CHARACTERIZATION AND EXTRACTION OF STARCH FROM IRISH POTATO (SOLANUM TUBEROSUM)

Ofuani Amalachukwu Grace
Department of Science Laboratory Technology,
Delta State Polytechnic, Ogwashi-Uku, Delta State.
graceokolobi@gmail.com

Abstract

This study focuses on the extraction and characterization of starch from Irish potatoes (Solanum tuberosum). The starch was extracted using a wet grinding method and characterized for its physicochemical properties. The results showed that the starch had a moisture content of 48.7%, ash content of 3.96%, swelling power of 29.7, bulk density of 0.42 g/cm³, and pH of 8.9. The study demonstrates that starch can be successfully extracted from Irish potatoes with desirable physicochemical properties comparable to commercial tuber starches. The starch's functional qualities make it suitable for various food, pharmaceutical, and non-food applications.

Keywords: Irish potato, extraction, starch, wet grinding method, quality etc.

1.0 INTRODUCTION

Irish potato (*Solanum tuberrosum*) is said to have originated from the highland of Bolivia in south America (Martin and Leonard, 1949). The spread of the crop outside it's centre of origin was mainly by deliberate introduction. Irish potato is ranked first in energy production per hectare per day, significantly above cassava and cereals. It is a lover of cool climate and therefore, requires a cool growing seasons with a moderate and well distributed rainfall of about 800mm during growing seasons with no prolonged dry weather. It could be grown under rain-fed condition or irrigated, but waterlogged areas are unsuitable. Temperature higher than 27^0C are favourable for the production of economics size tubers, observation have shown that temperature ranges of 21^{o}C 26^{o}C is required for sprouting of the tuber (Ahmed, 1980). Irish potato was introduced into Nigeria early in 20th century by European miners in Jos Plateau State.

Presently, the Government of Nigeria is encouraging the conversion of agricultural products into raw material for industrial applications, hence the production of starch from Irish potato would be a commercially viable venture in the country. Also, unlike cereal starches, the starch from potato has a high hot paste viscosity, which makes it preferable for the manufacture of adhesive (Food and Agricultural Organization (FAO) 1990). Starch pastes are used as thickeners and as binding, texturizing and stability agents in food systems and some of the properties that are obvious importance in these applications are paste viscosity; flow and viscos elastic properties paste clarity and freeze than stability. These functional properties of starch are obtained by gelatinization and loss of the crystalline structure of the starch granules (Robert & Cameron, 2000). The rheological properties of a food material influence its flow properties and provide fundamental insights into the structural organization of food (Ngadi et al., 2004). Knowledge of these properties is therefore essential in product development, the sensory evaluation of food processing equipment evaluation, quality control and storage stability analysis.

It has appeared in related studies that percentage of starch contents potato crops is dependent on many factors including weather climate, soil types, fertilizer, crop variety and growth period (Alvani et al., 2010; Martinez et al., 2017). These parameters have accountable effects on the morphological, thermal and rheological properties of the starch particles and on it's extraction yield (Alvani et al., 2010).

The rationale for choosing the starch industry is because it is under-exploited in Nigeria and has great potential for driving agribusiness calorific value, inherent excellent physiochemical properties and the case of its modification to other derivatives. Nigeria is one of the largest producers of Irish potato (*Solanum tubersum*) in the world and first in sub-saharan Africa Producing 4 million metric tonnes of Irish potato annually. (Udemezue, 2019). Yet ironically contributes less than 2% of the global starch production because of its industrial, research and development structure. In fact over 95% of Nigeria industrial starch needs are imported were about 580million is spend annually (Okojie, 2017).

Irish potatoes are a cool-season crop that thrives in specific ecological conditions, including cooler temperatures (16–20°C) and higher altitudes (1500–2800 meters above sea level). Temperatures below 10°C or above 30°C significantly hinder tuber development. This makes them unsuitable for many warm, tropical lowlands where crops like cassava and yams thrive. While possible to grow with fewer inputs, achieving high yields often requires significant inputs. Studies show that for high productivity and profitability, Irish potatoes benefit from balanced fertilizers and agrochemicals. By contrast, many local cassava varieties can produce a reasonable yield with far fewer external inputs.

Starch from Irish potatoes in different regions of the world have received a great deal of research attention on the starch sample (Chen et al., 2003). However, the literature on Irish potato starch in Nigeria is scarcity (Abegunde et al., 2012; Oladebeye et al., 2009) especially those that compared the Irish potato to other starch products.

