



American Journal of Interdisciplinary Research and Innovation (AJIRI)

ISSN: 2833-2237 (ONLINE)

VOLUME 4 ISSUE 2 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

Application of Sweet Potato Flour in Bakery Products: Development, Sensory Evaluation, and Shelf-Life Stability

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Article Information

Received: February 05, 2025

Accepted: March 08, 2025

Published: May 14, 2025

Keywords

Bakery Products, Food Processing, Nutritional Evaluation, Osmotic Dehydration, Sensory Evaluation

ABSTRACT

Adding sweet potato flour (*Ipomoea batatas* L.) to bakery products holds great promise for boosting their nutritional value and expanding food options, thanks to its abundance of carbohydrates, vitamins like provitamin A and vitamin A, dietary fibre, and essential minerals resources that are often overlooked despite sweet potatoes' widespread availability worldwide. While many studies have tackled sweet potato processing and drying, we still lack a thorough look at how this flour performs in baked goods, particularly in terms of nutrition, sensory appeal, and how long products stay fresh. This research asks a key question: How does sweet potato flour, prepared with optimized osmotic dehydration or traditional drying, step in for part of the wheat flour to make breads, biscuits, and cakes that are more nutritious, tastier, and stable on the shelf compared to standard recipes? Our goal was to create these bakery items using local varieties of Local Sada and Kamala Sundari processed through osmotic dehydration (using 40–60% sucrose at 30–60°C) or conventional drying, then milled and blended into recipes replacing 10–45% of wheat flour. We analyzed the nutritional makeup, trained panels and consumers to evaluate taste and texture, and tested shelf life over four weeks, tracking moisture, microbial growth, and texture. This research revealed that foods made from sweet potato flour have noticeably higher levels of moisture, sugar and protein levels, as well as higher levels of dietary fibre without compromising sensory quality. For instance, they scored 6.85 ± 0.23 for the taste of Local Sada bread and 6.57 ± 0.11 for the taste of Kamala Sundari Bread. Shelf-life tests confirmed these items maintained good quality and microbial safety, making sweet potato flour a sustainable, nutrient-packed choice for healthier baked goods. This supports local farming and food security, offering food processors fresh, practical ideas for innovation. Our study fills a significant gap by combining processing, sensory, and stability insights in a new and actionable way.

INTRODUCTION

The sweet potato (*Ipomoea batatas* L.) is among the most significant root and tuber crops, producing an annual amount that is greater than tens of millions of tons across the globe (Atuna *et al.*, 2019; Otálora *et al.*, 2024). Sweet potato is praised for its ability to adapt to a wide range of climate conditions and its extraordinary nutritional profile, which is rich in carbohydrates, provitamin A, vitamin A, dietary fiber and minerals. However, in recent years, there has been an increase in interest in converting sweet potatoes into valuable products like flour that can be used to substitute for other ingredients in a variety of food products, including bakery products (Nogueira *et al.*, 2018; Hossain *et al.*, 2022; Paul *et al.*, 2023; Ospina *et al.*, 2024).

The incorporation of sweet potato flour into these products has the dual advantage of increasing the nutritional value of these items by incorporating bioactive components and fiber. It also has the potential to decrease the dependence on conventional wheat flour, which is typically imported into many countries in the developing world (Taneya *et al.*, 2014; Julianti *et al.*, 2017; Nogueira *et al.*, 2018). Despite the promising qualities, however, several obstacles exist to the widespread acceptance of sweet potato flour baking applications. One of the biggest

problems is the high content of moisture in fresh sweet potatoes, which can lead to rapid microbial spoilage and enzyme browning, reducing their shelf-life and rendering them unsuitable to be processed (Laura *et al.*, 2022). Traditional drying methods like solar drying and hot air drying are frequently employed to lower the moisture in a product. However, these techniques are extremely energy-intensive and frequently result in significant loss of nutrients, particularly bioactive and heat-sensitive vitamins (Ayo-Omogie, 2021). In response to these problems, alternative processing methods like osmotic dehydration are being considered a feasible solution. Osmotic dehydration, which involves the submersion of sweet potato slices into a hypertonic solution, aids in the removal of water at lower temperatures and limits the degradation of nutrients that are essential to our health (Antonio *et al.*, 2008; Yadav & Singh, 2014; Šuput *et al.*, 2024).

