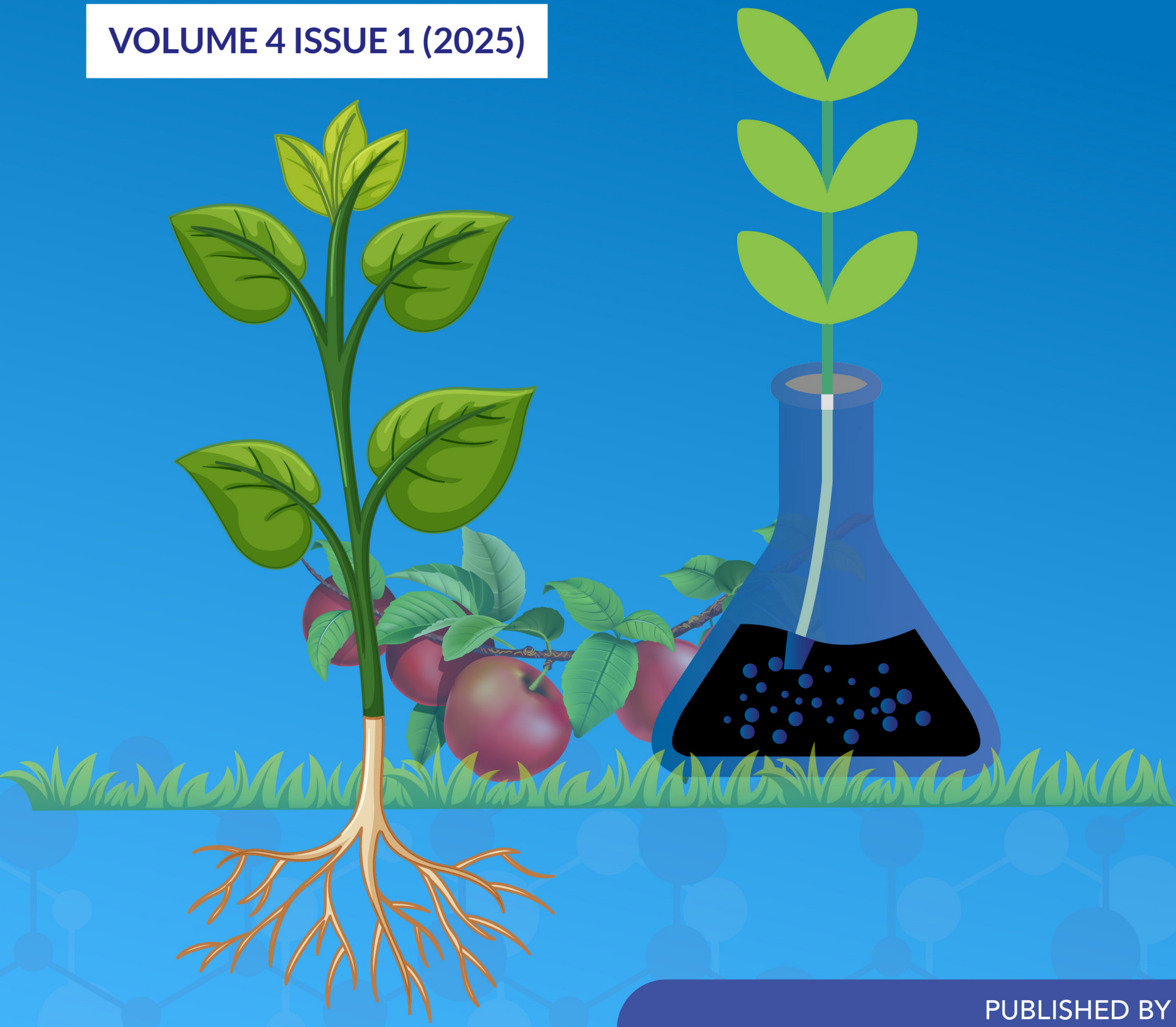
American Journal of Food Science and Technology (AJFST)

ISSN: 2834-0086 (ONLINE)

VOLUME 4 ISSUE 1 (2025)



PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of
Food Science and Technology (AJFST)

Volume 4 Issue 1, Year 2025
ISSN: 2834-0086 (Online)
DOI: https://doi.org/10.54536/ajfst.v4i1.3889
https://journals.e-palli.com/home/index.php/ajfst