The main aim of this study is to extract starch from Irish Potato and to determine the proximate composition (Moisture and ash contents, swelling power, pH and Bulk Density) of the starch obtained.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study on Irish potato starch extraction and characterization was conducted in Delta State Polytechnic Ogwashi-Uku due to its strategic location and academic focus. The institution's proximity to agricultural resources and favorable climate provides access to Irish potatoes, while its School of Applied Sciences offers a conducive environment for food science and technology research.

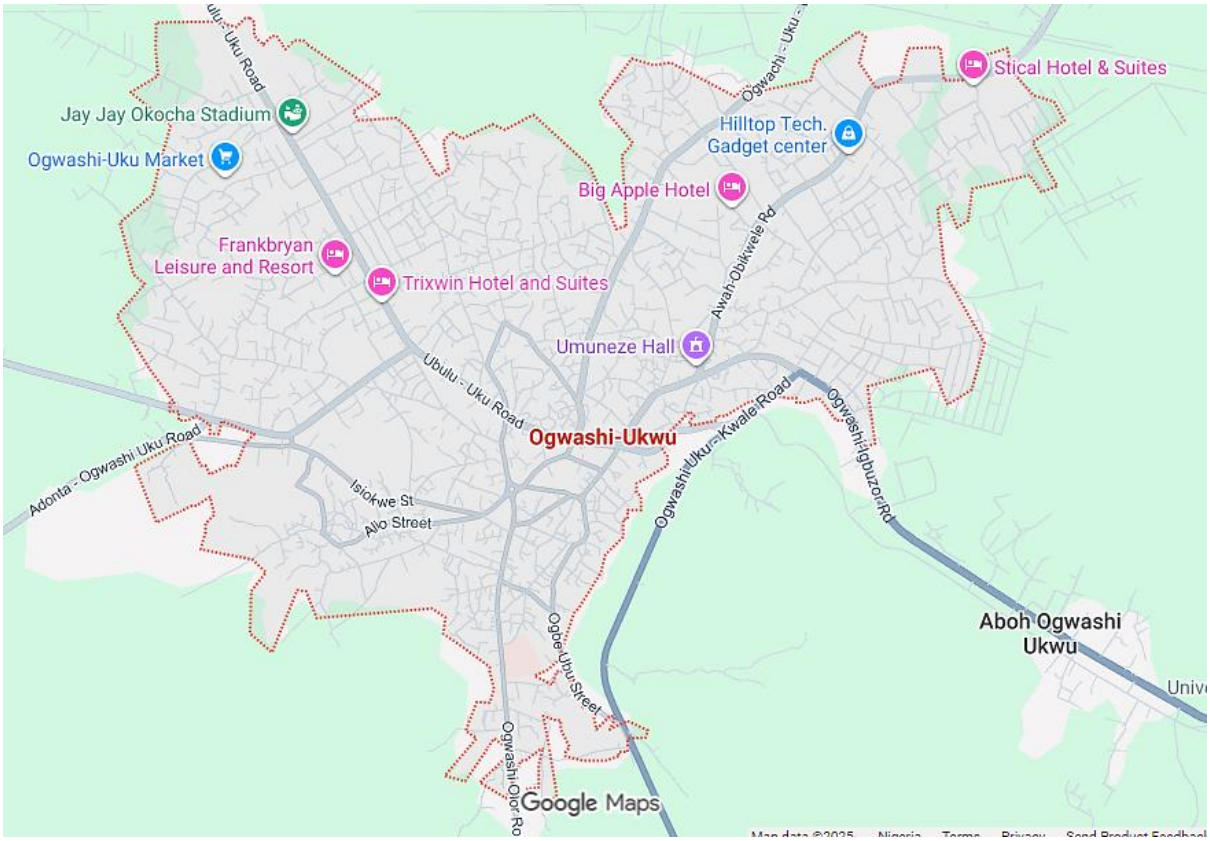


Figure 1: Map showing Ogwashi-Uku town.
Source: Google Map, 2025

2.2 Sample Collection

The Irish Potato used for Starch production was purchased from a local market in Ogwashi-uku, Delta State, Nigeria.

2.3 Sample Preparation

The tubers were peeled, washed and crushed with a local grater or electrical blender to form slurry. Add 100ml of water, then filtration of slurry. The starch, Add 100ml of water, then filtration of Slurry. The Starch milk was allowed to settle and then the Supernatant decanted. Discard the supernatant and the starch was re-suspended in water and washed repeatedly by fresh water and the resulting white starch was spread on a tray and air dried.