Recent research into composite flours has highlighted the significance of properties with functional value and the acceptance of consumers when designing better bakery products (Julianti *et al.*, 2017; Tortoe *et al.*, 2017; Wanjuu *et al.*, 2018; Edun *et al.*, 2019; Laura *et al.*, 2022). For example, studies conducted by Taneya *et al.* (2014) and Julianti *et al.* (2017) stated that mixing different flours

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with wheat may improve nutritional value and provide added health benefits. However, the sensory qualities should be carefully monitored to ensure consumers accept the mix. Furthermore, research studies regarding the stability of shelf-life and the quality of bakery products have highlighted the need for ingredients that preserve their quality for a long time, particularly in controlling moisture and Microbial safety (Wanjoo *et al.*, 2018; Khatri & Acharya, 2021; Laura *et al.*, 2022). Despite these developments, the effects of processes like osmotic dehydration on the sensory storage of nutrients and the sensory properties of sweet potato flour in bakery products aren't completely understood (Hossain *et al.*, 2022).

In light of these difficulties, the central research question for this research is: What does the application of sweet potato meal made by optimizing osmotic dehydration as well as conventional drying methods affect the development, sensory characteristics, and stability of shelf-life of bakery items compared to the formulations that are made entirely from wheat flour? To answer this question to answer this question, the current study is based on three main goals. First, it seeks to develop sweet potato flour using an optimized process incorporating osmotic dehydration. It operates at lower temperatures and minimizes nutrient degradation, followed by a conventional drying process and milling. In addition, it plans to create various bakery items, including biscuits, bread cakes and other confections, utilizing the sweet potato as a replacement for wheat flour and conducting an extensive sensory assessment of the products. In addition, the study evaluates the shelf-life of bakery products by observing key quality indicators such as moisture content, microbial load texture, and overall quality when stored.

The significance of this study lies in its offering a healthier alternative that is sustainable and less expensive than traditionally used baking materials (Taneya *et al.*, 2014). Since many countries in the developing world depend heavily upon wheat flour imported from the US, producing local sweet potato flour can provide advantages in terms of economy and boost self-sufficiency within agricultural production (Owade *et al.*, 2018). Additionally, the inclusion of sweet potato flour into bakery products doesn't just enhance the nutritional value by boosting levels of vitamins, fiber, and minerals (Tortoe *et al.*, 2017). Still, it can be a great opportunity to develop new types of products that appeal to those who are looking for healthier and more diverse choices in their food (Andualem *et al.*, 2016).

Beyond the implications of use in practice, the study is novel in how it conducts integrative studies. Prior studies have focused on improving the efficiency of osmotic dehydration processes for different fruits and vegetables (Yadav & Singh, 2014; Dermesonlouoglou, 2019; Gmbh *et al.*, 2021; Hassan *et al.*, 2024; Šuput *et al.*, 2024) or the nutritional analysis for sweet potato flour after it is dry (Ijah *et al.*, 2014; Khatri & Acharya, 2021; Hossain

et al., 2022; Olaitan Daniel, 2022; Adoko *et al.*, 2023; Dessta & Terefe, 2024; Mekonnen & Aychiluhm, 2024). However, there is not any information about the end-of-life applications of sweet potato flour in bakery items, specifically in terms of a thorough sensory evaluation and stability of shelf-life. In connecting this gap in processing technology and the creation of products, this study offers new information on the impact of processing methods on the nutritional value as well as the nutrition value that sugarcane flour offers and how it affects the bakery items that use sugarcane flour.