Comparative Study on the Functional, Pasting and Physicochemical Properties of Native and Pregelatinized Cocoyam Starch (*Xanthosoma sagittifolium*)

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Article Information

Received: October 09, 2024

Accepted: November 12, 2024

Published: February 08, 2025

Keywords

Cocoyam, Modification, Pregelatinization, Pasting, Starch

ABSTRACT

This study sought to extract and modify cocoyam starch for industrial use, as it is an underutilized tuber in Nigeria. Pregelatinization was employed to change cocoyam starch, and the functional, physicochemical, and pasting properties and proximate composition were evaluated using standard methods. The results show that pregelatinization improved the starch's water absorption capacity (164.333-249.333%), oil absorption capacity (97-106.333%), bulk density (0732-0769g/ml), and solubility index (8.667-14.667%), but swelling power dropped (9.553-7.147g.g-1). Native cocoyam starch had the lowest gelation capacity (8%), while pregelatinized cocoyam starch had a gelation capacity of 6%. Native cocoyam starch outperformed pregelatinized cocoyam starch in terms of peak viscosity (3724.5-944.5 RVU), trough viscosity (3041-822 RVU), breakdown viscosity (683.5-162.5 RVU), and final viscosity (5516.5-1923 RVU). After pregelatinization, cocoyam starch had a higher pasting temperature (83.05-84.4°C) and peak time (5.03-7.0 min). The proximate composition indicates a small increase in carbohydrate and protein concentrations while moisture levels fall.

INTRODUCTION

Cocoyam is an underutilized tropical crop in Nigeria that is abundant in carbohydrates and surpasses other root and tuber crops in terms of protein and amino acid content (Obiegbuna *et al.*, 2014). Despite this, farming has remained at subsistence level, with the tubers used only for boiling or frying and as a thickening agent in some traditional soup recipes. (Ejoh *et al.*, 2013). Cocoyam consumption can be increased by using its high starch content for both food and non-food industries (Arinola, 2019). According to Ashogbon and Akintayo (2014), starch is a naturally occurring, biodegradable substance that is widely available. In addition to its various industrial uses as a thickener, stabilizer, gelling agent, encapsulating agent, bulking agent, water retention agent, and adhesive, starch also influences the texture of many meals (Singh *et al.*, 2003). Water insolubility, retrogradation, heat sensitivity, shear stress, and pH limit the use of native starch. By changing the shape of the starch granules, these restrictions of native starch can be lessened or abolished, leading to enhanced physicochemical qualities (Oladebeye *et al.*, 2013). In order to improve its suitability for use in food and other applications, modified starch undergoes physical or chemical changes. Desired characteristics that are absent from native starch can be obtained through modification; many functional elements, including gelation, water absorption capacity, and thermal stability, can be brought to acceptable levels (Yousif *et al.*, 2012; Okunade & Arinola, 2021). One physical starch modification technique that is easy, affordable, and safe with no adverse health effects is pregelatinization (Ashogbon & Akintayo, 2014; Majzoobi *et al.*, 2011). Because physical alteration doesn't change the structure of starch granules or generate hazardous waste, it is also chosen (Zavareze & Dias, 2011). According to Okunade and Arinola (2021), heat moisture treatment improved cocoyam starch's pasting qualities. By oxidation, acetylation, and pregelatinization, Olatidoye *et al.*, (2019) also enhanced the swelling and solubility of cocoyam starch. In order to gather information for upcoming starch applications in the food sector, the goal of this study is to extract cocoyam starch, pregelatinize it, and compare the physicochemical, pasting, and functional properties of unmodified and modified starches.

MATERIALS AND METHODS

Materials

Cocoyam (*Xanthosoma* sp) used for this research work was obtained from the International Institute of Tropical Agriculture, Moniya, Ibadan

Cocoyam Starch Extraction

With minor adjustments, the technique outlined by Arawande and Ashogbon, (2019) was used to extract starch from cocoyam. Cocoyam was peeled. sliced and milled using a milling machine. Distilled water was added to the finished slurry (1:4). After passing the mixture through a muslin bag, the starch suspension was allowed to settle overnight at 4°C. After the supernatant had cleared, the white starch sediment was allowed to settle and then decanted after being cleaned three or four times with distilled water. A standard blender was used to blend the separated starch after it had been dried in an oven set to 40°C. Before being used, the product was sieved, sealed in ziplock bags, and stored at room temperature (26 ± 2 °C).