2.4 Apparatus

Analytical balance (0.1mg), pH meter, Buffers (pH 4.00, 7.00, 10.00), Water bath, Centrifuge, Drying Oven and desiccator and Magnetic Stirrer, Beaker, Graduated Cylinders, centrifuge tubes, stirring rod, filter Paper and evaporating dishes, Starch Sample (dried to constant weight) and deionized water, Thermometer, Measuring Cylinder, weighing balance, Samples, Funnel, Spatula, Tapping device.

2.5 Sample Analysis

Proximate Composition Analysis was determined by the method described by Association of Official Analytical Chemist (AOAC) (2003). The parameters analysed were Moisture and ash contents, swelling power, pH and Bulk Density.

1. Determination of Moisture Content

Principle: The sample is heated under specified conditions and the loss of weight is used to calculate the moisture Content of the Samples.

A Crucible and the lid were washed and dried in the Oven at 105°C for 20 minutes. it was then placed in a desiccator to Cold and after Cooling the empty Crucible and the weight of the Crucible and Sample was noted before drying. The Crucible and Sample were placed in the Oven and heated

at 105°C for 3hours, the result was Cooled and heated until a steady result (weight) was obtained and the weight was noted.

Moisture Content of each Sample was Calculated as follows:

%Moisture = $(W_1 – W_2) / (W_1 – W) \times 100$
Where W = Weight in grams of the empty dish
W1 = Weight in grams of the dish with the material before drying
W2 = Weight in grams of the dish with the materials after drying
OR
Moisture (%) = $(W_1 – W_2) / W_3 \times 100$
Where W_1 = Weight of Petri-dish + Sample before drying
W_2 = Weight of Petri-dish + Sample after drying
W_3 = Weight of the Sample

Calculation:

%Moisture = $(W_1 – W_2) / (W_1 – W) \times 100$
China dish W_1 = 16.65
Before drying = 1.04
Dried Sample = 17.41
$W_1 – W_2$ = 1.04 – 16.65 = 17.41 – 16-65 = 0.76g
$W_1 – W$ = 16.65 – 17.41 = 17.04g – 16.65 = 0.39g
%moisture = $\frac{0.76-0.39}{0.76}$ x 100 = $\frac{0.37}{0.76}$ x 100
= 48.68%

Moisture Content = 48.7%

2. Determination of Ash Content

The Association of Official Analytical Chemists (2003) method was used.

Porcelain Crucibles were washed and dried in an oven to a constant weight at 105°C for 20minutes. They were allowed to cool in a desiccator and weighed (W_1). 2g of the Samples of each Sample were weighed into the Porcelain Crucibles and reweighed (W_2). The Crucible Containing the Sample were transferred into a muffle furnace, they were then removed and allowed to cool in the desiccator then finally weighed (W_3). The Percentage ash Content was Calculated. In each, three replicate determinations were made and mean calculated.

Calculation Ash Content (%) = $(W_3 – W_1) / (W_2 – W_1) \times 100$
Where W_1 = Weight of empty Crucible
W_2 = Weight of Crucible + Sample

W_3 = Weight of Crucible + ash

Calculation:

W_1 (Empty Crucible) = 16.42g
Sample weight = 1.01 g
W_2 (Crucible + Sample before ashing) = 16.42 + 1.01 = 17.43g
W_3 (Crucible + ash) = 16.46g
%Ash = $(W_3 – W_1) / (W_2 – W_1) \times 100$
$W_3 – W_1$ = 16.46 – 16.42 = 0.04g
$W_2 – W_1$ = 17.43 – 16.42 = 1.01g

Calculate %ash

%Ash = 0.04 / 1.01 × 100
= 3.96% = %Ash = 3.96%

3. pH of Starch Slurry

The starch Sample was dry at 105°C to constant weight with an oven. 10% W/V Starch Slurry was Prepared by weighing 1.00g starch into a 100ml beaker and 99.0ml deionized water was added. It was stirred for 10minutes at room temperature to hydrate starch and magnetic stirrer was used to mixed the sample properly to get homogeneity. The Sample was heated to the target temperature, cool to room temperature and then the pH was measured. The pH meter was Calibrated with Standard buffers, the electrode was washed with deionized water and blot dry, the pH electrode was now inserted into the slurry ensuring the junction is covered and no air bubbles are trapped. The slurry was gently stirred while measuring. The pH was measured when the slurry became Stable (±0.02 pH unit). The process was repeated in triplicate and the mean values were recorded.

4. Bulk Density

The weight of the empty dry measuring cylinder was record as the Weight (W_1). The Sample was poured into the cylinder using a funnel, without compacting and it was levelled to the top. The filled cylinder was weighed and the total weight (W_2) was recorded. The cylinder was tapped gently 12 times on a flat surface to compact the sample slightly and remove air gaps. The final volume of the sample in the cylinder (V) was noted.