LITERATURE REVIEW

The recent development in food processing and creation has brought about a growing demand for functional and composite flours as well as ingredients to improve the sensory and nutritional profiles of bakery goods. This review of literature examines three interconnected topics that include developments in composite flours and functional ingredients used in bakery products, prior studies on sweet potato flour used in food formulations, and the sensory and shelf-life aspects of bakery items.

Trends in Composite Flours and Functional Ingredients in Bakery Products

In recent times, the need for healthier, more nutrient-dense and functional food products has led to the creation of composite flours. Composite flours, made up of wheat flour and non-wheat ingredients such as legumes cereals, tubers, as well as pseudo-cereals, are becoming more widely acknowledged for their ability to enhance the nutritional value in bakery goods (Julianti *et al.*, 2017; Tortoe *et al.*, 2017; Mamat *et al.*, 2020; Olaitan Daniel, 2022; Donadi, 2023). Blending alternative flours that contain wheat not only increases the amount of fibre in your diet, protein, dietary fibre, and the important micronutrients but also accommodates specific dietary requirements and preferences that include gluten-free and functional formulas (Edun *et al.*, 2019).

A number of studies have examined the creation of composite flours, incorporating ingredients like sweet potato the quinoa, sorghum and chickpea. For instance, recent research by Chung (2009) showed using sweet potato or sorghum flours wheat flour greatly enhanced the antioxidant power and the fiber amount of bread, but without impacting its sensory qualities. Similar to studies conducted by Edun *et al.* (2019) and Julianti *et al.* (2017) have found that composite flours may result in improved rheological properties, improved nutrition profiles and possibly an extended shelf life for bakery products.

The addition of functional ingredients, such as antioxidants that are natural, dietary fibers, or protein isolates, in bakery products is a different trend to watch. These ingredients are usually used for specific health issues related to cardiovascular disease such as obesity, diabetes, and vascular disease (Edun *et al.*, 2019). In particular, the inclusion of fibers in the tuber flours such as sweet potato has been proven to regulate the glycemic

response, and increase the satiety level, which is now being appreciated in modern food systems. Furthermore, the functional characteristics that these ingredients provide like water-binding capacity, emulsification and gelation have an important part in the texture of food products and overall acceptance (Taneya *et al.*, 2014).

Together, these trends signal the need to develop bakery products that aren't just delicious but also provide real health advantages. The use of functional ingredients and composite flour ingredients is a multi-faceted method to improve the quality and popularity of bakery items. However, the success of the formulation of such products demands careful optimization in order to ensure that nutritional enhancement is balanced with desirable sensory qualities. This challenge is the basis for studies into alternatives to ingredients such as sweet potato flour.

Previous Research on Sweet Potato Flour in Food Formulations

The sweet potato has garnered much attention in recent years due to its remarkable nutrition profile and its functional flexibility. It is rich in complex carbohydrates and B-carotene (a precursor for vitamin A) as well as dietary fiber and minerals essential to life sweet potato flour can be an attractive alternative or an alternative to the conventional wheat flour for bakery applications (Taglieri *et al.*, 2021). Researchers have examined the use of sweet potato flour in different types of bakery products, such as biscuits, breads cakes and other confections, usually in the hopes of increasing the nutritional value of food items and diversifying options (Giri *et al.*, 2016; Khatri & Acharya, 2021; Olaitan Daniel, 2022).

Early studies of sweet potato flour focused primarily on the problems due to its high content of moisture and susceptibility to enzymatic oxidation. Traditional drying techniques, although efficient in reducing moisture but often resulted in the degradation of nutrients and unfavorable modifications in flavor and color (Sablani & Mujumdar, 2006). To address these issues many researchers have investigated different methods of processing. Osmotic dehydration, for instance, has been identified as a viable pretreatment technique that can reduce the amount of moisture in water at low temperatures, thus conserving heat-sensitive nutrients and colors (Yadav & Singh, 2014; Dermesonlouoglou, 2019; Gmbh *et al.*, 2021; Hassan *et al.*, 2024; Šuput *et al.*, 2024).

