ASSESSMENT OF THE FUNCTIONAL PROPERTIES OF THE SWEET POTATO FLOUR PROCESS BY DIFFERENT DRYING METHODS

BY

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ND/23/NAD/FT/0038

SUBMITTED TO THE DEPARTMENT OF NUTRITION AND DIETETICS, INSTITUTE OF APPLIED SCIENCES (I.A.S), KWARA STATE POLYTECHNIC, ILORIN, KWARA STATE

IN PARTIAL FULFILMENT FOR THE AWARD OF NATIONAL DIPLOMA (ND) IN NUTRITION AND DIETETICS

JULY, 2025

APPROVAL PAGE

This project report has been read and approved as meeting the requirement of the Department of Nutrition and Dietetics, Institute of Applied Sciences, Kwara State Polytechnic, Kwara, Nigeria for the award of National Diploma in Nutrition and Dietetics.

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DEDICATION

I dedicated this work to Almighty God , the source of all knowledge, my parent who have been source of inspiration to me, my amiable siblings and special friends .

ACKNOWLEDGEMENT

All Glory, Honour and Adoration to Almighty God the author and finisher in my faith, the giver of life, for sparing my life till this present and sustaining me through the period of my studies. My sincere gratitude goes to my able supervisor **Miss Opadiran Z.O.** I also appreciate the immeasurable support of my parent for their financial support and advice for the success of this work, greater heights is success is my prayer for you.

I appreciate the HOD in the person of **Dr. Mrs. Hassan** and every lecturers in the department who have impacted me with knowledge throughout the course of my study in this polytechnic.

My sincere appreciation goes to my parent, **Mr. and Mrs. Ogundele,** for their moral, spiritual, financial support and care during the course of study. My appreciation also goes to my siblings.

Ogundele Dorcas Aduragbemi

ABSTRACT

The study titled "Assessment of the Functional Properties of Sweet Potato Flour Processed by Different Drying Methods" explores the influence of various drying techniques on the key functional attributes of sweet potato (Ipomoea batatas) flour. Amid growing interest in alternative flours for gluten-free, nutrient-enriched, and functional food applications, understanding how drying methods affect sweet potato flour's physicochemical and functional properties is critical for food product innovation.Sweet potato flour is acknowledged for its high carbohydrate content, dietary fiber, bioactive compounds, and potential health benefits, including a low glycemic index. However, its functional properties such as water absorption capacity (WAC), oil absorption capacity (OAC), swelling power, solubility, gelatinization behavior, bulk density, and emulsifying capacity vary significantly depending on both the drying technique and the sweet potato variety used.This research systematically assesses flours generated by different drying methods, namely Dehydrated, sun-drying, room drying. Each method imparts distinctive effects on flour microstructure and granule integrity, which subsequently influence functionality in food applications:For example, cabinet-dried samples at optimal temperatures and times show elevated swelling and solubility, supporting cost-effective food processing at both household and industrial scales.Results demonstrate significant dependence of functional properties on both drying method and sweet potato variety. Hot-air-dried flours display superior water absorption and structure-preserving characteristics, whereas freeze-dried flours feature heightened oil absorption and aeration abilities. In all cases, the sweet potato variety strongly influences gelatinization temperature, water solubility, sugar and starch content, and ultimately, specific food processing suitability. This work highlights the importance of selecting suitable drying methods for tailoring sweet potato flour's functional traits to target applications whether for gluten-free bread, soups, confectioneries, or specialized processed foods. The findings underline the need for integrated optimization of drying parameters to enhance nutritional quality, functional performance, and consumer acceptability of sweet potato flour in diverse food formulations. Furthermore, these insights can stimulate the broader utilization and cultivation of sweet potato, supporting food security and new product development in regions where it is a staple crop.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Sweet potato (Ipomoea batatas L) is one of the staple foods in many of the developing countries of the tropics and sub-tropics with different varieties and differences in skin and flesh colour which ranges from while to yellow-orange and deep purple (Woolfe, 1992, CIP, 2013).

Sweet potato helps in improving household and national food security, health and livelihoods of poor families in sub-Saharan Africa (Bovell-Benjamin, 2007). Different varieties exist in African which ranges from white, cream or yellow flesh (low in pro-vitamin A) and orange flesh (high in pro-vitamin A) (Oloniyo *et al.,* 2021).

Sweet potato roots have a number of physiochemical properties. The crop consists mainly of carbohydrates, with starch forming the larger part of the root dry matter (Enugoru *et al.,* 2010). It is majorly use in food industry in making different kinds of commercial products due to its high starch content (Engoru *et al.*, 2020).

Sweet potato can be processed into other products or dry into flour that can be used as a starting material for production of juice, bread, candy, noodles, snacks, alcohol and amala. Which food products? Sweet potato food products are usually subjected to some forms of pre-treatments which include hot water blanching and sulphiting before drying. Blanching helps to inactivate active enzymes that result into quality degradation (Moreno- Perez *et al.,* 2016). Blanching also help in softening structural tissues of food products and increase the rate of moisture diffusivity (Senadeera *et al.*, 2010).

