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# Effects of Dehydration Temperature on the Proximate and Physicochemical Properties of Akamu powder (dried pap) from maize, sorghum and millet grains.

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## ABSTRACT

*This research was carried out to determine the effects of drying temperature on proximate composition and physicochemical properties of Akamu powder produced from maize, sorghum and millet grains, in an attempt to extend the shelf life, minimize nutrient losses and impaired functionality of the powders. The Akamu powder samples were obtained by traditional method of processing using three different grain types (maize, sorghum and millet), by cleaning, wet milling, fermenting, drying at different temperature (40$^{o}$C, 50$^{o}$C and 60$^{o}$C), milling, sieving and packaging. The Akamu samples were analysed of proximate composition and physicochemical properties. The fat and ash increases, the moisture and crude fiber decreases with increases in temperature in all samples. The carbohydrate content of maize sample increases while that of sorghum and millet decreases within 40-60$^{o}$C. The highest values of protein (12.50%), crude fiber (2.86%) and carbohydrate (73.85%) were recorded at 40$^{o}$C, and that of fat (6.50%) ash (2.62%) and lower value of (5.68%) moisture content was at 60$^{o}$C drying temperature. The physicochemical properties increased with increase in temperature for titratable acidity and viscosity, and decreases in pH, no difference was noticed in the colour parameter of L*, a* and b* in all the samples. The highest values of titratable acidity (1.15%), viscosity at 30$^{o}$C (3654cps), viscosity at 80$^{o}$C (3140cps), colour a* (10.25) and lowest (3.40) for pH were recorded at 60$^{o}$C, while that of colour L* (86.25) and b* (33.02) was at 40$^{o}$C drying temperature. Highest values of WAC (3.80g/g), SC (10.92%) and lower GT (70.00$^{o}$C) was at 60$^{o}$C while that of SI (12.25%) and bulk density (0.87g/ml) was at 40$^{o}$C drying temperature. The result of the proximate composition and physicochemical properties of the samples were significantly affected by drying temperature range of 40-60$^{o}$C. The best dehydration temperature for proximate composition is at 40$^{o}$C, while that of physicochemical properties is at 60$^{o}$C, thus recommended for processing of wet Akamu to Akamu powders.*

***Keywords:*** Akamu (pap), Dehydration temperature, cereals, proximate, functional and physicochemical properties.



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## I INTRODUCTION

Maize (*Zea mays L.*), ranks third globally in total production after wheat and rice (SARI, 2020). It is a valuable source of carbohydrates73%, 10% protein, 8% oil, energy 365 Kcal/100 g and 14% other components, including vitamins and minerals [1].

Sorghum (*Sorghum bicolor*) ranks as the fifth most significant cereal crop globally, following rice, wheat, corn, and barley (FAO, 2019).Sorghum grain, similar to other cereals, is a good source of protein8 -13%, 65-76% carbohydrates,2%fibre, 10% ash, fat 7.60%, soluble sugar 4.20%, reducing sugar 0.53% including vitamins, minerals and phytochemicals [2].

Millet (*Pennisetum americanum*) is a semi-arid region crop cultivated in dry areas with limited rainfall and can adapt to various agro-climatic conditions [3]. Millets is a cereal crop that contains 60–70% carbohydrates, 7–15% proteins, 5% fat, ash 2%, 2–7% crude fiber, vitamins, minerals which contains all the amino acids except lysine and threonine[4].

'Akamu' (pap) is a common indigenous cereal gruel, found mostly in southern Nigeria, typical produced by traditionally method from maize, sorghum or millet grains [5]. The use of different cereal grains in 'Akamu' production is to create product differences among consumers [6]. 'Akamu' is known as pap in English, Akamu in Igbo, Ogi in Yoruba and Koko in Hausa, in Nigerian local languages. Itcan be eaten alone or taken with milk, sugar, and 'moi-moi' [7]. Akamu is preferred among the elderly as a traditional breakfast cereal and a weaning food for infants [8]. It is a food for the poor due to its cost and availability [9]. Apart from this, it is a food choice for sick, and a milk stimulant for breastfeeding mothers [10]. 'Akamu' has surpassed its purpose and is now enjoyed across all age groups. Its general acceptance is attributed to its appealing sensory attributes, including taste and mouthfeel [7].