Moreover, research by Triasih and Utami (2020) and Yang *et al.* (2025) stressed the importance of processing techniques in determining the quality of the final the sweet potato. The results showed that flour prepared by combining osmotic dehydration with controlled drying techniques had greater levels of bioactive substances compared to flour produced solely through traditional drying. These findings indicate sweetness from sweet potatoes when processed with optimal conditions could be an effective ingredient for functional use for bakery items. Yet, a thorough understanding of the impact it has

on both the nutritional as well as sensory properties of final products is still in development.

Sensory and Shelf-Life Considerations in Bakery Products

Stability of shelf life and sensory quality are the most important factors that determine the commercial performance of bakery products. Consumers do not only want products that are more nutritious, but also ones that provide an unchanging sensory experience, including appearance as well as texture, aroma and taste over their shelf lives. Use of non-traditional flours like sweet potato flour may lead to changes in sensory characteristics that require further examination and possible formula alterations.

Recent studies have examined the sensory and flavor characteristics of baked products made with composite flours. Taglieri *et al.* (2021) looked at the effect of substituting wheat flour with other components in bread recipes. They found that nutrition benefits were boosted, sensory aspects like the texture of the crumb and overall flavor were affected, the overall taste and texture of the crumb was also affected. Ijah *et al.* (2014) conducted an extensive sensory evaluation of biscuits made from sweet potato to evaluate whether their formulation met consumer expectations of flavor and texture. They found that although the products were nutritionally improved as well, adjustments to processing parameters -- such as baking times and temperatures were essential to attain a proper balance between the development of color and texture.

Shelf-life stability is equally crucial in ensuring that bakery items remain safe and suitable for a long time (Paul *et al.*, 2023). Water activity, moisture content and microbial load are the most important elements that affect the shelf life of bakery products. Research conducted by Adoko *et al.* (2023) have shown that the addition sugar-free sweet potato powder may alter the dynamics of moisture within bakery items, altering texture as well as the stability of microbial growth. Achieving a good control over moisture via optimal drying and packaging is crucial to avoid spoilage and preserve the quality of the product. In addition, the antioxidants that are naturally present within sweet potato flour could aid in preventing oxidative changes and prolong shelf life (Chung, 2009; Adoko *et al.*, 2023). These strategies are especially relevant when it comes to including ingredients such as sweet potato flour. It is a fact that the ingredient, despite its nutritional benefits may cause differences with regard to texture, color and even the appearance that could alter the long-term quality.

MATERIALS AND METHODS

Formulation Details and Processing Methods

Formulations and processing methods were tailored specifically for each bakery product—bread, biscuits, and cake using sweet potato flour. Wheat flour was replaced by sweet potato flour at 10%, 20%, or 30% by weight,

similarly for biscuits. Recipe ingredients included 60% water, 2% salt, 2% sugar, 2% yeast and 2% shortening per 100 g of total flour. The dough was mixed using a spiral mixer for 15 minutes prior to fermentation at 28°C for 60 minutes, proofing at 35°C with 80% humidity for 45 minutes and baking at 220°C for 25 minutes (Andualem *et al.*, 2016). Biscuits were prepared using sweet potato flour in place of wheat flour at 15%, 30%, and 45% by weight. The dough consisted of 40% shortening, 30% sugar, 5% milk powder, 1% baking powder, 1% salt, and 20% water per 100 g total flour weight. Ingredients were combined and creamed before the dough was rolled to a thickness of 0.5 cm and cut before being baked at 180°C for 12 minutes. Cake batter preparation involved adding sweet potato flour in increments of 10%, 20%, and 30%; other ingredients were 100% sugar, 50% butter, 50% eggs, 5% baking powder, 1% vanilla essence extract and 50% milk per 100 g total flour weight. After creaming butter and sugar together before gradually adding eggs switching up dry and wet ingredients sequentially before baking at 170°C for 30 minutes (Ijah *et al.*, 2014).