Storing potato crop has been a challenge and it can hardly stay for more than a week due to soft skin that is easily damaged by cuts and abrasion during harvesting transportation or distribution (Ree *et al.*, 2013) This result into huge losses especially during (Teye *et al.*, 2011) Due to this fact, It is consumed within a few days after harvest and makes it unavailable througout the year which include sun drying, room drying dehydrated. In developing countries like Nigeria research carried out shows that processed sweet potato roots into flour offers an opportunity of presenting the community in a more stable form (Van- Hal, 2000). One of the methods that can give stable product to sweet potato is drying. Drying process involves moisture removal as a result of simultaneous heat and mass transfer phenomena (Ertekin and Yaldiz, 2004, Olajire *et al.,* 2018).

Although series of works has been done on effect of pretreatment on the drying sweet potato into flour (Ahmed *et al.*,2010, Dinrifo 2012) , Haile *et al.*, 2015 and Lagrika *et al.,* 2021) but there is little information on the relation to drying of sweet potato. Hence, this work aimed at evaluates the effect of processing methods on the functional properties of sweet potato flour.

The functional properties of sweet potato flour, such as water absorption capacity, oil absorption capacity, swelling power, and bulk density, play a critical role in determining its suitability for various food applications. Different drying methods significantly affect these properties by altering the structural and chemical composition of the flour. For instance, studies have shown that the drying technique used can influence the retention of starch, protein, and fiber components in sweet potato flour, which directly impacts its functionality in food systems (Olatunde *et al.*, 2015).

Sun drying, room drying, and Dehydrated are among the most commonly used techniques in processing sweet potato into flour. Each of these methods has a different impact on the flour's functionality. Room drying typically results in flours with higher bulk density and lower water absorption capacity compared to freeze drying, which retains more cellular integrity and leads to higher swelling power (Adebowale *et al.*, 2018). Sun drying, though cost-effective, often results in lower-quality flour due to contamination and uneven drying, which can impair functional properties.

Dehydrated sweet potato flour has been reported to retain better physicochemical properties due to the gentle drying process that preserves heat-sensitive nutrients and microstructures. According to Singh et al. (2018), Dehydrated leads to superior water and oil absorption capacities, making it more suitable for bakery and baby food applications. On the other hand, oven-dried flours often display higher pasting viscosities, which may be desirable in products requiring thickening agents.

The differences in drying methods also influence the flour's rehydration ability and solubility, which are important for instant food formulations. A study by Kibar and Öztürk (2010) highlighted that freeze-dried flours exhibited higher solubility and rehydration rates due to minimal gelatinization of starch during drying. This implies that such flours could be beneficial in ready-to-eat or quick-cooking food products, where instant reconstitution is essential.

The choice of drying method in processing sweet potato flour has a significant effect on its functional properties, which in turn determine its industrial applications. It is also cost-intensive. Oven and sun drying, though more economical, may compromise certain quality aspects. Therefore, selecting the appropriate drying technique should be based on the intended use of the flour and the balance between quality and cost (Olatunde *et al.*, 2015; Adebowale *et al.*, 2018).

1.2 Statement of the Problem

Despite the high nutrients sweet potato have been reported to contain, only few fractions of these nutrients is eventually obtained during consumption due to poor post harvest handling and processing methods. Nutrient loss via processing methods highlight the need for an improved method in the processing of sweet potato flour that will preserve both its nutritional and functional properties.

1.3 Justification of the Study

Investigating and comparing the functional properties of sweet potato flour that has been processed via varying drying methods can improve shelf-life of sweet potato flour and reduce post harvest losses, thereby promoting food security and sustainable loses, food security and sustainable agriculture.

1.4 Aim of the Study

The aim of this study is to assess the functional properties of sweet potato flour processed by different drying methods.

1.5 Specific Objectives

i. To process sweet potato tubers into flour using different drying methods: sun drying, dehydrator, drying and room drying.

ii. To determine the functional properties of the sweet potato flours obtained from the different drying methods, including: e,g Water absorption capacity (WAC), Oil absorption capacity (OAC), Bulk density, Swelling power, Solubility index and Pasting properties

iii. To compare the functional properties of the sweet potato flours produced using different drying methods.

iv. To identify the most suitable drying method for producing sweet potato flour with optimal functional qualities for food applications.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Sweet Potato (Origin of Sweet Potato)

Sweet potato (*Ipomoea batatas*) is a tuberous root belonging to the Convolvulaceae family. It is cultivated widely in tropical, subtropical, and temperate regions. Sweet potatoes are rich in carbohydrates, dietary fiber, beta-carotene, and other vitamins and minerals. The color of the flesh can range from white to yellow, orange, or even purple, depending on the variety.

