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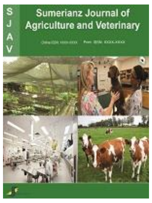

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The Effects of Steeping Temperature Variations on the Production of Pap (Akamu)

Egbe Ebiyeritei Wisdom
Agricultural and Environmental Engineering, Niger Delta University, Wilberforce Island Amassoma Bayelsa State
Email: ayibanoa4christ@yahoo.com

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Abstract

The effect of temperature variation on the nutritional quality of pap was studied using (AOCS) American Oil Chemists Standard Method. Pap ingredients were purchased from Amassoma ultramodern market, Bayelsa State. A thermometer was used to record an initial temperature of 80°C (Group A), 50°C (Group B) and 25°C a room temperature (Group C). After discarding the water, the cereal grains were carefully and independently cleaned with fresh water. An attrition mill was used to grind the wet grains, and the paste produced was mixed with 1000ml of purified water. A muslin cloth was used to filter the mixture's slurry. After allowing the filter to stand for a full day, the supernatant was disposed of. In order to allow additional water to drain off, the newly created pap was wrapped inside a muslin cloth and left to stand for the following 12 hours. The proximate composition of the pap was investigated at the varying steeping temperatures. From the result it shows that the proximate composition of pap can vary depending on the steeping temperature used, it shows that the moisture content ranged from 25.51-27-52%, protein ranged from 7.79%-8.15, fibre ranged from 2.16% – 2.24%, lipid content ranged from 8.22%–13.10%, carbohydrate ranged from 48.16% – 50.60% as the steeping temperatures increased from 25-100°C. The study revealed that the steeping temperatures had an impact on the pH, moisture, fiber, and carbohydrate contents of the papa samples, but not on the lipid, protein, mineral, or nitrogen contents, which stayed mostly unchanged. In order to preserve the nutritious value of the food, it is advised that pap be produced and steeped at a lower temperature.

Keywords: Pap; Nutritional quality; Temperature variation; Cereal grains; Proximate composition.

1. Introduction

A pap, which also known as ogi or akamu, is a traditional African porridge made from maize meal [1, 2]. Temperature plays a crucial role in the production process as it affects the gelatinization of starch in maize meal, which influences the final quality of the pap [3]. The production of pap involves mixing maize meal with water and steeping it over heat until it thickens into a smooth and creamy consistency. The temperature at which pap is steeped can have a significant impact on its final texture, taste, and nutritional content [4, 5].

Understanding the effect of temperature variation on the production of pap is essential for optimizing the production process and ensuring consistent quality. By controlling and monitoring temperature parameters, producers can achieve the desired texture, flavor, and nutritional content of pap [6-8].

A traditional Nigerian food known as "pap" is made from cornmeal, or maize flour, boiled with water until it takes on the consistency of thick porridge. It is frequently eaten as a side dish with meat, vegetables, or gravy and is a staple cuisine in many parts of Africa [3] and [9]. The production of pap involves a complex interplay of factors, with temperature being a critical variable in the fermentation process. However, there is a noticeable gap in scientific understanding regarding how variations in temperature influence the key parameters of pap production. Addressing these problems through systematic scientific inquiry is critical not only for the preservation and improvement of traditional pap production methods but also for informing modern approaches to ensure food safety, consistency, and nutritional value in this culturally significant food product. Conventionally, papa is made by immersing it in a bowl of water for a few days, then blending and producing it. However, this method does not reveal the nutritional makeup of the final product [10, 11].

Several studies have investigated the effect of temperature variation on the production of pap. For example, Adegunwa and Oyewole [6] found that higher steeping temperatures resulted in a faster gelatinization of starch, leading to a smoother and more homogeneous pap texture. On the other hand, lower steeping temperatures were associated with incomplete gelatinization, resulting in a lumpy and less palatable pap Adebowale and Sanni [12] & Olaoye, *et al.* [13]. In addition, Benard, *et al.* [14] explored the impact of temperature fluctuations during the fermentation process of pap production. The researchers observed that variations in fermentation temperature influenced the microbial activity and pH levels, affecting the overall quality and shelf life of the pap.

This study seeks to fill the existing gaps in knowledge and contribute valuable insights to the field of pap production. This research focused on investigating how steeping temperature variations such as a room, 50 and 100°C affect the nutritional production process of pap by determining the proximate analysis of the pap and to contribute to the scientific knowledge and understanding of the factors influencing the production of pap.