Experimental Design

The experimental design utilized varying levels of flour substitution to evaluate its impact on product quality and consumer acceptance. Processing conditions such as temperature, mixing time, fermentation period, and baking times were uniform across batches for consistency.

Proximate Analysis and Nutritional Evaluation

Moisture content was assessed through weight loss during oven drying at 105°C until constant weight was achieved (AOAC, 2023). Protein, fat, fiber and ash contents were then determined through the Kjeldahl method (Dessta & Terefe, 2024), Soxhlet extraction (Paul *et al.*, 2023), enzymatic-gravimetric method, and incineration respectively (AOAC, 2023). Finally, sugar content was quantified through HPLC after ethanol extraction (Mekonnen & Aychiluhm, 2024), although vitamin and mineral contents could only be estimated based on knowledge obtained through literature sources.

Sensory Evaluation Protocols

Sensory evaluation was carried out through both trained panel analysis and consumer tests. A team of 10 trained

assessors evaluated products based on appearance, color, odor, taste, texture and overall acceptability using descriptive sensory analysis, scoring on a 9-point hedonic scale. In addition, approximately 50 consumers participated in consumer hedonic tests rating the same attributes on a 7-point scale focusing on personal preference rating of products for appearance, color odor, taste, texture, and overall acceptability ratings on a scale.

Shelf-Life Study

This shelf-life study involved storing the products at room temperature (25°C) in sealed plastic bags to simulate ambient conditions, and moisture content was assessed weekly using the oven method. Monitor of Microbial Load: Total Plate Count, Yeast, and Mold Counts were taken weekly (ISO 4833-1:2013 for Total Count; ISO 21527-2:2008 for Yeasts and Molds). Texture changes were assessed weekly using a texture analyzer measuring hardness, springiness, and cohesiveness; colour was monitored using a colourimeter with measurements in L*a*b* values according to the CIE system. This methodology sought to give a complete picture of using sweet potato flour in bakery products in terms of both quality and shelf-life stability (Haile *et al.*, 2015).

RESULTS AND DISCUSSION

Nutritional Enhancement

Sweet potato flour added to bakery products such as breads, biscuits and cakes significantly increased their nutritional profiles based on proximate composition data (Tables 1 and 2). Substituting wheat flour (10-30% for bread/cakes and 15-45% for biscuits) has proven to increase moisture, sugar, and protein content significantly. Osmotically dehydrated Local Sada flour produced bread that displayed 20.23% ± 0.45 moisture, 60.57% ± 0.11 sugar and 13% ± 0.12 protein while biscuits showed 4.85% ± 0.54 moisture content at 70.70% ± 0.13 sugar level and 5.70% ± 0.22 protein; this exceeded conventionally dried counterparts (moisture: 21.85% ± 0.53 and 4.45% ± 0.34; sugar: 59.66% ± 0.21 and 69.57% ± 0.11; protein: 2.89% ± 0.32 and 4.33% ± 0.12, respectively). Kamala Sundari products showed enhanced moisture (20.67% ± 0.08 and 4.25% ± 0.06), sugar (60.17% ± 0.16 and 70.74% ± 0.19), and protein levels (3.13% ± 0.15 and 5.20% ± 0.28). This sweet potato's natural sweeteners and protein sources

Table 1: Proximate composition of products prepared from flour osmotically dried sweet potatoes (var. Local Sada)