The sweet potato (*Ipomoea batatas*) is a starchy, sweet-tasting root vegetable with a rich history that spans thousands of years. It is believed to have originated in Central or South America, with the earliest domesticated remains dating back to around 2500–1850 BCE in Peru.

Sweet potatoes are part of the Convolvulaceae family, which includes morning glories. They were first cultivated by indigenous peoples of tropical regions in the Americas. Evidence suggests that by the time Europeans arrived in the New World, sweet potatoes were already widely grown throughout Central and South America and had become a dietary staple.

After Christopher Columbus encountered sweet potatoes in the Caribbean during his voyages in the late 15th century, they were brought to Europe and subsequently introduced to other parts of the world. Spanish and Portuguese explorers played a major role in their global spread:

Africa and Asia: Sweet potatoes were introduced to Africa and Asia through Portuguese trade routes. In China, they were adopted around the 16th century and became a vital crop, particularly in areas with poor soil where rice could not grow well.

Polynesia: Interestingly, sweet potatoes were already present in Polynesia before European contact. This has led to theories that there was pre-Columbian contact between Polynesians and South Americans, likely around 1000–1100 CE, as supported by linguistic and genetic evidence.

Today, sweet potatoes are a major food crop worldwide. They are especially valued for their nutritional content, being rich in beta-carotene (vitamin A), fiber, and complex carbohydrates. They are a dietary staple in parts of Africa, Asia, and the Pacific Islands, as well as in the American South, where they are commonly used in traditional dishes.

2.1.1 Historical use of Sweet Potato Flour

The historical use of sweet potato flour can be traced back to regions where sweet potatoes were a dietary staple, particularly in parts of Africa, Asia, the Caribbean, and Central and South America. Traditionally, communities in these regions relied on sweet potatoes not only as a versatile food crop but also as a means to create flour when grain-based flours were scarce or expensive. Drying and grinding sweet potatoes into flour provided a way to preserve the crop and ensure year-round availability.

In Africa, for example, sweet potato flour has been used as a substitute or supplement to cassava, millet, and maize flours in the preparation of traditional foods such as porridge and flatbreads. During times of drought or food shortages, it served as a crucial fallback ingredient due to the resilience and high yield of sweet potato crops. In parts of Asia, particularly Japan and China, sweet potato flour has been incorporated into noodles, pastries, and rice-based dishes as both a functional and nutritional ingredient.

Sweet potato flour also gained renewed interest during global conflicts and economic hardship, such as World War II, when traditional wheat supplies were limited. Governments and households turned to local crops like sweet potatoes for flour production to reduce reliance on imports. Today, its use continues to grow not only in traditional cuisines but also in health conscious and gluten-free food markets, bridging historical practices with modern nutritional needs.

2.1.2 Importance of Sweet Potato Flour

Sweet potato flour is obtained by drying and milling the tubers. It is used in food formulations for baking, thickening, and as a gluten-free alternative to wheat flour. Its production enhances the utility of sweet potatoes by increasing their shelf life, reducing postharvest losses, and promoting value addition.

Sweet potato flour is a nutrient-rich, gluten-free alternative to traditional wheat flour that is gaining popularity in both food processing industries and health-conscious kitchens. Derived from dried and ground sweet potatoes (Ipomoea batatas), this flour offers a range of functional, nutritional, economic, and environmental benefits.

Sweet potato flour has gained popularity as a versatile and nutritious alternative to traditional wheat flour. It is made by drying and grinding sweet potatoes into a fine powder, retaining many of the root's beneficial nutrients. One of its primary advantages is its rich nutritional profile, as it contains high levels of dietary fiber, vitamins A and C, potassium, and antioxidants. These nutrients support immune health, vision, and digestive function, making sweet potato flour an excellent choice for health-conscious consumers.

This has contributed to its increasing use in gluten-free baking and cooking. It can be used in a variety of recipes, including bread, pancakes, cookies, and even as a thickening agent in soups and sauces. Its mildly sweet flavor also enhances the taste of baked goods, adding a unique touch compared to neutral-tasting flours.

Economically, sweet potato flour plays an important role in supporting agricultural communities, particularly in regions where sweet potatoes are abundant. By processing surplus or less visually appealing sweet potatoes into flour, farmers and small-scale producers can reduce food waste and increase income. It also offers a sustainable option for flour production, as sweet potatoes require relatively low inputs to grow and are resilient in a range of climates.

Sweet potato flour contributes to food security and diversification. In countries where wheat is imported, promoting the use of locally grown crops like sweet potatoes for flour production can reduce dependence on foreign imports. This not only strengthens the local economy but also ensures a more stable food supply during global disruptions. With its health benefits, economic impact, and potential to promote sustainability, sweet potato flour is an important ingredient for the future of food systems

2.1.3 Nutritional Benefits of Sweet Potato Flour

Sweet potato flour is a nutrient-rich alternative to traditional wheat flour, offering several health benefits due to its high content of vitamins, minerals, and dietary fiber. One of the key nutritional advantages is its abundance of vitamin A, in the form of beta-carotene, which plays a crucial role in maintaining healthy vision, skin, and immune function. Additionally, sweet potato flour is a good source of vitamin C and several B vitamins, which support metabolism and energy production.