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Cocoyam Starch Pregelatinization

The pregelatinization procedure described by Okunade and Arinola, (2021) was used. 150 ml of distilled water and a known weight (100g) of starch sample were heated in a water bath at 80°C for 15 minutes while being manually stirred intermittently with a stirring rod. A stainless steel tray was coated with a thin layer of pregelatinized starch, which was then dried for 24 hours at 40 degrees Celsius in the oven. After being processed, sieved, and packed in ziplock bags, this was kept at room temperature (26 ± 2°C) until it was needed.

Determination of Functional Properties

Water Absorption Capacity

This was determined using Onwuka's method (2005). One gram of sample was placed in a clean conical graduated centrifuge tube and aggressively agitated with 10 mL of distilled water using a mixer for 30 seconds. After 30 minutes at room temperature (28 ± 2 °C), the sample was centrifuged at 5000 rpm for 30 minutes. After centrifugation, the volume of supernatant water was measured directly from the graduated centrifuge tube. The absorbed water was then weighed (in grams) by multiplying it by the density of water (1 g/mL). Water absorption capacity is expressed as grams of water retained per gram of sample used.

Oil Absorption Capacity

Onwuka, (2005) technique was used to determine this. In a sterile conical graded centrifuge tube, one gram of the material was violently stirred for 30 seconds with 10 milliliters of oil. The sample was centrifuged at 5000 rpm for 30 minutes after being allowed to sit at room temperature (28 ± 2 °C) for 30 minutes. Following centrifugation, the graduated centrifuge tube was used to measure the amount of supernatant oil. The weight (in grams) of the absorbed oil was calculated by multiplying it by its density (0.894 g/mL). The amount of oil retained per gram of sample used is the measure of the oil absorption capacity.

Bulk Density

The method developed by Ashogbon and Akintayo, (2013) was used to ascertain this. A 10 ml graduated cylinder was filled with the sample until it reached the 10 ml threshold. To remove air from between the flour mixtures, the cylinder was tapped (agitated) for five minutes. Mass per volume (mL) is used to calculate bulk density.

Solubility

The total solubility of the starch samples at room temperature was ascertained using the methodology of Gbadamosi and Oladeji, (2010). Ten milliliters of distilled water were added to a centrifuge tube containing one gram of the material. After combining the mixture and letting it stand for an hour, it was centrifuged for 15 minutes at 4,000 rpm. In a moisture container that had been cleaned and weighed beforehand, the supernatant evaporated. The weight increase of the can over the weight of the sample is used to calculate the solubility, which is then represented as a percentage.

Swelling Power

A technique for figuring out the swelling power of modified cocoyam starch was presented by Arawande and Ashogbon, (2019). After weighing 1g of starch, 50ml of distilled water was added and carefully stirred. The slurry was heated in a water bath at temperatures between 55 and 95 degrees Celsius for 15 minutes. To prevent the starch from clumping, the slurry was gently churned. The tubes containing the paste were centrifuged for 10 minutes at 300 rpm after 15 minutes, and the supernatant was promptly decanted. The sediment's weight was calculated and noted. The dry matter composition of the gel was then ascertained by calculating its moisture content.

Swelling Power=Weight of wet sediment/Weight of dry matter in the gel (i)

pH

This was computed by adding 20 milliliters of filtered water to a beaker containing 5 grams of starch. After five minutes of agitation, the resultant suspension was allowed to settle for ten minutes. A calibrated pH meter was used to measure the water phase's pH (AOAC, 2010).

Least Gelation Concentration

The method developed by Onwuka, (2005) was applied to find the lowest gelation concentration. Ten test tubes were filled with a 5 ml suspension of starch (2-20% w/v), which was then cooked for an hour at 100 °C in a boiling water bath before being cooled in a cold water bath. Each test tube was inverted to determine the lowest gelation concentration after the samples had been cooled for two hours at 4°C. When the tube is inverted, the sample does not fall, indicating the lowest gelation concentration.