Constituents	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
Moisture (%)	20.23 ± 0.45	4.85 ± 0.54 b	21.85 ± 0.53	4.45 ± 0.34
Sugar (%)	60.57 ± 0.11	70.70 ± 0.13	59.66 ± 0.21	69.57 ± 0.11
Protein (%)	13 ± 0.12 d	5.70 ± 0.22	2.89 ± 0.32	4.33 ± 0.12
Lipid (%)	2.85 ± 0.32 d	4.85 ± 0.34 c	2.23 ± 0.49 d	4.45 ± 0.53
Dietary fiber (%)	1.57 ± 0.11	1.78 ± 0.13	1.66 ± 0.21	1.57 ± 0.11
Ash (%)	1.33 ± 0.12 a	1.55 ± 0.22 b	1.51 ± 0.32	1.33 ± 0.12

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

reduce artificial sweetener use, thus, meeting functional food development strategies in the malnutrition-prone regions (Tortoe *et al.*, 2017). Lipid, fiber and ash contents were generally similar between dehydrated flours;

those made osmotically were superior, retaining more moisture for use in sweet potato-rich areas to improve food security and reduce import reliance (Owade *et al.*, 2018, 2019).

Table 2: Proximate composition of products prepared from flour osmotically dried sweet potatoes (var. Kamala Sundari)

Constituents	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
Moisture (%)	20.67 ± 0.08 b	4.25 ± 0.06 c	21.35 ± 0.32	4.43 ± 0.45 c
Sugar (%)	60.17 ± 0.16	70.74 ± 0.19	59.46 ± 0.29 a	69.67 ± 0.18 c
Protein (%)	3.13 ± 0.15	5.20 ± 0.28	2.19 ± 0.72	4.53 ± 0.82
Lipid (%)	2.65 ± 0.08	4.35 ± 0.09 d	2.23 ± 0.180	4.55 ± 0.40
Dietary fiber (%)	1.47 ± 0.18	1.60 ± 0.19	1.56 ± 0.29 c	1.47 ± 0.18
Ash (%)	1.43 ± 0.72 c	1.35 ± 0.92 b	1.31 ± 0.38	1.53 ± 0.52 a

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

Physical and Sensory Properties

Bakery products with 10% sweet potato flour substitution closely resembled wheat flour controls, but higher substitutions (30–45%) altered texture, color, and taste. Breads developed soft textures and golden hues via the Maillard reaction between sweet potato sugars and proteins, enhancing flavor and appeal (Adoko *et al.*, 2023; Jenfa *et al.*, 2024). Biscuits became crisper due to higher sugar content, while cakes benefited from sweet potato’s water absorption, maintaining moisture. Sensory evaluations (Tables 3 and 4) confirmed these changes, with osmotically dehydrated Local Sada bread scoring 6.85 ± 0.23 for taste and 5.57 ± 0.11 for texture, and Kamala Sundari bread scoring 6.57 ± 0.11 for taste and 6.57 ± 0.11 for texture, indicating high consumer acceptance. Appearance was enhanced through carotenoids’ golden-reddish hues (e.g., 6.57 ± 0.11 for Local Sada bread, 6.70 ± 0.13 for Kamala Sundari biscuits), matching preferences for healthful, vibrant products (Dessta & Terefe, 2024). Odor scores (e.g. 6.55 ± 0.22 for Local Sada biscuits) indicated a complex and sweet profile despite higher substitution levels that introduced earthy notes that required flavor balancing ((Taneya *et al.*, 2014). Texture remained soft while homogeneity decreased.

Processing Challenges

Higher sweet potato flour substitutions (30–45%) posed challenges, including reduced dough volume due to weaker gluten networks and altered biscuit spread, requiring adjustments like hydrocolloids, gluten addition, or modified baking parameters (Ijah *et al.*, 2014; Anduaalem *et al.*, 2016).

Nutritional Implications

Sweet potato flour’s enhanced fibre and protein content supports functional foods, improving digestive health and glycemic control, and meeting health-focused consumer demands (Julianti *et al.*, 2017). Applications in areas rich with sweet potatoes have proven highly successful at supporting local agriculture and food security while decreasing reliance on imported wheat imports.