Another notable benefit of sweet potato flour is its high fiber content, which contributes to improved digestive health and better blood sugar regulation. Unlike refined flours, it has a lower glycemic index, meaning it causes a slower rise in blood glucose levels. This makes it a more suitable option for individuals managing diabetes or aiming to maintain steady energy levels throughout the day. The flour is also naturally gluten-free, making it a safe and nutritious option for people with celiac disease or gluten sensitivity.

Sweet potato flour is rich in essential minerals such as potassium, iron, and manganese, which support muscle function, oxygen transport, and bone health. Its antioxidant properties, largely due to the presence of beta-carotene and other phytonutrients, help combat oxidative stress and inflammation. This combination of nutrients not only supports overall wellness but also makes sweet potato flour a valuable ingredient in both sweet and savory dishes for those seeking a healthier, more wholesome diet.

2.2 Functional Properties of Sweet Potato Flour

The functional properties of sweet potato flours play an essential role in the manufacturing of food products. Such properties decide the production and use of sweet potato flours as a food ingredients for different foods, and also regulate the processing and storage of these items. For example, functional properties such as water absorption, oil absorption, and protein solubility affect the product's texture and appearance. According to Ojo *et al.*, 2014 pasting properties are functional properties that are related to the ability of an item to act in a paste-like manner. It provides details on the production of dough and gas retention. Hence, the functional properties of flour are directly determined their end uses. Starch gelatinization is correlated with thermal properties. Thermal properties are a critical property used during the baking cycle to understand the phenomena.

According to Kaur and Singh 2018, cooking time is a very significant part of the consistency of the cooking. This indicates that cooking time determines the cost of energy required. Overall, the functional properties of sweet potato flours describe the users' desires and decide the suitability of the foodstuff for a given purpose. Processing methods such as physical and chemical modifications of sweet potato flours are sometimes necessary to overcome certain undesirable characteristics and make them suitable for specific end uses. However, processing methods are reported to affect some functional properties such as bulk density, water and oil absorption capacity, swelling, solubility and digestibility. In this review paper, the functional properties of sweet potato flour such as bulk density, swelling power, solubility, water and oil absorption capacity, pasting properties, gel consistency, sediment volume, in vitro digestibility, thermal and morphological properties are reported

Functional properties refer to the physicochemical characteristics of flour that influence its behavior in food systems during processing and storage. Important functional properties include:

2.2.1 Water Absorption Capacity (WAC)

Water Absorption Capacity (WAC) refers to the ability of a material, typically a powder or flour, to absorb and retain water. It is a key functional property in food science and material science, especially for ingredients used in baking, meat processing, and other food formulations. WAC is influenced by factors such as particle size, protein content, fiber content, and the presence of hydrophilic (water-attracting) groups in the material. A high WAC indicates that the material can hold more water, which can improve the texture and yield of food products.

In flour-based applications, for example, WAC plays a critical role in dough formation, texture, and moisture retention. Flours with high protein or fiber content typically have higher water absorption due to the presence of polar amino acids or cellulose, which bind water molecules. This characteristic is important in developing products like bread, cakes, and pasta, where the right moisture level is essential for texture and shelf life. In meat products, ingredients with good WAC can help retain moisture during cooking, improving juiciness and reducing shrinkage.

WAC is also important in evaluating non-food materials, such as in the production of biodegradable packaging, pharmaceuticals, or absorbent products like diapers. In these contexts, WAC determines the efficiency and performance of materials under moist conditions. Measurement of WAC is usually done by mixing a sample with water, centrifuging it, and calculating the amount of water retained per gram of the sample. Understanding and optimizing WAC is vital for product development, quality control, and ensuring consumer satisfaction across a wide range of industries.

2.2.2 Oil Absorption Capacity (OAC)

Oil Absorption Capacity (OAC) is a critical functional property of food ingredients, especially flours and protein isolates, that reflects their ability to retain oil. This parameter is essential in the food industry, particularly in the formulation of products like sausages, doughnuts, soups, and baked goods, where oil retention can affect texture, flavor, and mouthfeel. OAC is typically expressed in terms of the amount of oil (in grams) that a material can absorb per gram of dry sample, and is influenced by the chemical composition, particle size, and surface characteristics of the food material.

Proteins and carbohydrates, especially those with nonpolar side chains or porous structures, often contribute significantly to OAC due to their ability to bind with lipids. A higher OAC in food ingredients is generally desirable for products requiring enhanced fat retention or improved emulsion stability. For example, in meat analogs and plant-based patties, a high OAC helps simulate the juiciness and texture of real meat. Similarly, in baked goods, ingredients with high oil-binding capacity can enhance moisture retention and prolong shelf life.