Determination of the Amylose and Amylopectin Content

The Hoover and Ratnayake, (2001) method was used to ascertain this. It entailed weighing 0.1 g of starch samples into a 100 mL volumetric flask and then progressively adding 9 mL of a 1M sodium hydroxide solution and 1 mL of 99% ethanol. Before heating the sample solution in boiling water for ten minutes to gelatinize the starch, the ingredients were well combined. Following cooling, distilled water was added until the solution reached the desired level and then gently shaken. Next, 1 mL of 1M acetic acid and 2 mL of 99% iodine were added to 5 mL of the starch solution in a 100 mL volumetric flask. Since the solution was opaque, 10 mL was made by mixing 1 mL of the sample solution with 9 mL of distilled water. A UV/Vis spectrophotometer set to 620 nm was used to measure absorbance. The absorbance of the sample was deducted from the blank value. The following formulas are used to determine the contents of amylose and amylopectin.

Amylose Content (%)=3.06 x Absorbance x 20 (ii)
Amylopectin Content (%)=100-% Amylose Content (iii)

Pasting Properties

Pasting characteristics, such as peak viscosity, trough viscosity, breakthrough viscosity, final viscosity, setback viscosity, pasting temperature, and peak duration, were determined for both native and modified starch samples using the Rapid Visco Analyzer. A 12% (w/w; db) flour suspension was made by mixing a 3 g flour sample with 25 ml of water in the RVA canister. To guarantee proper mixing, a paddle was placed inside the canister and its blade was jogged through the suspension up and down roughly six times. The RVA machine was then filled with the paddle-containing canister. The sample was heated from 50 degrees Celsius to 95 degrees Celsius in 3 and a half minutes, held at 95 degrees for two and a half minutes, and then cooled back to 50 degrees Celsius for three and a half minutes. This was followed by a two-minute phase in which the temperature was maintained at 50 degrees Celsius. The 12-minute profile was employed.

Proximate Analysis

AOAC (2006) procedures were used to determine the samples' proximate components.

RESULTS AND DISCUSSION

Functional Properties of Native and Pregelatinized Starch

The solubility index, bulk density, swelling capacity, water and oil absorption capacities, and other functional characteristics of native and pregelatinized starch are contrasted in Table 1.

Water Absorption Capacity of Native and Pregelatinized Starch

Compared to native starch (164.33%), pregelatinized starch exhibited a greater capacity to absorb water (249.333%). Arawande and Ashogbon's, (2019) 162.51% water absorption capacity for cocoyam starch was comparable to the water absorption capacity observed for native cocoyam starch. However, it falls short of the 180.0% for cocoyam starch that Ariwaodo *et al.* (2017) were able to obtain. Arinola, (2019) findings for both pregelatinized and microwave-radiated cocoyam starch are in line with the observed increase in water absorption capacity for pregelatinized cocoyam starch. Additionally, cassava starch demonstrated a greater capacity to absorb water (Sarifudin *et al.*, 2020). Following modification, starch granule disintegration and macromolecular rupture have been connected to the enhanced water absorption capacity of modified cocoyam starches (Alcazar-Alay & Meireles, 2015). The porosity of starch granules has been determined using their water absorption capacity (Wang *et al.*, 2016). Better starch digestion was suggested by an increased capacity for water absorption (Ariwaodo *et al.*, 2017).

Oil Absorption Capacity of Native and Pregelatinized Starch

Compared to native starch, pregelatinized starch was able to absorb more oil (106.333%). Okunade and Arinola, (2021) found that modified cocoyam starch has a higher potential to absorb oil. Following alteration, Sanyaolu *et al.* (2021) observed a comparable rise in cassava and red cocoyam starch. Both native and pregelatinized cocoyam starch have lower oil absorption capacities than those reported by Yussuf *et al.* (2022), which are 164.0 and 173%, respectively.

Table 1: Functional Properties of Native and Pregelatinized Starch

Sample	Water Absorption Capacity %	Oil Absorption Capacity %	Swelling Power g.g^{-1}	Solubility Index (%)	Bulk Density g/ml	pH
A	164.333±3.055	97.000±1.732	9.553±0.023	8.667±1.155	0.732±0.015	5.710±0.044
B	249.333±2.082	106.333±2.081	7.147±0.041	14.667±2.309	0.769±0.000	5.960±0.010

The values represent the means ± standard deviation of the triplicate determination. The key B is pregelatinized starch, and A is native starch

One crucial functional characteristic that influences the choice of starch in baked and extruded foods is the capacity to absorb oil (Arinola, 2019). One important determinant of how well starches retain flavor is their ability to absorb oil (Aidoo *et al.*, 2022). In certain dietary compositions that demand optimal oil absorption, starch's ability to bind to oil is beneficial (Ariwaodo *et al.*, 2017). Starch's strong oil absorption capability indicates that it contains hydrophobic proteins, signifying increased lipid binding. This is significant because fat preserves flavor and improves the mouthfeel of foods (Yussuf *et al.*, 2018).