2. Material and Method

2.1. Materials

1000g each of fresh millet (*Panicum miliaceum)*, guinea corn (*Sorghum bicolor*) and yellow corn (*Zea mays*) was bought from a popular market named Tombia market situated in the capital city of Yenagoa Bayelsa State and was transport to processing laboratory in the department of Agricultural and Environmental Engineering, Faculty of Engineering, Niger Delta University Wilberforce Island Amassoma Bayelsa State for the production of pap. The proximate analysis was conducted at the chemistry Laboratory, Department of Chemical Sciences Niger Delta University, Bayelsa State. The following apparatus were used for the production of the pap/ogi,/akamu in the laboratory includes sample collectors (bucket), electronic grinders, water, and electronic weighing balance.

2.2. Experimental Procedure

A total weight of 700g guinea millet, yellow corn and 300g of millet were mixed together manually and was steeped with 5 litres of water. Thermometer was used to record an initial temperature of 80°C (Group A), 50°C (Group B) and 25°C a room temperature (Group C) for a day. After discarding the water, the cereal grain was carefully and independently cleaned with fresh water. An attrition mill was used to grind the wet grains and the paste produced was combined with 1000ml of purified water. A muslin cloth was used to filter the mixture's slurry. After allowing the filter to stand for a full day, the supernatant was disposed of. In order to allow additional water to drain off, the newly created pap was wrapped inside a muslin cloth and left to stand for the following 12 hours [15]. This was carried out consistently for all steeping temperature.

2.3. Determination of Proximate Composition

In proximate analysis, the following components were typically determined.

2.3.1. Moisture Content by Oven Drying Method

The apparatus used were Analytical-weighing balance, Moisture extraction oven, desiccator-containing desiccant, Moisture can and tongs. The moisture content in percentage was calculated using the formula [16, 17].

$$\%\text{Moisture content} = \frac{W_2-W_3}{W2_2-W_1} X \frac{100}{1} \qquad 1$$

Where: W_1 = Weight of empty dried moisture can.
W_2 = Weight of moisture can + sample before oven steeping.
W_3 = Weight of moisture can + sample after oven steeping.

2.3.2. Ash Content

The apparatus used were Muffle furnace, weighing balance, desiccator, long tongs and crucibles. The percentage ash content was calculated using the following formula according to Adeyeye and Afolabi [18]; Oke and Ogunlade [19] & Ogunleye and Oyewole [20]

$$\%\text{Ash} = \frac{W_3-W_1}{W_2-W_1} X \frac{100}{1} \qquad 2$$

Where: W_1 = Weight of empty dried crucible, W_2 = Weight of empty dried crucible + sample
W_3 = Weight of the empty dried crucible + ash

2.3.3. Crude Fibre

The apparatus used were, Weighing balance, oven, heating mantle, desiccator, Buckner funnel, muslin cloth, muffle furnace, crucible and beaker. The loss in weight on incineration was due to crude fibre (AOAC, 2005).

$$\%\text{Crude fibre} = \underline{W_1 - W_2} \text{ x } 100 = \frac{W_1-W_2}{1} \text{ X } 100 \qquad 3$$

Where: W 1 = Weight of dried residue and crucible before incineration.
W 2 = Weight of crucible and remains of residue after incineration.

3.3.4. Crude Fat

Soxhlet extraction, unit analytical weighing balance, extraction thimble, heating mantle were the apparatus used. The crude fat content was calculated using the formula [21].

$$\%\text{Crude fat} = \underline{F_2 - F_1 X 100} \qquad 4$$

Where F_2 = Weight of flask + fat

F_1 = Weight of flask
Weight of sample = W_2- W_1

3.3.5. Crude Protein

Apparatus**:** Kjeldahl digestion and distillation units, weighing balance and heating mantle, boiling chips and fume cupboard.

Reagent**:** Concentration H_2SO_4, 40% NaOH, 2% boric acid, mixed indicator, sodium sulphate (Na_2SO_4) and copper sulphate ($CuSO_4.5H_20$), the nitrogen content calculated using the formula [21]

$$\%Nitrogen = \frac{T-B\ X\ H_{HCL}X\ 0.00014\ X\ Volume\ made\ x\ 100}{Aliquot\ x\ mass\ of\ sample\ used} \quad 5$$

Where: T = Titre value of the sample, B = Blank titre value, N_{Hcl} = Normality of standard Hcl used. Aliquot = Sample aliquot volume taken out of the whole volume; Volume made = $100cm^3$

%Protein = %Nitrogen x protein conversion factor [21].