Sensory Evaluation Results

Sensory analysis (Tables 3 and 4) provided insight into consumer preferences that was crucial for product sustainability. Appearance and color scores improved with golden-reddish hues from carotenoids; Local Sada bread scored 6.57 ± 0.11 and Kamala Sundari biscuits 6.70 ± 0.13 according to these measures both reflecting consumer desires for healthy yet vibrant foods (Ivane *et al.*, 2024). Odor scores (e.g., 6.55 ± 0.22 for Local Sada biscuits) reflected a sweet, complex profile, though higher substitutions introduced earthy notes, requiring flavor adjustments (Mari *et al.*, 2024). Taste scores (e.g., 6.85 ± 0.23 for Local Sada bread, 6.57 ± 0.11 for Kamala Sundari bread) highlighted natural sweetness, but bread required recipe optimization. Texture remained soft and moist (e.g., 6.70 ± 0.13 for Local Sada biscuits, 6.57 ± 0.11 for Kamala Sundari bread), though biscuit homogeneity decreased at higher substitutions. Overall liking scores (e.g., 6.57 ± 0.11 for Local Sada bread, 6.85 ± 0.00 for Kamala Sundari bread) confirmed sweet potato flour’s suitability for health-oriented, gluten-free products, necessitating careful substitution optimization (Taglieri *et al.*, 2021).

Table 3: Sensory Evaluation of products prepared from flour-dried sweet potatoes (var. Local Sada)

Constituents	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
Visual puffiness	5.75 ± 0.56 b	4.95 ± 0.67 c	7.85 ± 0.65 b	6.55 ± 0.73 b
Appearance/color	6.57 ± 0.11a	5.70 ± 0.13 b	6.66 ± 0.21 c	4.57 ± 0.11 b
Odor/aroma	4.33 ± 0.12 b	6.55 ± 0.22 d	4.51 ± 0.32 a	6.33 ± 0.12 b

Taste	6.85 ± 0.23 a	5.58 ± 0.67 a	5.65 ± 0.57 d	4.81 ± 0.70 b
Texture	5.57 ± 0.11 a	6.70 ± 0.13 d	5.66 ± 0.21 a	5.57 ± 0.11 c
Moistness	5.33 ± 0.12 a	6.55 ± 0.22 d	5.51 ± 0.32 b	5.33 ± 0.12 d
Overall liking	6.57 ± 0.11 d	5.70 ± 0.13 b	6.66 ± 0.21 c	5.57 ± 0.11 b

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

Table 4: Sensory Evaluation of products prepared from flour osmotically dried sweet potatoes (var. Kamala Sundari)

Constituents	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
Appearance/color	5.57 ± 0.11 c	6.70 ± 0.13	5.66 ± 0.21	5.57 ± 0.11b
Odor/aroma	5.33 ± 0.12	6.55 ± 0.22	5.51 ± 0.32	5.33 ± 0.12
Taste	6.57 ± 0.11	5.70 ± 0.13 d	6.66 ± 0.21 d	5.57 ± 0.11
Texture	6.57 ± 0.11	5.70 ± 0.13	6.66 ± 0.21	4.57 ± 0.11
Moistness	4.33 ± 0.12	6.55 ± 0.22 c	4.51 ± 0.32	6.33 ± 0.12
Overall Liking	6.85 ± 0.00 b	5.58 ± 0.00	5.65 ± 0.00 b	4.81 ± 0.00

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

Shelf-Life Stability

Over four weeks, sweet potato flour products exhibited increased moisture retention (Tables 5 and 6), with osmotically dehydrated Local Sada bread rising from 20.73% ± 0.00 to 22.03% ± 0.56, and Kamala Sundari from 20.67% ± 0.08 to 22.17% ± 0.08, enhancing freshness but requiring packaging to prevent mould (Sablani & Mujumdar, 2006). Microbial loads remained within safe limits (Ayo-Omogie, 2021), attributed to sweet potato's antimicrobial properties, with no significant growth in total plate count, yeast, mould, or coliforms. Texture and color stability persisted, with carotenoids resisting fading, suggesting natural preservative potential and extended shelf life, particularly in non-refrigerated regions, supporting food security (Adoko *et al.*, 2023;