Measurement of OAC is typically done by mixing a known quantity of sample with oil, centrifuging it, and then quantifying the unabsorbed oil. The differences in OAC among various ingredients can guide food technologists in selecting the right functional component for specific applications. Moreover, OAC also plays a role in the sensory appeal of food, as it impacts mouthfeel and flavor delivery, making it a valuable property in both product development and quality control processes.

2.2.3 Swelling Capacity

Swelling capacity is an important functional property used in assessing the potential use of sweet potato flour in food formulations, especially as a thickening or gelling agent. It refers to the ability of flour to absorb water and swell under specified conditions, which is influenced by the structural integrity of starch granules and the presence of other macromolecules such as proteins and fibers. According to Olapade and Adeyemo (2014) revealed that flours obtained through drum drying exhibited reduced swelling capacity, likely due to the partial gelatinization of starch during processing, which limits further swelling during rehydration. These findings underscore the role of processing conditions in determining the functionality of sweet potato flour, especially in products where moisture retention and texture are key quality parameters. Selecting an appropriate drying method not only enhances the promotional appeal of the flour but also broadens its application in the food industry by improving its functional performance.

2.2.4 Bulk Density

Bulk density is a physical property of particulate materials such as soil, powders, grains, and aggregates. It is defined as the mass of particles in a given total volume, which includes the space between the particles (interparticle voids). Bulk density is typically expressed in grams per cubic centimeter (g/cm^3) or kilograms per cubic meter (kg/m^3). This measurement is important in various fields, such as agriculture, civil engineering, and material science, as it affects storage, transport, and application processes.

In soil science, bulk density provides insights into soil compaction and porosity. A high bulk density usually indicates compacted soil with fewer pores, which can restrict root growth, water infiltration, and air movement essential factors for plant development. Conversely, low bulk density suggests a looser soil structure with higher porosity, which supports better water retention and root penetration. Factors that influence soil bulk density include soil texture, organic matter content, and management practices like tillage and crop rotation.

Understanding bulk density is also critical in industrial applications. For example, in the pharmaceutical industry, bulk density affects how powders flow through machinery and how tablets are formed. In construction, the bulk density of aggregates like sand and gravel influences the strength and durability of concrete. Accurately measuring and managing bulk density ensures the consistency and quality of products and materials, optimizing both efficiency and performance in various technical processes.

2.3 Effect of Drying Methods on Functional Properties

Drying methods influence the structure and composition of starches and proteins in flours, which in turn affect their functional properties.

2.3.1 Sun Drying

Traditional and inexpensive, but depends on weather conditions. May lead to microbial contamination and uneven drying. Sun Drying is one of the oldest and most natural methods of food preservation. It involves using the heat and energy from the sun to remove moisture from food items such as fruits, vegetables, grains, and fish. By reducing the moisture content, sun drying helps prevent the growth of bacteria, yeast, and mold, thereby extending the shelf life of the food. This method is especially popular in rural and tropical regions where sunlight is abundant and access to modern preservation technologies may be limited.

The process of sun drying is simple and cost-effective, requiring minimal equipment. Typically, food items are cleaned, sliced, and spread out on trays, mats, or raised platforms to allow even exposure to sunlight and air. Good air circulation and protection from dust, insects, and animals are essential to ensure hygienic drying. Depending on the climate and the type of food being dried, the process can take anywhere from a few hours to several days.

While sun drying has many advantages, such as low cost and energy savings, it also has some limitations. The method is highly weather-dependent, making it less reliable in regions with frequent rain or high humidity. Additionally, the quality of sun-dried products may vary due to uneven drying, contamination, or exposure to harmful ultraviolet rays. Despite these challenges, sun drying remains a valuable and widely used technique, particularly in small-scale food processing and traditional food systems.

2.3.2 Room Drying

Controlled and consistent; offers better microbial safety and more uniform results but may cause degradation of heat-sensitive nutrients.

Room drying, also known as ambient or shade drying, is a traditional and low-cost method used to reduce the moisture content of agricultural products like sweet potatoes. In this method, sliced or grated sweet potato is spread thinly on trays or mats and left to dry under natural air circulation at room temperature. This process can take several days, depending on ambient humidity, temperature, and ventilation. Room drying does not require electricity or advanced equipment, making it suitable for rural and small-scale processing where resources are limited (Omodamiro *et al.*, 2013).

However, the effectiveness of room drying in preserving the quality and functional properties of sweet potato flour is limited. Due to the prolonged drying time and exposure to environmental contaminants such as dust, insects, and microorganisms, the resulting flour may have compromised microbiological safety and reduced shelf life. Additionally, enzymes and microbial activity during slow drying may lead to undesirable changes in color, flavor, and nutrient content (Mwithiga & Sifuna, 2006). Functional properties such as water absorption and swelling power may also be negatively affected due to partial fermentation or enzymatic breakdown of starches during the drying period.