Swelling Power and Solubility Index of Native and Pregelatinized Starch

After pregelatinization, native starch's swelling power reduced by 25%, from 9.553 to 7.14 g.g-1, while its solubility index increased by 41% (8.666 to 14.667 g.g-1). This is consistent with Arinola's (2019) findings about pregelatinized cocoyam starch. Olatunde *et al.* (2017) found a comparable decrease in swelling power after pregelatinization of plantain starch. Compared to Ariwaodo *et al.* (2017), who discovered 0.105 g/mL for modified cassava starch and 0.505 g/mL for modified sweet potato starch, the swelling power values obtained are higher. Inadequate gelatinization of the starch may be the cause of the reduced swelling power seen for pregelatinized cocoyam starch. One method of assessing the quality of food is to look at its swelling power, which gauges a substance's capacity to become hydrated (Adams *et al.*, 2019). The degree of interaction between starch chains in the crystalline and amorphous domains is referred to as solubility (Oladebeye, 2013). The granule size and amylose content of cocoyam starch may be responsible for the rise in the solubility index.

Bulk Density of Native and Pregelatinized Starch

Pregelatinized starch had a bulk density of 0.769g/mL, whereas native starch had a bulk density of 0.732g/mL. Bulk density values for red and white cocoyam starch were determined by Yussuf *et al.* (2022) to be 0.71 and 0.70 g/mL, respectively. The findings, however, fall short of the 0.88g/ml cocoyam starch content reported by Arawande and Asogbon, (2019). According to Ibikunle *et al.* (2019), bulk density is a measurement of the weight of solid samples that is used to guide material handling and application in food processing as well as the kind of packing material required. Particle size and starch sample density dictate bulk density. The starch sample's coarseness is also reflected in bulk density. The bulk density of the material determines how much may be packed in a specific area (Adewumi *et al.*, 2020).

pH of Native and Pregelatinized Starch

Despite being both acidic, the pH of the pregelatinized cocoyam starch samples is somewhat higher than that of the native starch. The samples' pH is lower than the 7.84 reported by Ashogbon, (2017) but equivalent to the 5.48–5.75 reported by Olatidoye *et al.* (2018) for native and pregelatinized cocoyam. The pH range of native and pregelatinized starches, which are widely utilized in the domestic, culinary, and pharmaceutical sectors, is 3 to 9. Because it affects whether the liquid medium is acidic or alkaline, the starch's pH is significant for applications (Awolu *et al.*, 2020; Yusuf *et al.*, 2018). pH controls a number of essential functional characteristics of starch, including swelling and solubility, so understanding the pH is critical (Gbadamosi & Oladeji, 2013).

Least Gelation Capacity of Native and Pregelatinized Starch

The findings of the native and pregelatinized starch gelation at the lowest concentrations are shown in Table 2.

Table 2: Least Gelation of Native and Pregelatinized Starch

Concentration%	Sample A	Sample B
2	Viscous	Viscous
4	Viscous	Viscous
6	Viscous	Gel
8	Gel	Gel
10	Gel	Gel
12	Gel	Gel
14	Gel	Gel

Key: A = Native Starch, B =Pregelatinized Starch

The concentration at which native cocoyam starch gelled was 8%, while the concentration at which pregelatinized cocoyam starch gelled was 6%. This implies that pregelatinization enhanced the starch's capacity to gel. The lowest gelation concentration found for native starch is comparable to the native cocoyam starch reported by Okunade and Arinola (2021). The smallest quantity of starch needed to create gel in a weighted volume of water is referred to as least gelation. Depending on their structural components—protein, carbs, and lipids—starches have different gelation capacities (Ohizua *et al.*, 2016). One crucial measure of starch's gelling capacity is the lowest gelation concentration (Yadav *et al.*, 2018). Better starch gelling capabilities are implied by the fact that lower concentrations are needed to form starch gel (Shrivastava *et al.*, 2018).

