^{b}\pm0.02$
OPw (Control)	$1.82^{a}\pm0.02$	$1.70^{a}\pm0.42$	$0.03^{d}\pm0.02$

Values are means ± standard deviation of duplicate samples
Means that do not share a letter are significantly (p<0.05) different.
OFd = Ogi from dry milled finger millet
OFs = Ogi from soaked and dry milled finger millet
OFw = Ogi from soaked, wet milled and wet sieved finger millet
OPd = Ogi from dry milled pearl millet
OPs = Ogi from soaked and dry milled pearl millet
OPw = Ogi from soaked, wet milled and wet sieved pearl millet

3.3 Effect of Processing Methods on the Proximate Composition of two Varieties of Millet Ogi

Table 4 presents the proximate and energy values of the millet ogi samples. Moisture content is the measure of the amount of water present in food product, it ranged from 2.75 – 7.50% in finger millet ogi and 3.50 - 11.00% in the pearl millet ogi samples. Moisture content of the samples were significantly different (P<0.05). The control sample of (OFw) the finger millet and the soaked and dried milled pearl millet (OPs) sample had the least moisture contents. The moisture content is indicative of the level of processing as well as shelf life stability of the products. The lower the moisture contents of all the ogi samples, the better the shelf stability (Sanni *et al*., 2008).

Fat content of the samples varied significantly (P<0.05) from 3.20 - 4.10 and 6.00 - 9.10% for the finger and pearl millet ogi samples. These values are higher than the report for maize ogi (Obinna-Echem *et al.*, 2014). This implies that the samples will be free from oxidative rancidity-spoilage associated with high fatty foods, thus the samples would have extended shelf life.

Table 3. Effect of Processing Methods on the Proximate Composition (%) and Energy values (Kcal/100g) of two Varieties of Millet Ogi

Varieties	**Sample Codes**	Moisture	Ash	Crude protein	Fat	Crude fibre	Carbohydrate	Energy
Finger millet	**OFd**	$7.50^{b}\pm0.71$	$3.49^{b}\pm0.14$	$9.71^{b}\pm0.18$	$3.40^{c}\pm0.28$	$5.65^{a}\pm0.07$	$70.28^{c}\pm1.27$	$350.54^{c}\pm1.84$
	OFs	$7.50^{b}\pm1.41$	$3.96^{a}\pm0.03$	$6.16^{c}\pm0.08$	$3.20^{c}\pm0.28$	$3.25^{b}\pm0.36$	$75.92^{a}\pm1.54$	$357.12^{c}\pm8.37$
	OFw (Control)	$2.75^{c}\pm1.77$	$1.57^{c}\pm0.04$	$9.02^{b}\pm0.43$	$4.10^{c}\pm0.42$	$2.73^{c}\pm0.11$	$79.85^{a}\pm1.05$	$392.34^{b}\pm9.76$
Pearl millet	**OPd**	$11.00^{a}\pm0.71$	$1.49^{c}\pm0.01$	$6.29^{c}\pm0.27$	$6.00^{b}\pm0.28$	$3.15^{b}\pm0.07$	$72.07^{b}\pm0.79$	$367.42^{c}\pm1.67$
	OPs	$3.50^{c}\pm1.41$	$1.02^{d}\pm0.03$	$12.39^{a}\pm0.27$	$9.10^{a}\pm0.71$	$2.72^{c}\pm0.12$	$71.28^{b}\pm1.76$	$416.56^{a}\pm1.75$
	OPw (Control)	$7.50^{b}\pm0.71$	$0.42^{e}\pm0.11$	$9.16^{b}\pm0.06$	$6.30^{b}\pm0.14$	$2.08^{d}\pm0.03$	$73.04^{b}\pm1.25$	$385.50^{b}\pm6.02$