'Akamu' contain enough moisture to permit chemical reactions by indigenous enzymes and microorganisms [11]. Thus, resulting in short storage life under ambient conditions. Therefore, there is need to dehydrate the Akamu into powdered form. Moreover, dehydration can increase the shelf life, yet can devalue nutrients and impaired functionality [5] [12]. This makes dehydration a fundamental unit operation in Akamu powder processing.

However, dehydration temperature has been identified by many researchers as the major processing variable that could influence dried pap qualities [12] [13]. Many works have been done on the effect of drying temperature on ogi powder. The soaking and drying effect on the functional properties of ogi produce from some selected maize varieties, they found out that the drying temperature have noticeable effect on the functional properties studied (Bolaji *et al.*, 2014). The effects of process variables (soaking and drying temperature) on proximate composition of oven dried maize pap and they found out that 46$^{o}$C drying temperature was the optimized temperature for proximate composition of the ogi powder [14].

However, no work has been done on the effects of dehydration temperature on proximate and physicochemical properties of the 'Akamu' powder (powdered pap) produced from maize, sorghum and millet grains. Dehydration of Akamu into powdered form at appropriate drying temperature will produce Akamu with less bulky and more stable form. It will minimize nutrient losses and improved functionality, and produced products of suitable qualities.

## II MATERIALS AND METHODS

The three grain types- maize, sorghum and millet- were obtained from national cereal research institute Umuahia, Abia State, Nigeria. 2kg of each grain type were thoroughly cleaned. Each sample was soaked in water for 48 hours at room temperature. The water was changed every 24hours for each of the sample. Decanted and wet milled with attrition milling machine and filtered with agitator sieve. The water was squeezed out and dried in hot air food dehydrator each of the wet slurry at 40, 50 and 60 $^{o}$C, respectively. The dried samples were milled with Kenwood blender, sieved (212) and packaged for proximate composition and physicochemical properties.

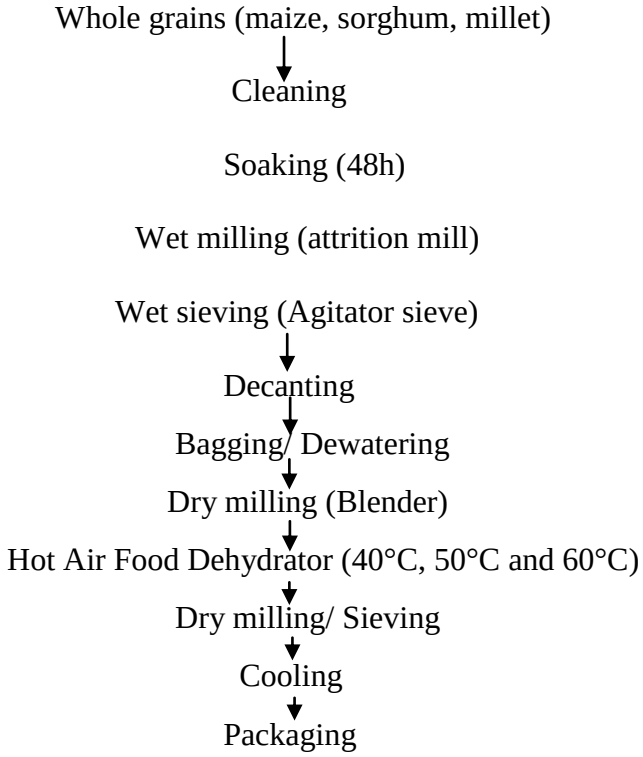



Figure 1. Flow chart for the production of '*Akamu'* powders.

**Determination of proximate composition of Akamu powder samples**

The proximate parameters (fat, crude protein, crude fibre, ash, moisture content) were determined using the methods of A.O.A.C (2010). Carbohydrate content was determined by difference 100-(%moisture+protein+fat+ash+fiber) and the protein content was determined using micro-Kjeldahl procedure and nitrogen conversion factor of 100/16 (N% x 6.25).

**Determination of physicochemical properties of Akamu powder samples**

The potential hydrogen ion (pH)was determined using a pH meter (model WPA CD70, India)and titratable acidity were determined by the method of [16].The colour of the Akamu samples was measured using a colour measuring instrument (Colour Tec-PCM, model SN 3000421, USA) and the values expressed on the L*, a*, and b* tristimulus scale [17].The viscosity of different Akamu powder samples were measured at controlled temperature of 80°C for hot paste and 30°C for the cold paste using a digital rotational Brookfield viscometer (Brookfield Viscometer DV-11+Pro, RVDV-11+P Model).