Amylose and Amylopectin Content of Native and Pregelatinized Starch

The amylose and amylopectin content results are shown in Table 3. Following pregelatinization, the amylose content of native cocoyam starch decreased to 26.510 percent, while the concentration of amylopectin rose from 58.474% (native cocoyam starch) to 73.490% (pregelatinized starch). Amylose and amylopectin are the two main glucose polymers that make up starch. Amylose makes about 20–30% of regular starches, whereas amylopectin makes up the remaining portion. Ishiwu *et al.* (2017) state that the percentage of amylose in cocoyam starch varies by species and ranges from 3 to 43%. Although it surpasses the values reported by Okunade and Arinola, (2021) for white (17.47%) and red (15.68%) cocoyam starch, the amylose level found in this study is within this range. Additionally, it is lower than the cocoyam starch value of 20.09 percent reported by Adewunmi *et al.* (2020). Species variations or the agricultural environment in which the plants were cultivated could be the cause of the observed discrepancy. This study proved that amylopectin, a component of starch, is heavier than amylose. Swelling happens when products have starch with a low amylose content. Because it affects pasting, gelatinization, retrogradation, swelling power, and enzymatic vulnerability, the amount of amylose and amylopectin in starches is significant (Arawande & Ashogbon, 2019).

Pasting Properties of Native and Pregelatinized Starch

Because they impact the functional and sensory aspects of food formulation, affecting texture, digestibility, and starch consumption in food systems, pasting qualities are important when it comes to the usage of starch. The pasting characteristics of native and pregelatinized starches are contrasted in Table 4.

Peak Viscosity of Native and Pregelatinized Starch

Compared to pregelatinized starch (984.5), native starch has a higher viscosity (3724.5 RVU). The maximum viscosity recorded during or right after the fast visco analyzer's heating phase is known as the peak viscosity. It shows the amount of viscosity that will be present during mixing. Because peak viscosity shows resistance to granule breakdown, it is also used to evaluate the stability of starch (Adewunmi *et al.*, 2015).

Table 3: Amylose and Amylopectin Content of Native and Pregelatinized Starch

Sample	Amylose (Mg/100g)	Amylopectin (Mg/100g)
A	41.526±0.520	58.475±0.520
B	26.511±0.633	73.490±0.633

The values represent the means ± standard deviation of the triplicate determination. Key: A = Native Starch, B = Pregelatinized Starch

Pregelatinization decreased the peak viscosity of cocoyam starch, which is in line with the pattern seen by Yussuf *et al.* (2022) and Sanyaolu *et al.* (2021). A similar drop in peak viscosity was found by Obioma *et al.* (2022) after yam and sweet potato starch underwent chemical and physical modifications. This runs counter to the results of Arinola, (2019), who found that the peak viscosities of pregelatinized red and white cocoyam starch were higher than those of native starch. The obtained peak viscosity is lower than that reported by Lopulalan *et al.* (2020), who discovered that the native cocoyam starch had a peak viscosity range of 4601-5155RVU. Molecular weight, intermolecular conformation, amylose and amylopectin polymerization degree, amylopectin branching quantity, amylose/amylopectin quantities and ratios, and the presence of minor components can all have an impact on viscosity (Subroto *et al.*, 2019). Since peak viscosity and the degree of starch damage have been related, higher peak viscosity will be the consequence of more starch breakdown (Obioma, 2022). Poor molecular connections between starch granules are directly linked to high peak viscosity in starch, making them more prone to disintegration (Falade & Okafor, 2015).

Trough Viscosity of Native and Pregelatinized Starch

Pregelatinized starch had a trough viscosity of 822 RVU, whereas native cocoyam starch had 3041 RVU. Following pregelatinization, the gelatinized cocoyam starch's trough viscosity, also known as its minimum viscosity, decreased. The duration that samples are exposed to a constant temperature and mechanical shear stress is referred to as the hold time (trough), which is also called shear thinning, holding strength, or hot paste viscosity (Kiin-Kabari, 2015; Addy *et al.*, 2014). The results of Obioma *et al.* (2022) for modified sweet potato, trifoliate yam, and white yam starches are in line with the reduction in trough viscosity observed with modified cocoyam starch. The trough viscosity value for native starch is greater than the 2868 RVU found by Lopulalan *et al.* (2020) and the 2213 RVU and 2519 RVU found by Arinola, (2019) for native white and red cocoyam starches, respectively.