The bulk density was Calculated using the formula:
$Bulk\ Density\ (g/cm^3) = (W_2 – W_1) / V$
Bulk density → 30ml of sample

$W_1 = 143.56$
30ml of the sample
$W_2 = 156.04$
$W_2 – W_1 = 156.04 – 143.56$
= 12.48g
Bulk Density = 12.48 / 30
= 0.42

The Bulk density = 0.42

5. Swelling Power

The starch Sample was dry at 105°C to Constant weight with an oven. 1g was weighed into a beaker and recorded as W(g). The samples was prepared by weighing 1.00g starch into a 100ml beaker and 90ml distilled water was added. The tubes were placed in a water bath at the 90°C to incubate for 30mins with occasional gentle shaking. After incubation, the Sample tube was removed and Cools to room temperature for 10minutes to compact Swollen granules the Sample Supernatant was Carefully decanted Poured into a Pre-weighed Separate tube. The Centrifuge decanted, Poured into a Pre-weighed separate tube. The Centrifuge tube Containing the wet Sediment was weighed and recorded as Wwet = Sed (g)

Swelling power = Weight of Sediment / Dry weight Starch Sample
= 2.97 / 0.1
Swelling Power = 29.7

2.6 Statistical Analysis

The data obtained from these analyses were analysed using the mean values and similar work that have been done by other researchers.

3.0 RESULTS AND DISCUSSION

3.1 Results

The results obtained for the characterization of the Irish potato starch samples were represented in Table 1 and Table 2 with Table 1 showing the mean values of proximate composition and Table 2 shows the mean values of the physiochemical properties of the Irish potato starch samples.

Table 1. Mean Value of Proximate Composition of Irish potato starch Samples

Parameter	Mean Values
Moisture content(%)	48.7
Ash content (%)	3.96

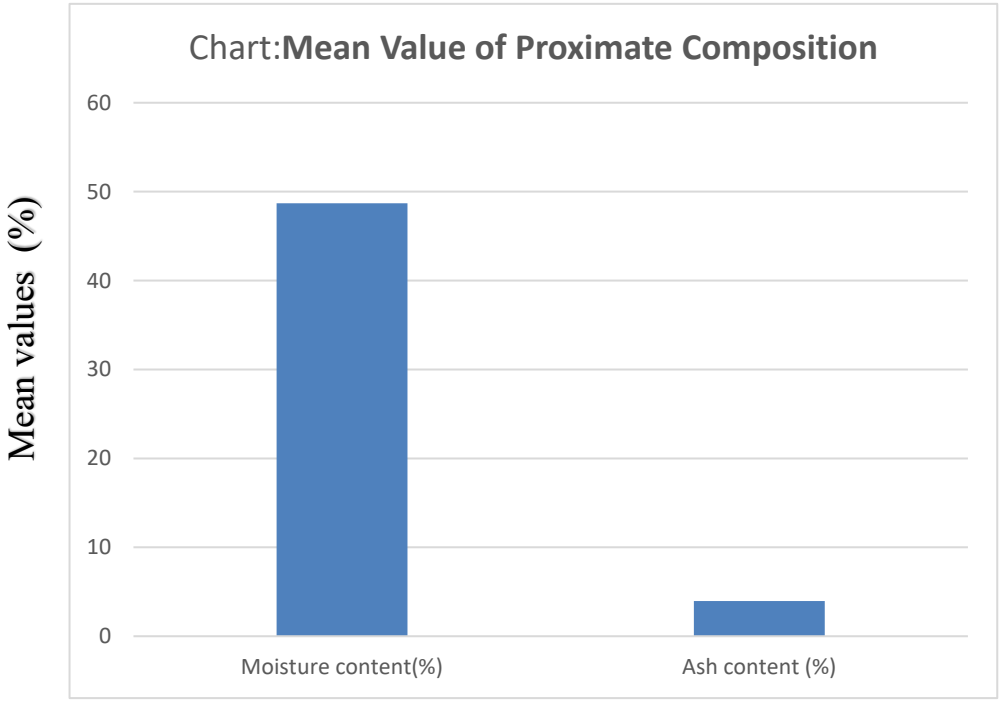
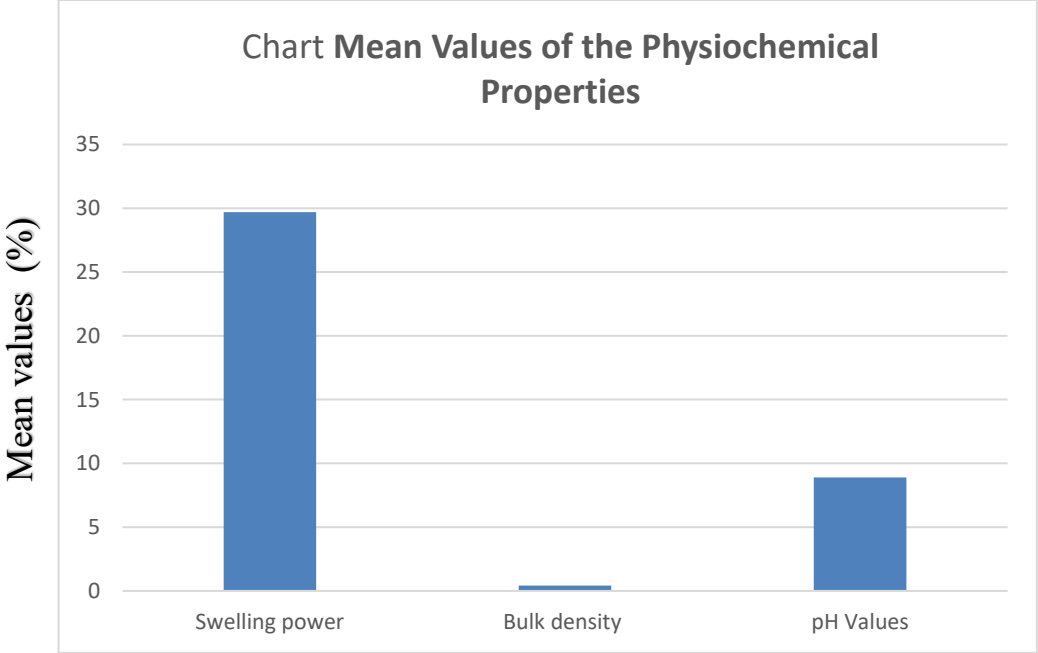