**Determination of functional properties of Akamu powder samples**

The bulk density, water absorption capacity, least gelation capacity and gelatinization temperature were determined as described by the method of [20]. The swelling capacity and solubility index was determined by the method of [18].

**Statistical Analysis**

The data obtained from this study were subjected to one way analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS) software, Duncan's multivariate test was used to determine the level of significance of variables at different temperatures at $p<0.05$.

## RESULTS AND DISCUSSION

### PROXIMATE COMPOSITION

The result of the proximate composition of Akamu powder samples at different dehydration temperature of 40$^{o}$C–60$^{o}$C are presented in table 3.1.

From the result in table 3.1, the moisture content of the samples decreased significantly ($p< 0.05$) in all temperatures from (10.00-7.72%) maize, (8.00-7.00%) sorghum and (6.41-5.68%) for millet powder. Lower values were recorded at 60$^{o}$C, this may be due to rapid evaporation of moisture, thereby lowering its moisture content. The millet powder had lower values in all temperatures, this entails better shelf stability than others. This is within the range of 12% recommended for long term storage for Akamu [13] [28].

The protein content of the samples was not significantly ($p>0.05$) affected by drying temperature of 40$^{o}$C-60$^{o}$C. The protein content decreased minimally with no noticeable difference from (10.58-10.56%), maize (11.84-11.82%) sorghum and (12.50-12.48%) millet powder. This implies that drying within 40$^{o}$C-60$^{o}$C does not have influence on the protein content of the samples. The values are within the range reported by [14] [19] [28].

The fat content of the samples increased significantly ($p<0.05$) in all temperatures, except that of maize at 40$^{o}$C and 50$^{o}$C. However, the fat content increased from (6.00-6.50%) maize (5.03-5.83%) sorghum and (4.10-4.60%) for millet powder. Higher values were recorded at 60$^{o}$C, this may be due to the breakdown of starch at higher temperature, making fat more available for extraction. The increases in values are in agreement with that of [14] [21].

The ash content of the samples increased significantly ($p<0.05$) in all temperatures, except for sorghum powder at 50$^{o}$C and 60$^{o}$C. Within 40$^{o}$C to 60$^{o}$C, the ash content increased from (0.68-1.30%) maize (2.22-2.62%) sorghum and (1.76-2.46%) millet powder. Higher values were recorded at 60$^{o}$C.this may be due to partial degradation of organic matter, leaving more organic residues (minerals). The increases in values are in agreement with that of [14] [22]. While that of fiber decreased minimally with no difference from (0.43-0.41%) maize, (2.86-2.83%) sorghum and (1.38-1.35%) millet powder. Sorghum were higher in all temperatures, may be due to grain composition differences [21].

The carbohydrate content of maize powder increased significantly ($p\leq 0.05$) from (72.31%-73.51%). The increase may be due the reduced moisture content, which concentrates the carbohydrate content. This collaborated with the report of [21] [23]. A contrary trend was found in sorghum and millet powders, which decreases significantly from (70.05 to 69.90%) sorghum and (73.85to 73.43%) millet, this may be due to gelatinization of starch at higher

temperatures. This showed that Akamu powder dried at 40 to 60°C will enhance the carbohydrate content of the powders. The decreases in values collaborated with that of [24].