Breakdown Viscosity of Native and Pregelatinized Starch

Native and pregelatinized starches have respective breakdown viscosities of 683.5 and 162.5 RVU. The breakdown viscosity, which evaluates the degree of granule disintegration, paste stability, and the starch's ability to withstand crumbling during cooling, is calculated by deducting the trough (hold) viscosity from the viscosity (Ojo *et al.*, 2017; Kiin-Kabari, 2017). How well cooked starch may withstand shear-induced disintegration depends on its breakdown viscosity. The starch is very stable under heat and shear stress when the breakdown viscosity is low; however, high values suggest that the starch's resistance to heat and shear stress during cooking is reduced (Ezeocha & Okafor, 2016). It is well known that breakdown viscosity is significantly impacted by amylose content. The decrease in breakdown viscosity values found in this investigation is in line with the results of Aidoo, (2022) for cassava starch and Arinola, (2019) for modified red and white cocoyam starch.

Final Viscosity of Native and Pregelatinized Starch

Pregelatinized starches have a final viscosity of 1923 RVU, whereas native starches have 5516.5 RVU. The final viscosity is decreased by pregelatinization. The observed decrease aligns with the results of Obioma *et al.* (2022) about the starches of cocoyam, white yam, and sweet potatoes. The ability of a starch material to solidify into a thick paste or gel upon heating or chilling is known as its ultimate viscosity. According to Awolu *et al.* (2017), it is a gauge of starch quality. After boiling and cooling, the final viscosity is used to evaluate the starch's capacity to gel. It explains how stable heated paste or gel is. Paste stability decreases as breakdown viscosity rises (Ikegwu *et al.*, 2010). One important factor in determining and predicting the textural quality of foods high in starch is final viscosity (Arinola *et al.*, 2016). A realignment of the amylose and amylopectin molecules may be the cause of the decrease in final viscosity. This would strengthen the link between the amylose and amylopectin molecules in starch granules and reduce the likelihood of retrogradation (Subroto, 2019).

Table 4: Pasting Properties of Native and Pregelatinized Starch

Sample	Peak viscosity (RVU)	Trough (RVU)	Break down (RVU)	Final viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting temp (°C)
A	3724.5±70.00	3041±4.24	683.5±74.25	5516.5±99.70	2475.5±95.46	5.03±0.14	83.05±0.00
B	984.5±36.06	822±21.21	162.5±14.84	1923±41.01	1101±19.79	7±0.00	84.4±0.57

Values are means of triplicate determinations ± standard deviation. Key: A = Native Starch, B = Pregelatinized Starch

Setback Viscosity of Native and Pregelatinized Starch

Pregelatinized starch had a setback viscosity of 1101 RVU, while natural starch had 2475 RVU. In line with the pattern noted by Awolu *et al.* (2020) for pregelatinized and acid-thinned maize starch, pregelatinization decreased setback viscosity. The starch molecules' structural loosening and disruption may be the cause of the low setback value; hence, the larger the setback value, the greater the retrogradation upon cooling. The likelihood of the starch going stale increases (Awolu & Olofinlae, 2016). The capacity to re-crystallize gelatinized starch after chilling can be evaluated using setback viscosity (Subroto, 2019). The texture of different starch-based products is correlated with the retrogradation tendency of cooked starch after cooling, which is indicated by setback viscosity (Ojo *et al.*, 2017; Ezeocha & Okafor, 2016). Lower vulnerability to retrogradation during cooling is indicated by a high setback number (Aidoo *et al.*, 2022). This implies that a paste made from native cocoyam starch will be less likely to retrograde, which could be beneficial for nutritional bioavailability and food metabolism as retrograded starch is insensitive to human digestive enzymes.

Pasting Temperature and Peak Time of Native and Pregelatinized Starch

The native starch pasting temperature was 83.05°C with a peak time of 5.03 minutes, whereas the pregelatinized starch pasting temperature was 84.4°C with a peak time of 7.00 minutes. Arawande and Ashogbon (2019) discovered a similar peak time of 5.03 °C for cocoyam starch. Shrivastava *et al.* (2018) found a slightly longer peak time of 5.23 minutes and a higher pasting temperature of 89.63 °C for cocoyam starch. In line with Arinola's (2019) finding that native red cocoyam starch rose from 80.70 to 83.20 °C following pregelatinization, the pregelatinized starch had a little higher pasting temperature than the original starch. According to Rosa *et al.* (2017) and Kiin-Kabari, (2015), the pasting temperature is the lowest temperature needed to cook a specific food sample or starch. It is the temperature at which viscosity increases noticeably for the first time and serves as a gauge for the first alteration brought on by starch swelling. Due to the closer connection between starch granules, a high pasting temperature usually signifies a high capacity for water absorption (Julanti *et al.*, 2015; Tortoe *et al.*, 2019). The amount of time needed to boil starch is known as the pasting or peak time (Obioma, 2019).