Table 2 Mean Values of the Physiochemical Properties of the Irish Potato Starch Samples

Parameter	**Mean Values**
Swelling power	29.7
Bulk density	0.42
pH Values	8.9



3.2 Discussion

Moisture Content

The study recorded the moisture content as 48.7% for Irish potato starch, which is higher than the general standard range of 10-20% for starch. This indicates a high-water retention capacity that may affect storage stability. According to Liu *et al.* (2019), moisture content is a crucial factor in extrusion and can impact gelatinization degree, crystallinity, amylose, and amylopectin degradation of potato starch. High moisture content can lead to spoilage and microbial growth, constraining shelf life.

Ash Content

The ash content was 3.96%, which is relatively higher than typical value for purified potato starch usually reported at <1.0%. This suggests the presence of mineral residues, possibly incomplete removal of non-starch components during washing. An extra purification step, such as alkaline washing, could help reduce ash levels.

Swelling power

The swelling power (29.7 g/g) is high, typical of tuber starches due to their high amylopectin content and loose crystalline structure, making them ideal for thickening and gelling applications. According to Rasper (1969), swelling power and solubility indicate the strength of non-covalent bonding between starch molecules. Swelling power of Irish potato starch varies considerably among varieties and at different temperatures (Moorthy, 2002).

Bulk density

Bulk density (0.42 g/cm³) indicates that the starch is relatively very light and fluffy, which can influence its packaging & transportation efficiency. According to Collado et al. (2001) in their work observed the Potato Starch density to be 0.769 g/cm³ (native over-dried potato starch) which is higher than the 0.42 g/cm³ discovered in this study.

pH

The pH value of 8.4 shows that the starch is slightly alkaline, which may be due to the extraction process and washing water source. According to Tomasik et al., (2004), a low pH environment can lead to hydrolysis of starch, breaking down glycosidic bonds and altering functional properties. Neutral pH maintains starch molecular weight and functional properties.

CONCLUSION

This research focused on the Characterization and Extraction of starch from Irish potatoes (*Solanum tuberosum*). Fresh Irish potatoes were washed, peeled, grated or blended, filtrate settled, dried and milled to obtain starch. The extracted starch was analysed for proximate composition and physiochemical properties. The findings revealed the value of Moisture Content as 48.7 %, Ash Content is 3.96 %, Swelling power as 29.7 %, Bulk density as 0.42 g/cm, and pH is 8.9. The high swelling power suggests potential for thickening and gelling application in the food industry. The alkaline pH may enhance paste clarity and reduce microbial growth however, the high moisture Content indicates the need for further drying before long term storage.

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