Despite its limitations, room drying remains an important technique in regions with limited access to modern drying technologies. Improvements such as using enclosed drying chambers or mesh screens can help minimize contamination while allowing airflow. When optimized, room drying can still produce acceptable sweet potato flour for home or local consumption, particularly when immediate use or short-term storage is intended (Omodamiro *et al.*, 2013). However, for industrial-scale production or products requiring strict quality standards, more controlled drying methods are generally preferred.

2.3.3 Dehydrated Drying

Dehydrated drying, commonly referred to as mechanical or artificial drying, involves the use of controlled heat and airflow in a dehydrator or drying oven to remove moisture from sweet potato slices or mash. This method provides consistent drying conditions, such as temperature, humidity, and air velocity, which helps produce flour with more uniform quality. Compared to traditional methods like sun or room drying, dehydrated drying is faster, more hygienic, and less dependent on weather conditions (Akinola *et al.,* 2014). The controlled environment reduces the risk of microbial contamination and enzymatic browning, helping to preserve the color and nutritional value of sweet potato flour.

Functionally, sweet potato flour produced through dehydrated drying typically exhibits improved physical and chemical properties. For instance, the rapid removal of moisture can help retain starch integrity, resulting in higher swelling power and better water and oil absorption capacities (Adepeju *et al.,* 2011). Additionally, the consistent drying temperature minimizes the loss of heat-sensitive nutrients like vitamin C and beta-carotene. This makes dehydrated drying a preferred method for commercial flour production where quality consistency is crucial for applications in baking, snack production, or as a thickening agent in soups and sauces.

Despite its advantages, dehydrated drying does require energy input and equipment investment, which may not be feasible for all producers, especially in low-income or rural areas. The cost of operation and maintenance of mechanical dryers must be considered when scaling production (Akinola *et al.,* 2014).

CHAPTER THREE

3.1 MATERIALS AND METHODS

3.1.1 Sweet Potato

The potato flour were obtained from Sango Market in Ilorin, KwaraState, Nigeria.

3.1.2 Sweet Potato

Sweet potato was thoroughly washed and cleaned to remove the impurities and was cut into small pieces which contains peeled and unpeeled after which was splitted into two bowls in other to get soaked for 24hours after this process the soaked potato was removed form the water and the water was changed for another 24 hours to get soaked and it was placed into a bigger sieve allowing the water to drain after this, peeled and unpeeled sweet potato was splitted into six groups as shown in the experimental design:

3.2 Experimental design

Table 1: Experimental design

Samples	Content
A	Peeled Dehydrated
B	Unpeeled Dehydrated
C	Peeled Sun Dried
D	Unpeeled Sun Dried
E	Peeled Room Dried
F	Unpeeled room dried

3.2.1 Milling of Potato/Production Potato Flour

Sample A and B

Peeled and unpeeled sweet potato was put into dehydrator for 14hours at 90^0c in other to remove the moisture and get it dried and was blended with Sliver Crest blender to get the sweet potato flour.

Sample C and D

Peeled and Unpeeled Sweet Potato were sun-dried for which was grinded with grinder to get sun dried sweet potato flour.

Sample E and F

Peeled and Unpeeled room sweet potato was placed in a well maintained room in other to get dried with the help of the air after a week I took it to the grinder to grind it to get my room dried potato flour.

3.3 Functional Analysis

Functional analysis of sweet potato flour involves evaluating the physical and chemical properties that determine its performance in food formulations. Key functional properties include water absorption capacity (WAC), oil absorption capacity (OAC), swelling power, solubility, bulk density, and pasting characteristics. These properties are essential in predicting how the flour behaves during processing, cooking, and storage, and they influence its application in products such as baked goods, soups, sauces, baby foods, and snack items (Olatunde *et al.,* 2015).

Water and oil absorption capacities are critical for understanding the flour's ability to retain moisture and fat, which affect texture and mouthfeel. High WAC is beneficial in products like bread and cakes, as it improves yield and freshness by retaining moisture. Similarly, high OAC makes the flour suitable for flavor retention in fried foods. Drying methods significantly affect these parameters; for instance, freeze-dried flour tends to have higher WAC and OAC due to its porous structure, while sun-dried or room-dried flour may have reduced absorption due to partial starch degradation or compaction (Singh *et al.,* 2018).

Other functional attributes such as swelling power and bulk density influence the flour’s volume and rehydration characteristics. High swelling power is desirable in products requiring thickening, while bulk density affects packaging and transport.

Pasting properties, measured through Rapid Visco Analyzer (RVA), provide insight into gelatinization behavior and viscosity changes during heating and cooling. These parameters help in selecting the appropriate flour type for specific industrial uses. Overall, understanding and optimizing functional properties through drying method selection ensures the production of sweet potato flour that meets quality and performance standards for targeted food applications (Adebowale *et al.*, 2018).

3.3.1 Oil Absorption Capacity (OAC)

Oil absorption capacity (OAC) was determined using the method of AOAC (2005). About 1g of the sample (W°) was weighed into pre weighed 15ml centrifuge tubes and thoroughly mixed with 10ml (V1) of refined pure groundnut oil using vortex mixer. Samples were allowed to stand for 30mins. The sample- oil mixture was centrifuged at 3000rpm for 20mins. Immediately after centrifugation, the supernatant was carefully poured into a 10ml graduated cylinder, and the volume was recorded (V2).