**Table 3.1 The effect of dehydration temperature on proximate of Akamu samples**

| Grain Types | Drying Temperature °C | Moisture (%) | Protein (%) | Fat &Oil (%) | Ash (%) | Crude Fiber (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| **MZ** | 40 | $10.00^{a}\pm0.10$ | $10.58^{a}\pm0.10$ | $6.00^{b}\pm0.08$ | $0.68^{c}\pm0.01$ | $0.43^{a}\pm0.01$ | $72.31^{bc}\pm1.71$ |
| | 50 | $8.38^{b}\pm0.12$ | $10.57^{a}\pm0.09$ | $6.37^{b}\pm0.08$ | $1.08^{b}\pm0.00$ | $0.41^{a}\pm0.01$ | $73.19^{b}\pm1.75$ |
| | 60 | $7.72^{c}\pm0.13$ | $10.56^{a}\pm0.10$ | $6.50^{a}\pm0.09$ | $1.30^{a}\pm0.02$ | $0.41^{a}\pm0.00$ | $73.51^{a}\pm1.82$ |
| **SG** | 40 | $8.00^{b}\pm0.06$ | $11.84^{bc}\pm0.11$ | $5.03^{bc}\pm0.08$ | $2.22^{d}\pm0.12$ | $2.86^{b}\pm0.10$ | $70.05^{bc}\pm1.60$ |
| | 50 | $7.50^{c}\pm0.05$ | $11.83^{bc}\pm0.10$ | $5.52^{c}\pm0.07$ | $2.62^{bc}\pm0.00$ | $2.84^{b}\pm0.09$ | $69.69^{c}\pm1.63$ |
| | 60 | $7.00^{bc}\pm0.03$ | $11.82^{bc}\pm0.10$ | $5.83^{b}\pm0.06$ | $2.62^{bc}\pm0.00$ | $2.83^{b}\pm0.09$ | $69.90^{b}\pm1.65$ |
| **MLT** | 40 | $6.41^{bc}\pm0.05$ | $12.50^{c}\pm0.12$ | $4.10^{c}\pm0.00$ | $1.76^{c}\pm0.09$ | $1.38^{bc}\pm0.11$ | $73.85^{b}\pm1.66$ |
| | 50 | $6.14^{b}\pm0.03$ | $12.49^{c}\pm0.11$ | $4.40^{cd}\pm0.01$ | $2.16^{b}\pm0.10$ | $1.36^{bc}\pm0.11$ | $73.45^{c}\pm1.74$ |
| | 60 | $5.68^{a}\pm0.04$ | $12.48^{c}\pm0.11$ | $4.60^{b}\pm0.02$ | $2.46^{a}\pm0.09$ | $1.35^{bc}\pm0.11$ | $73.43^{c}\pm1.75$ |

Values are mean ±standard deviation of the triplicates. Means in the same column bearing different subscript differed significantly ($p<0.05$).
Key MZ-maize, SG- sorghum and MLT-millet.