Values are means ± standard deviation of duplicate samples
Means that do not share a letter are significantly (p<0.05) different.
OFd = Ogi from dry milled finger millet
OFs = Ogi from soaked and dry milled finger millet
OFw = Ogi from soaked, wet milled and wet sieved finger millet
OPd = Ogi from dry milled pearl millet
OPs = Ogi from soaked and dry milled pearl millet
OPw = Ogi from soaked, wet milled and wet sieved pearl millet

Protein content of millet ogi ranged from 6.16 - 9.71 and 6.29 - 12.39% for the finger and pearl millet ogi respectively. The ogi sample (OFd) from dry milling process had the highest protein content for the finger millet ogi while the sample (OPs) from the soaking and drying milling process had the highest for the pearl millet ogi. These results are comparable with the report of the protein content of millet ogi (4.12 - 7.92%) by Oyarekua & Eleyinmi (2004). According to a Joint WHO/FAO/UNUExpert Consultation report (WHO, 2007). The daily protein energy requirements for an infant of 6 months old male and female involved in moderate physical activity is 1.12 g/Kg body weight respectively. For an infant male and female weighing 7.8 and 7.2 respectively, they will require 8.06 g/Kg body weight of protein per day. The protein content of100 g of the millet ogi will meet about 90 -142 and 83 -131% of the protein requirement of infant male and female respectively. This commendable for a popular complementary food in the face of malnutrition amongst infants.

The crude fibre content of all the samples showed a significant (P<0.05) difference from 2.73 - 5.65 and 2.08 - 3.15% respectively for the finger and pearl millet The control samples (OFw and OPw) had the least fibre content and the samples from dry milling process had the least. Foods with more fiber are important for easy passage of waste by expanding the inside walls of the colon, make an effective anti-constipation, lowered cholesterol level in the blood and reduce the risk of various cancers (Wardlaw & Kessel, 2002). However, emphasis has been placed on the importance of keeping fiber intake low in the nutrition of infants and weaning children because high fiber levels in weaning diet can lead to irritation of the gut mucosa (Bello *et al*., 2008).

Ash is the residue after burning all organic components in food sample and this consist of the inorganic components in form of salts or oxides AOAC, (2012). Increase in ash content is an indication of an increase in the mineral content of the product (Adeleke & Odedeji, 2010). Ash content of the millet ogi samples ranged from 1.57 - 3.96 and 0.42 – 1.49% respectively for the finger and pearl millet ogi samples. This was higher than the value (0.20 – 0. 40%) reported for traditionally processed akamu from different locations in Port Harcourt Rivers State (Obinna-Echem *et al*., 2014). The ash content of the finger millet ogi was significantly (P<0.05) higher than those of pearl millet ogi samples. The control samples of both varieties had the lowest ash content which is an indication of low mineral content in the ogi processed using the traditional soaking, wet milling and wet sieving process. The same challenge of loss of nutrient content from the traditional process.

The carbohydrate content ranged from 70.28 - 79.85 and 72.07 - 73.04% for the finger and pearl millet ogi respectively. The variation in the samples may be attributed to the production process as well as the variations in other nutrient content as the carbohydrate was obtained by difference. The results are higher than values of 66.90 – 68.80% reported for pearl millet (Pawase *et al*., 2021) but lower than the carbohydrate content of 76.57 – 84.05 % for millet ogi (Pikuda & Ilelaboye, 2013). The energy value of the finger millet ogi ranged from 350.54 - 392.34 kcal/100g while that of the pearl millet ogi ranged from 367.42 - 416.56 kcal/100g. The protein, fat and carbohydrate content of the ogi contributed to the energy values of the samples and are responsible for the variations. The energy values of the samples are comparable to results from a similar work carried out by Emelike *et al.,* (2020) on ogi product. The daily energy requirements for a 6 month old male and female involved in moderate physical activity is 335 and 340 kJ/Kg body weight respectively (WHO, 2007). An infant weighing 7.8 and 7.2 for the male and female will require 2448 and 2613 KJ of energy per day. The energy content of 100 g the millet ogi would meet 150 – 179 and 140 – 167% of the energy need of the infant male and female respectively. This value makes millet ogi a better raw material for complementary food for infants. For adults weighing 50 Kg and aged 18 - 29, the energy requirement for the male and female involved in moderate activities is 212 and 108 KJ/Kg body weight. The millet ogi will meet about 61 -72 and 52 - 61% of the energy requirement for adult male and female respectively. This makes the millet ogi a good energy meal for adults too.