Oil absorption capacity (millilitre of oil per gram of sample) was calculated. Oil

Absorption capacity = V1 – V2

3.3.2 Swelling Capacity (SC)

The method described by Awolu (2017) was used to determine the swelling capacity. The gel obtained from swelling index was used in calculating swelling capacity (SC) thus;

$$\%SC = \frac{\text{weight of wet gel}}{\text{Weight of sample}} \times 100$$

3.3.3 Bulk Density (BD)

20g of the sample was added to a graduated measuring cylinder. The cylinder was gently tapped and volume occupied by the sample was determined. Bulk density was reported as weight per unit volume (g/mL).

$$\text{Bulk Density g/ml} = \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

3.3.4 Water Absorption Capacity

Water Absorption Capacity (WAC) is a crucial functional property that indicates the ability of flour to absorb and retain water, influencing its application in various food systems such as bakery, meat extenders, and weaning foods. According to Adebowale et al. (2005), WAC is significantly influenced by the drying method applied during flour processing, as different techniques impact the structural integrity and physicochemical properties of starch and proteins in the flour. Freeze-dried sweet potato flour typically shows higher WAC due to the preservation of porous structures and native starch granules, which enhance water- binding sites (Falade & Okafor, 2015). In contrast, oven drying may cause partial gelatinization or denaturation, leading to reduced water absorption capacity.

Sun drying, while economical, has been reported to result in uneven moisture removal and potential microbial contamination, which may negatively affect WAC (Onabanjo & Ighere, 2014). Additionally, the prolonged exposure to ambient conditions during sun drying can lead to enzymatic and oxidative degradation, thereby altering the flour's hydration properties.

The findings of Olapade and Aworh (2012) support this, indicating that oven- and freeze-dried sweet potato flours generally exhibit superior functional properties, including higher WAC, compared to sun-dried samples. These variations highlight the importance of selecting an appropriate drying technique to maintain or enhance the functional characteristics of sweet potato flour for specific industrial and nutritional applications.

3.5 Data Analysis

Means and standard error of means were calculated for each sample. Analysis of variance (ANOVA) were used to determine significant differences between the samples.

CHAPTER FOUR

4.1 RESULTS AND DISCUSSIONS

TABLE 2: Functional analysis of potato flour dried by different methods.

GROUP	WAC	OAC	SC	BD
Peeled (room dried)	142.67± 1.43^{c}	206.50± 1.43^{c}	100.00± 0.00^{a}	0.78± 0.01^{e}
Unpeeled (room dried)	143.94± 0.45^{c}	209.55± 1.10^{c}	145.00± 5.00^{c}	0.75± 0.00^{c}
Peeled (sun-dried)	130.76± 1.45^{ab}	190.34± 0.96^{b}	95.00± 5.00^{a}	0.76± 0.00^{d}
Peeled (dehydrator dried)	127.04± 1.08^{a}	177.79± 0.74^{a}	125.00± 5.00^{b}	0.74± 0.00^{b}
Unpeeled (sun-dried)	135.00 ± 0.92^{b}	219.83±0.43^{d}	110.00 ± 0.00^{ab}	0.71± 0.00^{a}
Unpeeled (dehydrator dried)	133.03 ± 1.55^{ab}	195.15± 2.99^{b}	110 ± 0.00^{ab}	0.71± 0.00^{a}

4.1.1 Water absorption capacity

The result of the functional analysis showed that the unpeeled room dried sample had the highest WAC, followed closely by the peeled room dried samples. However, There is significant difference in ($p<0.05$) in the WAC of both peeled and unpeeled room dried samples compared to P and U.P sun dried and dehydrated dried samples. Also, the peeled room dried sample had the least of WAC

4.1.2 Oil absorption capacity

The result of he functional analysis showed that all unpeeled samples had the highest

OAC. However, there is a significant difference (P<0.05) in the OAC of all unpeeled samples compare to all peeled samples dried with the same method. Also the peeled dehydrated has the least OAC

4.1.3. Swelling capacity

The result of the functional analysis showed that U.P room dried had the highest SC, However, there is a significant difference (P <0.05) in the SC of U.P room dry compared to PD,UD,US,PS and US. Also PS has the least of SC

4.1.4 Bulk Density

The result of the functional analysis showed that PR sample had the highest BD.However, there is a significant difference (P<0.05) in the BD of PR compared to PS, US, PD, UD and UR samples. Also US and UD samples has the least BD

4.2 Discussion

4.2.1 Oil Absorption Capacity (OAC)

The oil absorption capacity ranked from highest to lowest in the order :
US > UR > PR > UD > PS > PD.

Unpeeled Sun-dried (US) had the highest OAC. This may be due to the presence of peel (fiber, proteins, and pigments) which can increase surface area and binding sites for oil.