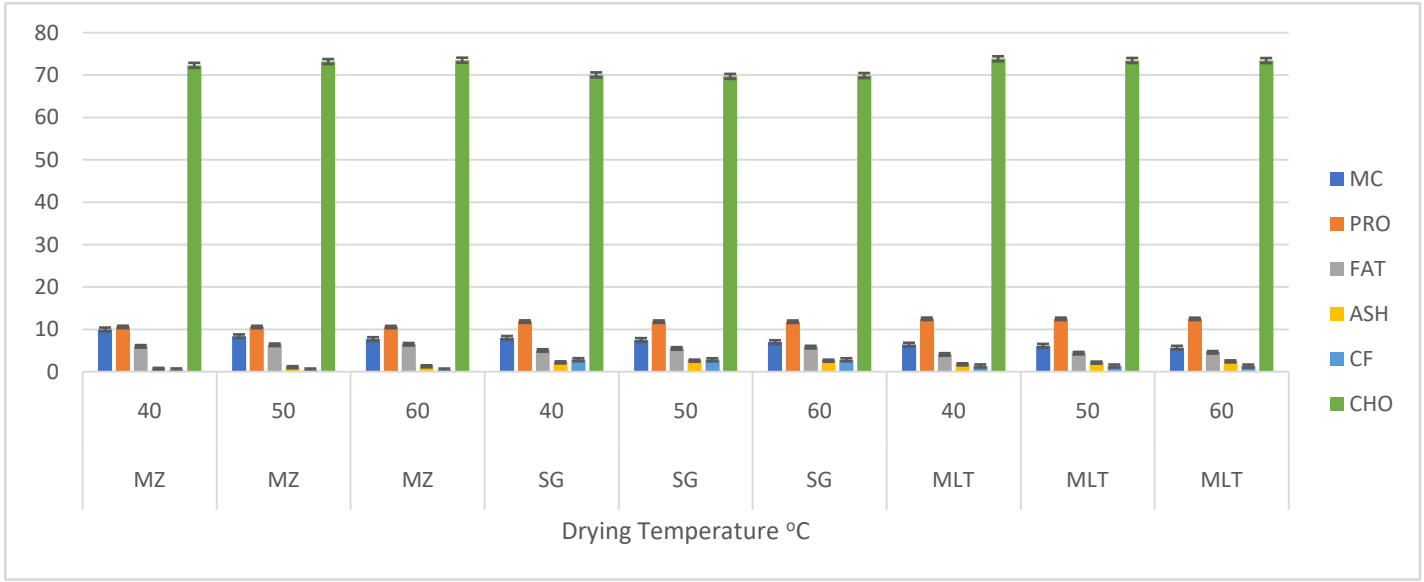



**Figure 2. Proximate composition of the Akamu samples at different drying temperature (°C)**

## PHYSICOCHEMICAL PROPERTIES

The physicochemical properties of the Akamu samples at different drying temperatures are presented in Table 2.

The pH of the samples decreases significantly ($p<0.05$) from (4.50-4.00) maize (3.70-3.42) sorghum and (3.50-3.40) millet powder. This may be due to the breakdown of organic acids during drying. The lower pH values are found at 60°C, means better shelf life. They are lower

than the recommended pH of less than 4.6 for better shelf life. The decreases are in agreement with that of [13]. The titratable acidity of the samples increases significantly from (0.79-0.89%) maize (1.00-1.10%) sorghum and (1.08-1.15%) for millet powder, it may be due to the breakdown of acids which increases the acidity and producing Akamu with sour taste. Higher values are recorded at 60$^{o}$C, which implies better shelf life than others. They are within the recommended value of 0.79-1.20% [25].

The hot and cold paste viscosity of maize powder increased significantly ($p<0.05$) from (2550-3140cps) at 80$^{o}$C and (3132-3654cps) at 30$^{o}$C. Higher values were recorded at 60$^{o}$C. This may be due to enhanced starch modification, making them more prone to gelatinization during heating. The increases are in agreement with that of [12] [13]. Contrary trend was observed for both sorghum and millet, which decreased significantly ($p<0.05$). Higher values of (1505 and 1400cps) at 80$^{o}$C and (2174 and 1950cps) at 30$^{o}$C were recorded at 40$^{o}$C for both sorghum and millet samples. The decreases may be due to partial gelatinization of starch at higher temperatures. The decreases are in agreement with that of [12] [13].

The result revealed no significant differences ($p>0.05$) in the degree of L*, a* and b* within 40-60$^{o}$C drying temperature for all the samples. However, the samples decrease minimally in values for both L* and b* and increases minimally for a* within 40-60$^{o}$C for all the samples. Higher L* values of (86.25-85.19) were recorded for maize in all temperatures, this may be due to its natural grain colour. Higher a* values of (10.10-10.25) were recorded for sorghum, this entails higher amount of anthocyanins content than others. While maize had the highest b*values of (33.02-32.54), this entails higher carotenoid content than others. The values are within the range reported by [13] [26] [27].