3.3. 6. Carbohydrate by Difference

In this method, carbohydrate content was obtained by calculation having estimated all the other fractions of the food by proximate analysis [21].

i.e:%Available carbohydrate = 100- (%Moisture + %Ash + %Protein + %Fiber + %Fat) **6**

3. Results and Discussion

3.1 Results

The mean values of proximate analysis of pap at different temperature's trend and results are presented in Table 1 and Appendix 1

Table-1. Proximal Composition of Pap

Sample Tag	pH	MC%	LpC%	FC%	PC %	CC%	M%	N%	Calorie Kcal/100g
100	4.33	25.51	13.1	2.16	7.79	48.16	3.28	1.25	342
	4.32	25.53	13.08	2.18	7.79	48.14	3.28	1.25	341
50	4.35	27.51	8.23	2.21	7.88	50.9	3.27	1.26	309
	4.34	27.53	8.23	2.2	7.86	50.92	3.26	1.26	309
Control (20°C)	4.78	27.52	8.23	2.23	8.14	50.6	3.28	1.3	309
	4.76	27.52	8.22	2.24	8.15	50.6	3.27	1.3	309

3.2. Discussions on the Proximate Composition of Pap at Steeping Temperatures

Pap is a traditional fermented cereal-based food commonly consumed in Nigeria and other West African countries [22]. It is made from maize, sorghum, or millet, and is a popular breakfast food due to its high nutritional value and easy digestibility. The fermentation process involved in the production of pap plays a crucial role in its nutritional composition, as it leads to the breakdown of complex nutrients into simpler forms that are more easily absorbed by the body [23].

Proximate composition analysis is an essential tool in determining the nutritional content of food products [11]. From table 1, the proximate composition of pap (also known as ogi or akamu) at different temperatures, specifically at 25, 50, and 100°C. The results obtained for pH, moisture content (MC%), lipid content (LpC%), fiber content (FC%), protein content (PC%), carbohydrate content (CC%), mineral content (M%), nitrogen content (N%), and calorie content in the table 1 above.

3.2.1. pH

The pH of a food product is an important indicator of its acidity or alkalinity [24]. From table 1 above, the pH of pap samples taken at 25, 50, and 100 degrees Celsius was found to be 4.78, 4.35, and 4.33, respectively as indicated in the table 1 above. The decrease in pH with increasing temperature can be attributed to the denaturation of proteins and the release of organic acids during the heating process. The pH of pap is slightly acidic, which is typical for fermented foods, this finding is in conformity with a study by Omale, *et al.* [25], they carried out a research effect of drying temperature on the nutritional quality of tiger nut.

3.2.2. Moisture Content

In the table 1 above, the moisture content (MC%) of pap samples at 25, 50, and 100 degrees Celsius was found to be 27.52%, 8.23%, and 13.1%, respectively. The decrease in moisture content with increasing temperature can be attributed to the evaporation of water during heating. The moisture content of pap is relatively high, which is typical for cereal-based foods, this obviously is due to the increase of the heat which enhanced the gaining of more kinetic energy, hence rapid escape of the water molecule from the nut. The result of the moisture content is in agreement with the findings of Onovo and Ogaraku [26] that carried out a research on the effects of temperature on the physicochemical properties of pap. ANOVA revealed there's no significant difference ($P \leq 0.05$) observed in the moisture content of the papa subjected to the different steeping temperature of 25°*C*, 50°*C* and 100°*C*.

3.2.3. The Lipid Content (LpC%)

From table 1, the lipid content (LpC%) of the pap samples steeped at 25, 50, and 100 degrees Celsius were 8.23%, 8.23%, and 13.1%, respectively. Lipids, or fats, are an important source of energy in the diet and play a role in the absorption of fat-soluble vitamins. In this case, the lipid content of the pap samples did not vary significantly with steeping temperature. The result of the lipid content is in agreement with the findings of Omale, *et al.* [25], they reported on a research effect of drying temperature on the nutritional quality of tiger nut.

3.2.4. Fiber Content (FC%)

The fiber content (FC%) of the pap samples steeped at 25, 50, and 100 degrees Celsius were 8.15%, 7.88%, and 2.16%, respectively. Fiber is an important component of the diet that aids in digestion and helps maintain a healthy gut. In this case, the fiber content of the pap samples decreased as the steeping temperature increased, with the sample steeped at 100 degrees Celsius having the lowest fiber content. The fibre content of the pap was significantly different at $P \leq 0.05$. The highest fibre content of 8.15% was observed at control experiment (room temperature) while the lowest fibre content of 2.61% was observed at 100*°C*. The fiber content was observed to decrease as the temperature increases; this is in line with the findings on the effects of heat treatments on dietary fibre Oyedele and Ogunnale [27], Adel, *et al.* [28] and Akinoso, *et al.* [29].