Proximate Composition of Native and Pregelatinized Cocoyam Starch

The approximate proportions of native and pregelatinized cocoyam starches are shown in Table 5. While pregelatinized starch had 8.67% moisture level, native starch had a 9.45% moisture content.

Table 5: Proximate Composition of Native and Pregelatinized Cocoyam Starch

Sample	Moisture (%)	Ash (%)	Crude fiber (%)	Fat (%)	Protein (%)	Carbohydrate (%)
A	9.45±0.17	1.37±0.06	1.06±0.00	1.03±0.000	1.33±0.044	84.96±0.33
B	8.67±0.29	2.07±0.15	1.20±0.048	1.13±0.030	1.97±0.044	85.76±0.15

Values are means of triplicate determinations ± standard deviation. Key: A = Native Starch, and B = Pregelatinized Starch

Despite the lower moisture content of pregelatinized starch, both were within the commercially acceptable range of less than 14.0% for stable shell life. Because it affects the product's shelf life, moisture content is a crucial food characteristic. The results of Olatidoye *et al.* (2019), who found that the moisture content of pregelatinized cocoyam starch increased from 7.52% to 11.34%, are in conflict with the decrease in moisture content values reported in this study. Native and pregelatinized starches had an ash percentage of 1.37% and 2.07%, respectively. This is higher than Okunade and Arinola's (2021) white and red cocoyam starch concentrations of 1.28% and 1.56%, respectively. The results also exceed the 0.21% reported by Ashogbon and Adeleke, (2019) for cocoyam starch. The ash content implies that the product contains inorganic nutrients. The crude fiber content of native starch was 1.06%, whereas pregelatinized starch was 1.20%. Olatidoye *et al.* (2019) and Ojo *et al.* (2023) have found that the crude fiber content of native starch is higher than that of cocoyam starch, at 0.05% and 0.10%, respectively. The figures, however, fall short of the yam and cocoyam starch estimations of 3.22% and 2.01%, respectively, reported by Modu *et al.* (2015). The crude fiber indicates the starch's cellulose, hemicelluloses, and lignin content (Ojo *et al.*, 2023). Dietary fiber helps to prevent constipation, digestive issues, and piles, so it is essential to include it in the diet.

Native and pregelatinized starch had respective protein and fat content of 1.33%, 1.97%, and 1.03%, 1.13%. The protein and fat content in this study is lower than that found in red and white cocoyam starch by Okunola and Arinola, (2021) and in white yam, trifoliate yam, and sweet potato starch by Obioma *et al.* (2022). Awolu and Olofinlae, (2016) stated that the protein content of water yam starch was less than 1%, however Nadir *et al.* (2015) found that the protein content of potato starch ranged from 0.17 to 0.40%. With values ranging from 0.07 to 0.17%, Olatidoye *et al.* (2019) found a similar trend in the fat content of native and modified cocoyam starches. Both native and modified starch are beneficial ingredients in the creation of low-fat foods due to their low fat content. Since protein levels in starch below 5% have been shown to have no discernible impact on its thermal characteristics, the low protein and fat content suggests that there would be little interaction with the starch's qualities (Okunola & Arinola, 2021). The carbohydrate content of native starch was 84.96%, while pregelatinized starch was 85.76%. Pregelatinization increased the starch's carbohydrate content. Cocoyam starch is a good carbohydrate source that provides dietary energy for many organ functions in the body and can be a substantial energy source when consumed (Oko *et al.*, 2015). Obioma *et al.* (2022) discovered a comparable carbohydrate gain after modifying white yam starch (85.36 to 87.17%), trifoliate yam starch (86.49 to 87.73%), and sweet potato starch (85.09 to 85.51%). Ojo *et al.* (2023) discovered that red native, white native, and Ghana native cocoyam starch all had the same carbohydrate content.

CONCLUSION

Pregelatinization of cocoyam starch increased its solubility, bulk density, and capacity to absorb water and oil while decreasing its pasting ability. Both the food and non-food sectors employ pregelatinized cocoyam starch.

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