3.4 Effect of Processing Methods on the Pasting Properties of two Varieties of Millet Ogi

The pasting properties of millet ogi are shown in Table 3. Peak viscosity of the samples varied significantly (P<0.05) from 272.62 - 310.84 and 182.42 - 310.84 RVU respectively for the finger and pearl millet ogi. The control sample had the highest peak viscosity while the sample from the dry milling process had the least for each variety. Peak viscosity reflects the water binding capacity of the starch grains and the flimsiness of swollen granules i.e. the ability of the starch to swell freely before their physical breakdown (Obinna-Echem, 2017). According to Balagoplan *et al.,* (2008); Ikeagwu *et al.,* (2010) peak viscosity also indicates the ease of cooking of the starch fraction. The implication is that the control and the sample from soaking before dry milling process would cook easily than the samples from the dry milling process.

Trough viscosity of the samples varied significantly (P<0.05) with values in the range of 131.04 - 202.87 and 23.55 - 121.34 RVU for the samples from the finger and pearl millet respectively. The control had the highest trough value while samples from the soaking before drying milling process had the least. The ability of the starch to withstand breakdown during cooling is shown by its trough viscosity. The result indicated that the control samples will withstand breakdown on cooling than the other samples. This could be attributed to the changes in the starch during the soaking and fermentation stages of the control sample. Similar trend was recorded for the setback viscosity (117.93 - 131.59 and 28.25 -126.41 RVU) and final viscosity (249.53 - 331.56 and 52.33 - 247.76 RVU) for finger and pearl millet. Setback viscosity is related to the degree of polymerization of the amylose fraction leached during swelling (Chung *et al*., 2003) and the final viscosity indicates the ability of the raw material to form gel after cooking and cooling (Obinna-Echem & Ogbuagha, 2023). The control sample therefore has more gelling ability than the product of the dry milling process with the least setback and final viscosity, and would maintain the consistency desirable by consumers of ogi.

Pasting temperature is the minimum temperature required for the samples to cook and form gel, while the pasting time indicates the required time for the cooking and gelatinization. There was no significant difference ($P<0.05$) in the pasting time of the finger millet ogi (5.08 - 5.69 min) and the pearl millet ogi (4.07 - 4.26 min), while the pasting temperature varied from 80.05 - 93.70^oC for the finger millet ogi to 78.19 - 81.10^oC for the pearl millet ogi. This signifies that the samples will cook at different temperatures with no significant difference in the time it will take to cook. The results from this study are significant as a guide for the cooking quality index in ogi from different processing methods and varieties of the grains.

Table 4. Effect of Processing Methods on the Pasting Properties of two Varieties of Millet Ogi