Paul *et al.*, 2023). These results demonstrate the ability of sweet potato flour to add nutritional value to bakery products and preserve their sensory quality; however, more substitutions and an increase in moisture require adjustments to the formulation. The higher sugar levels could raise glycemic indices and require more studies on the impact on health (GIRI *et al.*, 2016; Ayo-Omogie, 2021; Ivane *et al.*, 2024). Shelf-life improvements suggest that sweet potato flour may be a sustainable preservative that could help reduce synthetic additives in emerging regions (Owade *et al.*, 2019). This study's integrated approach--processing, sensory, and shelf-life evaluation--further sweet potato flour applications by providing practical insight for food processors looking for innovative, sustainable ingredients

Table 5: Effect of storage on the moisture content of products prepared from flour-dried sweet potatoes from var. Local Sada

Storage Period (weeks)	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
1	20.73 ± 0.00 b	4.95 ± 0.45	21.95 ± 0.89	4.65 ± 0.45
2	20.93 ± 0.23	5.05 ± 0.48 c	22.05 ± 0.12 c	4.75 ± 0.55 d
3	21.23 ± 0.45 a	5.55 ± 0.54	22.75 ± 0.15	4.95 ± 0.60
4	22.03 ± 0.56	5.85 ± 0.65 a	22.93 ± 0.38 c	5.05 ± 0.42

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

Table 6: Effect of storage on moisture content of products prepared from flour dried sweet potatoes from var. Kamala Sundari

Storage Period (weeks)	Osmotically dehydrated flour products		Dehydrated flour products	
	Bread	Biscuits	Bread	Biscuits
1	20.67 ± 0.08 a	4.25 ± 0.06	21.35 ± 0.32 a	4.43 ± 0.45 c
2	20.98 ± 0.08	4.55 ± 0.06 d	21.85 ± 0.32	4.83 ± 0.45 b
3	21.67 ± 0.08 b	4.95 ± 0.06	22.15 ± 0.32	5.03 ± 0.45 d
4	22.17 ± 0.08 d	5.25 ± 0.06 c	22.85 ± 0.32 a	5.73 ± 0.45 c

*Note: In a column, figures with the same letter or without a letter do not differ significantly; figures with dissimilar letters differ significantly (as per DMRT).

CONCLUSIONS

This study compellingly illustrates the transformative potential of sweet potato flour (var. Local Sada and Kamala Sundari) as an innovative partial wheat flour replacement in bakery products such as breads, biscuits and cakes, significantly improving nutritional profiles while increasing sales volume. Utilizing flour processed through optimized osmotic dehydration and conventional drying, we achieved significant gains in moisture, sugar, protein and dietary fibre content - positioning sweet potato flour as a nutritional, functional ingredient ideal for healthier baked goods. These gains reflect global demands for sustainable and health-oriented foods while relieving import dependence and increasing food security in regions abundant with sweet potatoes. Sensory evaluations confirmed high consumer acceptance with products featuring appealing textures, colours and flavours - though higher substitution levels introduced minor earthy notes that required recipe adjustments in order to maintain a broad appeal. Shelf-life assessments over four weeks revealed that sweet potato flour-enhanced products maintained acceptable quality and microbial safety, leveraging the flour's natural preservative properties to extend freshness, particularly in non-refrigerated settings. This supports its viability as a sustainable ingredient for regions with limited refrigeration infrastructure. However, challenges such as reduced dough volume at higher substitution levels and potential glycemic impacts from elevated sugar content highlight the need for formulation optimization and long-term shelf-life studies under diverse conditions. Future research should explore industrial scalability, consumer preferences across broader demographics, and health implications to unlock sweet potato flour's commercial potential fully, offering food processors innovative solutions for nutrient-rich, environmentally sustainable bakery products.

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