**Table 3.2. Effect of dehydration temperature on physicochemical properties of Akamu samples.**

| Grain Types | Drying Temp oC | pH | Titratable Acidity (%) | Viscosity 80$^{o}$C (cps) | Viscosity 30$^{o}$C (cps) | Colour L* | Colour a* | Colour b* |
|---|---|---|---|---|---|---|---|---|
| **MZ** | 40 | 4.50$^{a}$±0.09 | 0.79$^{c}$±0.01 | 2550.00$^{c}$±20 | 3132.00$^{c}$±35 | 86.25$^{a}$±1.52 | 4.53$^{bc}$±0.04 | 33.02$^{a}$±0.13 |
| | 50 | 4.30$^{ab}$±0.08 | 0.82$^{bc}$±0.02 | 2578.33$^{b}$±29 | 3261.67$^{b}$±24 | 85.22$^{a}$±1.44 | 4.56$^{bc}$±0.08 | 32.55$^{a}$±0.15 |
| | 60 | 4.00$^{c}$±0.08 | 0.89$^{a}$±0.02 | 3140.33$^{a}$±30 | 3654.00$^{a}$±30 | 85.19$^{a}$±1.30 | 4.58$^{bc}$±0.10 | 32.54$^{a}$±0.14 |
| **SG** | 40 | 3.70$^{a}$±0.10 | 1.00$^{bc}$±0.02 | 1505.00$^{c}$±6.50 | 2174.05$^{b}$±10 | 82.50$^{bc}$±1.12 | 10.10$^{c}$±0.09 | 15.20$^{bc}$±0.09 |
| | 50 | 3.43$^{bc}$±0.09 | 1.04$^{b}$±0.03 | 1461.20$^{bc}$±6.51 | 1985.00$^{cd}$±16 | 82.49$^{bc}$±1.14 | 10.20$^{c}$±0.09 | 15.15$^{bc}$±0.08 |
| | 60 | 3.42$^{c}$±0.08 | 1.10$^{a}$±0.02 | 1410.25$^{b}$±6.52 | 1977.01$^{c}$±11 | 82.47$^{bc}$±1.15 | 10.25$^{c}$±0.10 | 15.10$^{bc}$±0.07 |
| **MLT** | 40 | 3.50$^{b}$±0.11 | 1.08$^{c}$±0.01 | 1400.00$^{a}$±5.00 | 1950.00$^{a}$±15 | 64.93$^{b}$±1.31 | 1.16$^{a}$±0.01 | 2.90$^{c}$±0.00 |
| | 50 | 3.41$^{bc}$±0.09 | 1.14$^{b}$±0.02 | 1350.10$^{bc}$±5.05 | 1900.15$^{bc}$±13 | 64.64$^{b}$±1.30 | 1.17$^{a}$±0.01 | 2.87$^{c}$±0.01 |
| | 60 | 3.40$^{c}$±0.08 | 1.15$^{a}$±0.02 | 1300.00$^{c}$±4.75 | 1850.20$^{b}$±10 | 64.62$^{b}$±1.30 | 1.20$^{a}$±0.00 | 2.85$^{c}$±0.01 |

Values are mean ±standard deviation of the triplicates. Means in the same column bearing different subscript differed significantly ($p<0.05$).

**Table 3.3. Effect of dehydration temperature on functional properties of Akamu samples.**

| Grain Types | Drying Temp °C | Bulk Density (g/ml) | WAC (g/g) | Least Gelation Capacity% | Solubility Index (%) | Swelling Capacity (%) | Gelatinization Temperature (°C) |
|---|---|---|---|---|---|---|---|
| Maize | 40 | $0.87^{a}\pm0.03$ | $3.20^{bc}\pm0.13$ | $8.00^{a}\pm0.15$ | $12.25^{a}\pm0.24$ | $8.88^{c}\pm0.13$ | $71.10^{b}\pm1.71$ |
| | 50 | $0.87^{a}\pm0.03$ | $3.58^{b}\pm0.14$ | $8.00^{a}\pm0.14$ | $10.50^{b}\pm0.23$ | $9.55^{b}\pm0.12$ | $72.00^{a}\pm1.75$ |
| | 60 | $0.70^{b}\pm0.02$ | $3.80^{a}\pm0.12$ | $8.00^{a}\pm0.14$ | $10.00^{c}\pm0.22$ | $10.92^{a}\pm0.14$ | $70.00^{bc}\pm1.80$ |
| Sorghum | 40 | $0.73^{bc}\pm0.01$ | $2.37^{bc}\pm0.10$ | $8.00^{b}\pm0.15$ | $5.59^{a}\pm0.07$ | $5.50^{bc}\pm0.10$ | $74.00^{cd}\pm1.81$ |
| | 50 | $0.73^{bc}\pm0.01$ | $2.37^{bc}\pm0.10$ | $8.00^{b}\pm0.14$ | $5.00^{c}\pm0.08$ | $5.50^{bc}\pm0.10$ | $77.50^{a}\pm1.71$ |
| | 60 | $0.65^{c}\pm0.00$ | $2.75^{b}\pm0.12$ | $8.00^{b}\pm0.14$ | $5.36^{b}\pm0.09$ | $6.95^{a}\pm0.11$ | $76.00^{b}\pm1.41$ |
| Millet | 40 | $0.72^{cd}\pm0.00$ | $1.90^{b}\pm0.07$ | $6.00^{c}\pm0.11$ | $8.75^{b}\pm0.29$ | $5.00^{b}\pm0.17$ | $80.00^{b}\pm1.85$ |
| | 50 | $0.72^{cd}\pm0.01$ | $2.30^{a}\pm0.10$ | $6.00^{c}\pm0.11$ | $7.74^{cd}\pm0.27$ | $5.25^{a}\pm0.18$ | $82.50^{a}\pm1.90$ |
| | 60 | $0.61^{c}\pm0.01$ | $2.30^{a}\pm0.10$ | $6.00^{c}\pm0.10$ | $8.10^{c}\pm0.28$ | $5.25^{a}\pm0.18$ | $82.52^{a}\pm1.90$ |

Values are mean ±standard deviation of the triplicates. Means in the same column bearing different subscript differed significantly ($p<0.05$).