Varieties	Sample Codes	Peak (RVU)	Trough (RVU)	Breakdown (RVU)	Final viscosity (RVU)	Set back viscosity (RVU)	Peak time (min)	Pasting Temperature ℃
Finger millet	**OFd**	266.41^{c}±0.72	178.12^{b}±1.36	86.84^{d}±1.41	311.18^{b}±0.69	131.59^{a}±1.40	5.69^{a}±0.25	93.50^{a}±1.27
	OFs	266.13^{c}±1.46	131.04^{c}±0.76	134.58^{b}±1.41	249.53^{c}±1.38	117.93^{c}±1.40	5.08^{a}±0.08	80.05^{b}±0.99
	OFw (Control)	272.62^{b}±1.36	202.87^{a}±1.48	68.64^{e}±1.46	331.56^{a}±1.32	127.68^{b}±1.27	5.85^{a}±0.60	93.70^{a}±1.41
Pearl millet	**OPd**	182.42^{d}±1.41	49.73^{e}±1.45	131.68^{b}±1.40	136.76^{d}±1.40	86.05^{d}±1.34	4.26^{a}±0.09	78.68^{b}±0.67
	OPs	122.73^{e}±1.32	23.55^{f}±1.33	98.21^{c}±1.36	52.33^{e}±1.31	28.25^{e}±0.71	4.07^{a}±0.09	78.19^{b}±1.36
	OPw (Control)	310.84^{a}±0.69	121.34^{d}±0.69	188.53^{a}±1.38	247.76^{c}±1.39	126.41^{b}±0.72	3.98^{a}±1.35	81.10^{b}±0.78

Values are means ± standard deviation of duplicate samples
Means that do not share a letter are significantly ($p<0.05$) different.
OFd = Ogi from dry milled finger millet
OFs = Ogi from soaked and dry milled finger millet
OFw = Ogi from soaked, wet milled and wet sieved finger millet
OPd = Ogi from dry milled pearl millet
OPs = Ogi from soaked and dry milled pearl millet
OPw = Ogi from soaked, wet milled and wet sieved pearl millet

3.5 Effect of Processing Methods on the Sensory Properties of two Varieties of Millet Ogi
The assessor's degree of likeness of the sensory attributes of the millet ogi is shown in Figure 1.

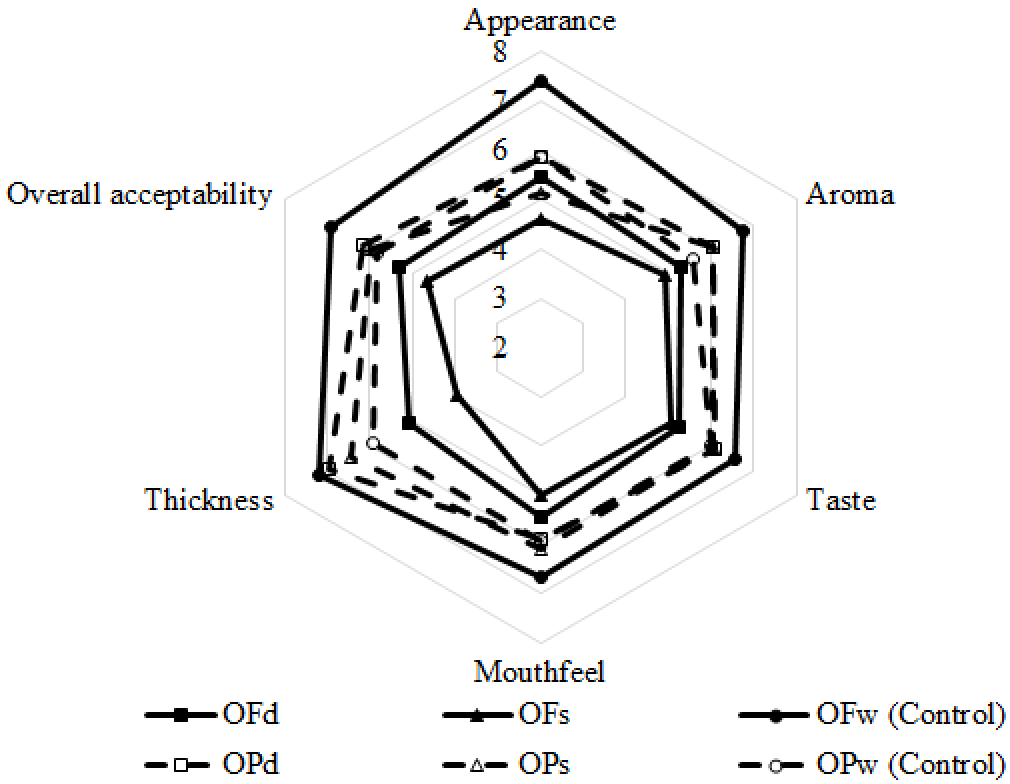

Figure 1. Effect of Processing Methods on the Sensory Properties of two Varieties of Millet Ogi