Sun-dried samples (US & PS) generally showed higher OAC than their dehydrator (UD & PD) or room-dried (UR & PR) counterparts, likely because sun-drying causes more porous structures due to uneven heating and slower drying, aiding oil absorption.

Unpeeled samples (US, UR, UD) mostly absorbed more oil than peeled ones, supporting the idea that the peel contains compounds that enhance OAC.

Falade&Okafor, 2015, and Olatunde*et al.*, 2012reported that unpeeled and sun-dried sweet potato flours tend to have higher OAC due to the presence of fiber and less compact starch structure.It is known that sun drying produces flour with higher porosity, leading to increased oil-binding capacity.

4.2 .2 Swelling Capacity

The swelling capacity ranked from the highest to lowest in the order:

UR > PD > US = UD > PR > PS.

UR (Unpeeled Room-dried) had the highest swelling capacity. This suggests that mild drying methods (like room drying) help maintain starch granule integrity, improving the ability to swell in water.

Peeled Sun-dried (PS) had the lowest swelling capacity, possibly because sun drying degrades starch through partial gelatinization or retrogradation due to exposure to fluctuating temperatures and light.

Again, unpeeled samples generally did better than peeled ones, likely due to higher fiber content in the peel which improves water retention and gel formation.

Studies by Rickman *et al.*, 2007 and Shittu*et al.*, 2009 suggests that excessive heat (e.g., sun drying) can denature or break down starch, reducing swelling.

Unpeeled samples retain more fiber and protein, which enhances water binding, as shown in (Oduro*et al.*, 2000).

4.2.3 Bulk Density (BD)

Peeled Room-dried (PR) had the highest bulk density. This suggests that peeling and gentle drying resulted in a more compact flour with fewer air pockets, which packs better.

Sun-dried unpeeled flour (US) had the lowest BD. This supports the notion that sun drying creates less dense, more porous flour with lower particle packing efficiency.

Room drying appears to give the most consistent density, which may be ideal for packaging and storage.

Onabanjo&Ighere, 2014reported that lower bulk density is associated with higher porosity, commonly seen in sun-dried flours.

High BD, as seen in peeled, room-dried samples, is ideal for product formulation (like compact snacks or gruels).

4.2.4 Water Absorption Capacity (WAC)

UR (Unpeeled Room-dried) had the highest WAC. This aligns with expectations, as the peel contains fibers and cell wall components that help retain water. Also, room drying is gentler and may preserve the hydrophilic (water- attracting) structure of starch and protein more than harsher drying methods.

Unpeeled samples (UR, US) generally have higher WAC than peeled ones (PR, PS, PD).

Sun-dried and room-dried samples (US, UR, PR, PS) showed higher WAC than dehydrator-dried (UD, PD), likely because high-temperature dehydration can damage starch granules, reducing their ability to bind water.

PD (Peeled Dehydrator-dried) had the lowest WAC, probably due to both peeling (loss of fiber) and high drying temperature leading to compact, less porous flour.

Aina*et al.*, 2009, and Olatunde*et al*., 2012reported that unpeeled and room- dried flours retain more water due to the presence of fiber, intact cell structures, and minimal thermal damage.

High WAC is important for products like dough, batter, or reconstituted foods that require moisture retention and softness.

Conclusion

Drying Method and Peeling Significantly Influence Functional Properties

Room drying generally preserved the quality of the flour better than sun or dehydrator drying, especially in terms of swelling and water absorption capacities. Peeling reduced water and oil binding due to the loss of fibrous material.

Unpeeled Samples Performed Better Overall, unpeeled flours had higher OAC, WAC, and SC across most methods, showing the functional benefits of retaining the peel during processing.

Sun-drying Enhanced Oil Absorption but Reduced Density. Sun-dried samples (especially US) showed higher oil absorption and lower bulk density, likely due to their porous, less compact structure. However, swelling and water absorption were not as high as in room-dried counterparts.

Dehydrator-dried Samples Had the Lowest Functional Qualities, especially when peeled (PD), dehydrator-dried samples showed lower WAC, SC, and OAC, possibly due to heat-induced starch damage and compact structure.

Recommendations

- For higher functional quality (especially WAC and SC), unpeeled, room- dried flour is ideal and can be recommended for products like amala, fufu, or rehydrated porridges.
- Use Sun-Dried Unpeeled Flour for Oil-Retentive Products. If the product requires high oil absorption (like fried snacks or baked goods), sun-dried, unpeeled flour can be an economical and functional choice.
- Avoid High-Temperature Dehydrator Drying for Functional Uses. Unless rapid drying is necessary, avoid dehydrator drying especially after peeling if the end product relies on water or oil binding, swelling, or light structure.
- Consider Peeling Only When Smooth Texture or Appearance is Prioritize. For products where smoother texture or color is needed (like baby food or fine-texture baking), peeled flour may still be useful, but functional losses should be accounted for.

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