3.2.5. Protein Content (PC%)

The protein content (PC%) of the pap samples steeped at 25, 50, and 100 degrees Celsius were 8.15%, 7.88%, and 7.76%, respectively. Proteins are essential nutrients that are important for growth, repair, and maintenance of body tissues. In this case, the protein content of the pap samples did not vary significantly with steeping temperatures. It was shown that the pap's protein content level decreased with rising temperatures. The papa was heated to 100°C, which produced the maximum protein amount of 13.10%, while 50°C produced the lowest protein level of 8.23%. A significant difference at $P \leq 0.05$ was found by analysis of variance. As per the findings of [30], pap is a highly nutritious food item. However, our research indicates that heating it to a higher temperature significantly lowers its protein content. This is consistent with the findings of Miroslawact, *et al.* [31], who reported that applying heat causes the hydrophobic force to unzip, resulting in partial or total disruption of the primary, secondary, tertiary, or quaternary structure of protein molecules, which in turn lowers the protein content of the heated sample.

3.2.6. Carbohydrate Content (CC%)

The carbohydrate content (CC%) of the pap samples steeped at 25, 50, and 100 degrees Celsius were 50.6%, 7.88%, and 48.16%, respectively. Carbohydrates are the main source of energy in the diet and are important for fuelling the body's activities. In this case, the carbohydrate content of the pap samples varied significantly with steeping temperature, with the sample steeped at 25 degrees Celsius having the highest carbohydrate content. The decrease in carbohydrate content with increasing temperature can be attributed to the breakdown of carbohydrates during heating. Carbohydrates are the main source of energy for the body and play a crucial role in maintaining blood sugar levels, this finding is in similar with the research conducted by Maliki, *et al.* [32] they worked on Proximate analysis of selected agricultural materials for their nutritional potential.

3.2.7. Mineral Content (M%)

The mineral content (M%) of the pap samples steeped at 25, 50, and 100 degrees Celsius were 3.27%, 3.27%, and 3.28%, respectively. Minerals are essential nutrients that are important for various bodily functions, including bone health, muscle function, and nerve transmission. In this case, the mineral content of the pap samples did not vary significantly with steeping temperature. The result of the lipid content is in agreement with the findings of Omale, *et al.* [25], they reported on a research effect of drying temperature on the nutritional quality of tiger nut.

3.2.8. Nitrogen Content (N%)

The nitrogen content (N%) of pap samples at 25, 50, and 100 degrees Celsius was found to be 1.3%, 1.26%, and 1.25%, respectively. The nitrogen content of pap is relatively low, which is typical for cereal-based foods. Nitrogen is an essential nutrient that is a component of proteins and plays a crucial role in various bodily functions. The result of the lipid content is in agreement with the findings similar with the research conducted by Maliki, *et al.* [32] they worked on Proximate analysis of selected agricultural materials for their nutritional potential.