OFd = Ogi from dry milled finger millet
OFs = Ogi from soaked and dry milled finger millet
OFw = Ogi from soaked, wet milled and wet sieved finger millet
OPd = Ogi from dry milled pearl millet
OPs = Ogi from soaked and dry milled pearl millet
OPw = Ogi from soaked, wet milled and wet sieved pearl millet

There was significant ($P<0.05$) variation in the degree of likeness of the sensory attributes of the ogi samples from the two varieties of millet. The aroma, appearance, taste, mouthfeel, thickness and overall acceptability of the finger millet ogi ranged from 4.95 - 6.75, 4.60 - 7.40, 5.05 - 6.55, 3.95 - 7.20 and 4.66 - 6.88 respectively. The values indicated disliked moderately, disliked slightly, neither liked nor disliked, liked slightly and liked moderately. In each case, the sample from the traditional processing (OFw) had the highest degree of likeness while ogi samples from the soaking and dry milling process (OFs) had the least degree of likeness. The pearl millet ogi samples had varying degrees of likeness in the range of 5.60 - 6.05, 5.15 - 5.85, 6.00 - 6.10, 5.90 - 6.10, 5.90 - 6.95 and 5.81 - 6.16 for respectively, for aroma, appearance, taste, mouthfeel, thickness and overall acceptability. These values represented neither liked nor disliked to liked slightly. The traditionally processed samples (OPw) had the least degree of likeness for aroma, taste, thickness and overall acceptability but had the highest degree of likeness for only appearance. Sample OPs that was soaked and dry milled had the highest degree of likeness for aroma, taste, and mouthfeel but had the least for appearance. Sample OPd that was process by dry mill had the least degree of likeness for thickness and overall acceptability but the least for mouthfeel. Sensory analysis is an important criterion for assessing quality of new products in meeting the desired or stated needs of consumer regarding the product. The various samples had varying degrees of likeness for the attributes by the assessors. the millet ogi prepared following the traditional method had highest degree of overall acceptability for the finger millet ogi and the least degree of overall likeness for the pearl millet. The range of degree of likeness of the finger millet ogi was wider from disliked moderately to liked moderately while that of the finger millet ogi was between neither liked nor disliked and liked slightly. Regardless of the method of production and the variety, the assessors liked the samples to varying degrees and samples from the pearl millet could be said to have better degree of likeness in general.

4. Conclusion

The result from this study has shown that pH and titratable acidity of the millet ogi produced using the traditional soaking, wet milling and wet sieving reflected the acidity required for the sourness of ogi. Ogi produced from pearl millet had the lowest viscosities that is desirable for nutrient dense yet less viscous for infant feeding. The functional and pasting properties indicated the cooking qualities of the samples. The ability to form gel at a given temperature and time and be able to withstand breakage on cooling. High bulk density and peak viscosity implied increased nutrient density with easy of cooking. The control and the sample from soaking before dry milling process would cook easily than the samples from the dry milling process. Finger millet samples had higher pasting viscosities than the pearl millet. The proximate composition revealed higher nutrient content in the dry milling, soaking and dry milling process indicating the loss of nutrient in the traditional process. All samples had varying degrees of likeness for the sensory attributes, though pearl millet ogi had better degree of likeness in general. The protein and energy ratios signified that 100 g of the millet ogi would meet >80 and >100% of the protein and energy requirement respectively, useful in combating protein- energy malnutrition. This information is relevant in utilizing millet as raw material for good quality ogi production.

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