The functional properties of the Akamu powder samples at different drying temperature are presented in Table 3.3.

The bulk density of the samples decreased significantly ($p<0.05$) except that of maize, sorghum and millet at 40 and 50°C.The bulk density decreased from (0.87-0.70g/ml) maize (0.73-0.65g/ml) sorghum and (0.72-0.71g/ml) for millet powder. Higher values were recorded at 40 and 50°C for all the samples. The decreases may be due to more moisture loss that alters the compactness of the powders. Maize powder had higher values in all temperature, which indicates greater compactness than others. The decreases are in agreement with that of [12] [21] [28].

The water absorption capacity of the samples increased significantly ($p<0.05$) with increase in drying temperature except that of sorghum at 40 and 50°C and millet at 50 and 60°C. The values increased from (3.20-3.80g/g) maize (2.37-2.75g/g) sorghum and (1.90-2.30g/g) for millet powder. Higher values were recorded at 60°C for both maize and sorghum, while that of millet was at both 50 and 60°C. The increases may be due to more moisture loss, creating space for more water to be absorbed. Maize recorded higher values in all temperature, which implies thicker gruel than others. The increases are in agreement with that of [12] [28].

The least gelation capacity of the samples was not significantly ($p>0.05$) affected by drying temperature. Within 40-50°C, constant values of (8%) maize, (8%) sorghum and (6%) for millet were recorded. Millet powder was lower (6%) in all temperature. This may be due to the high level of protein in the powder. The lower the value, the better the gelling ability of proteins [29].

The solubility index of the samples was significantly ($p\leq 0.05$) affected by drying temperature. The solubility decreased from (12.25-10.00%) maize, (5.59-5.00%) sorghum and (8.75-7.74%) for millet powder. Higher values were recorded at 40°C, this may be due to more moisture loss. Whereas maize powder had higher values in all temperature, which entails better reconstitute power in water than others. The decreases are in agreement with the report of [12] [30].

The swelling capacity of the samples were significantly ($p<0.05$) affected by drying temperature, except that of sorghum at 40and 50$^{o}$C and millet at 50 and 60$^{o}$C. Within 40-60$^{o}$C, the swelling capacity increases from (8.88-10.92%) maize, (5.50-6.95%) sorghum and (5.00-5.25%) millet powder. Higher values were recorded at 60$^{o}$C for both maize and sorghum, while that of millet was at 50 and 60$^{o}$C. The observed increases with temperature, varies directly as water absorption capacity. Maize had higher values in all temperature, which indicates higher starch content. The increases are in agreement with the report of [12] [30].

The gelatinization temperature of the samples was significantly ($p<0.05$) affected by drying temperature except millet at 50 and 60$^{o}$C. Within 40-60$^{o}$C, the maize powder decreases from (72.00-70.00$^{o}$C). The sorghum increases from (74.00-77.50$^{o}$C) and millet (80-82.52$^{o}$C). Lower values were recorded at 60$^{o}$C for maize, this may be due to high water absorption capacity. While that of sorghum and millet was at 40$^{o}$C, may be due to low water absorption capacity. The lower values of maize powder in all temperatures means higher starch content, will require lesser energy to prepare the gruel and they will form paste of greater stability. The decreases and increases are in agreement with that of [13][28].

## CONCLUSION

The proximate composition of fat and ash increases with increase in drying temperature, the moisture and crude fiber decreases in all samples. The carbohydrate content of maize sample increases while that of sorghum and millet decreases within 40-60$^{o}$C. The physicochemical properties increased for titratable acidity and viscosity, and decreases in pH, no difference was noticed in the colour parameter of L*, a* and b* in all the samples. The result of the functional properties increases within 40-60$^{o}$C for water absorption capacity, swelling capacity and gelatinization temperature of maize, and decreases in solubility index and GT for sorghum and millet, while the density and LGC remains constant with drying temperatures, for all the samples. Grain types also had evident effect on the qualities, which were influenced by major components in Akamu powders.

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