3.2.9. Calorie Content

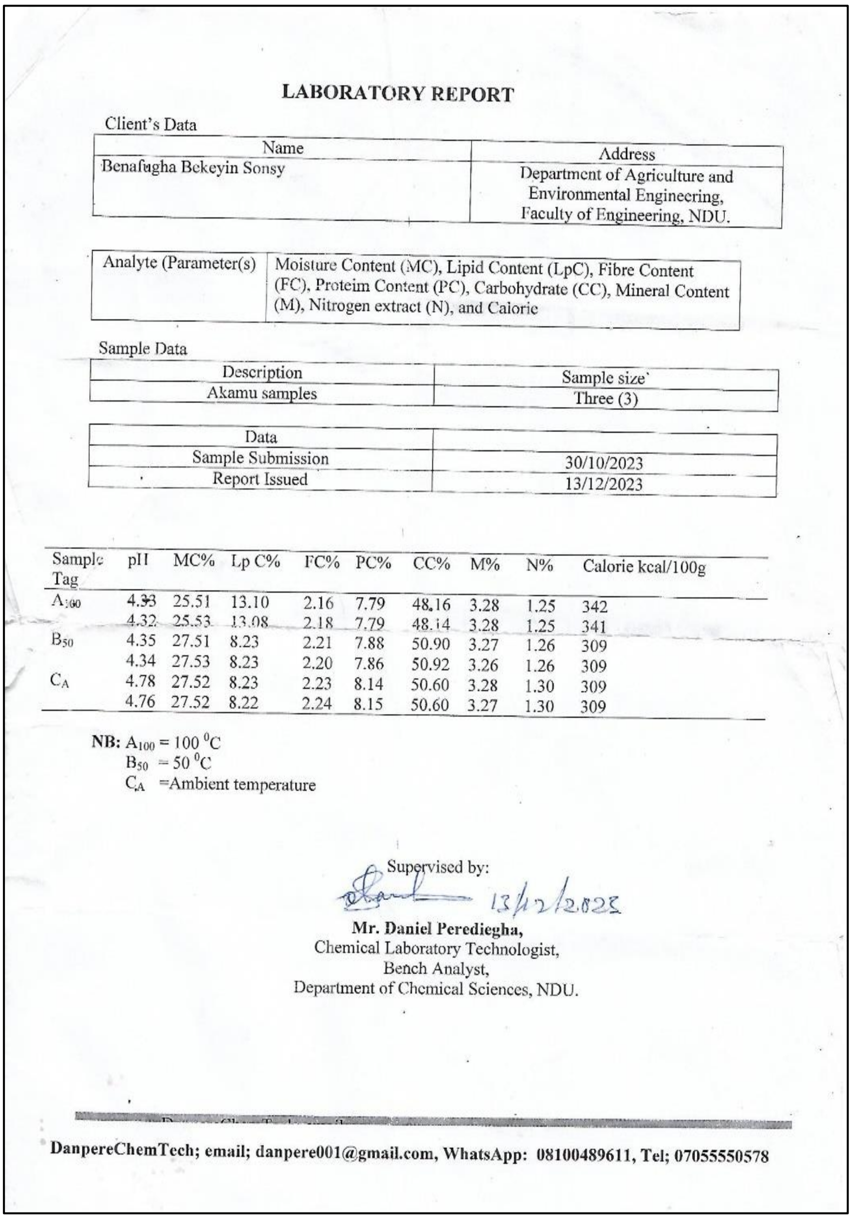
The calorie content of pap samples at 25, 50, and 100 degrees Celsius was found to be 309, 309, and 342, respectively. The increase in calorie content with increasing temperature can be attributed to the breakdown of nutrients during heating. Calories are a measure of the energy content of food and play a crucial role in maintaining energy balance in the body. The result of the lipid content is in agreement with the findings of Oyedele and Ogunnale [27]. They reported on a research The Effects of Drying Temperatures on some Physicochemical Properties of Extracted Tiger Nut.

4. Conclusion and Recommendation

4.1. Conclusion

The steeping temperatures had a significant impact on the proximate composition of the pap samples, affecting parameters such as moisture content, lipid content, fiber content, carbohydrate content, and calorie content. The results suggest that steeping temperatures plays a crucial role in determining the nutritional composition of pap. Ultimately, the study revealed that the steeping temperatures had an impact on the pH, moisture, fiber, and carbohydrate contents of the papa samples, but not on the lipid, protein, mineral, or nitrogen contents, which stayed mostly unchanged. In order to preserve the nutritious value of the food, it is advised that pap be produced and steeped at a lower temperature.

APPENDIX A



LABORATORY REPORT

Client's Data

Name	Address
Benafagha Bekeyin Sonsy	Department of Agriculture and Environmental Engineering, Faculty of Engineering, NDU.

Analyte (Parameter(s)	Moisture Content (MC), Lipid Content (LpC), Fibre Content (FC), Proteim Content (PC), Carbohydrate (CC), Mineral Content (M), Nitrogen extract (N), and Calorie

Sample Data

Description	Sample size
Akamu samples	Three (3)

Data	
Sample Submission	30/10/2023
Report Issued	13/12/2023

Sample Tag	pH	MC%	Lp C%	FC%	PC%	CC%	M%	N%	Calorie kcal/100g
A_{100}	4.33	25.51	13.10	2.16	7.79	48.16	3.28	1.25	342
	4.32	25.53	13.08	2.18	7.79	48.14	3.28	1.25	341
B_{50}	4.35	27.51	8.23	2.21	7.88	50.90	3.27	1.26	309
	4.34	27.53	8.23	2.20	7.86	50.92	3.26	1.26	309
C_A	4.78	27.52	8.23	2.23	8.14	50.60	3.28	1.30	309
	4.76	27.52	8.22	2.24	8.15	50.60	3.27	1.30	309

NB: $A_{100} = 100\ ^0C$
$B_{50} = 50\ ^0C$
C_A =Ambient temperature

Supervised by:

13/12/2023

Mr. Daniel Perediegha,
Chemical Laboratory Technologist,
Bench Analyst,
Department of Chemical Sciences, NDU.

DanpereChemTech; email; danpere001@gmail.com, WhatsApp: 08100489611, Tel; 07055550578

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