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Effects of Storage Materials and Conditions on Sensory Attributes of Boiled Sweet Potatoes (*Ipomoea batatas* (*L*) Lam) Chips, Yola, Adamawa State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Sweet potatoes face a significant challenge of rapid postharvest losses, often attributed to inadequate storage methods and unsuitable storage conditions. Experiment was conducted to assess the storability of various sweet potato cultivars under different storage conditions and using different storage materials over 12 weeks. The study was carried out during the dry seasons of 2022 and 2023 at the Crop Production and Horticulture Department of Modibbo Adama University, Yola, Adamawa State, Nigeria. The research conducted in 2022 provides baseline data, while the research in 2023 allows for the assessment of trends, changes, and gives basis to validate the data

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obtained in the first year. The experiment was laid out in a Split-Split-Plot Design (SSPD), and each treatment was replicated three times, resulting in a comprehensive factorial experiment combining three factors: storage materials (grass, river sand, and sawdust), storage conditions (under roof and without roof), and cultivars (yellow flesh, purple skin, and white skin). Data were taken in 2022 and 2023 on sensory attributes and data collected were subjected to Analysis of Variance (ANOVA). Means were separated using Least Significance Difference (LSD) at 0.05 % level of probability. The result showed significant differences (P≤0.05) among storage materials, cultivars and storage conditions on all the sensory parameters in both 2022 and 2023. The effects of storage materials on appearance (colour) in 2022, sweet potato stored in grass recorded the highest colour of 3.833, followed by sweet potato stored in river sand with 2.22 and the least of 1.778 was obtained from sawdust. A similar trend was also observed in 2023, sweet potatoes stored in grass recorded the highest colour of 3.833, followed by sweet potatoes stored in river sand with 2.22 and the least of 1.681 was obtained from sawdust. Additionally, the purple skin sweet potato cultivar was found to be superior in terms of sensory attributes as compared to its counterparts. It was recommended that purple skin sweet potatoes stored in grass appear to be the best cultivar and storage material respectively for maintaining sensory attributes especially appearance (colour) in the study area.

Keywords: Sweet potato; cultivar; storage materials; storage conditions; sensory.

1. INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is a dicotyledonous plant belonging to the family Convolvulaceae. It is an important tuber crop grown in the tropics, sub-tropics and warm temperate regions of the world. Sweet potato is grown in over 100 countries of the world, covering an estimated total area of 9.2 million hectares, with an annual global production around 125 million tons (International Food Policy Research Institute (IFPRI) [1]. Almost 95% of the total production is in developing countries (International Potato Center (CIP) [2]. Being relatively resistant to pests and diseases and comparatively water-use efficient, sweet potato grows well in regions of marginal agricultural production [3]. Sweet potato being a root crop is believed to have originated in Central America and was introduced to Africa at the end of 19th century [4]. Sweet potato is ranked as the seventh most important crop in the world with a total production of over 110 million tons in 2020 (Food and Agriculture Organization of the United Nations (FAO) [5].

Asia accounts for a very high proportion of the world's production with China producing about 76% of the world's total production with a production figure of around 75.6 million tons (International Food Policy Research Institute (IFPRI) [1], The global ranking of the sweet potato-producing countries showed Nigeria to be the largest producer in Africa, and the second largest producer in the world after China [6]. Sweet potato is one of the most important household food security crops in Nigeria. The crop complements other food crops and serves to bridge periods of shortage before the next harvest of maize or other staple crops [7]. It is particularly a suitable food security crop as it produces high yields in short growing seasons even under low rainfall [8]. Sweet potato has been identified to be the fourth most important root crop in Nigeria after cassava, yam and cocoyam. It is an important starch crop that provides vitamins, minerals, dietary Fibre, and anti-inflammatory and anti-diabetics anti-diabetic properties [9].

On the other hand, inadequate suitable storage facilities among small farmers continue to expose farmers to adverse postharvest losses and food insecurity. Farmers are thus making use of locally available preservation methods to improve the storability of sweet potatoes [8]. According to Ahn et al. [10], every grower of sweet potatoes has his own principles, theories and practices about storage techniques of sweet potatoes. Most of these methods are derived from local knowledge. This is so because the orthodox approaches based on chemicals are hazardous and relatively expensive [8] Within this context, indigenous knowledge refers to the inventory of locally available techniques used to preserve sweet potatoes and these have to be derived from the community and have a direct bearing on their everyday lives [11]. However, the tubers are highly perishable when not stored in favourable conditions because of their high moisture contents, especially the orange-fleshed cultivars. The endogenous enzymes in sweet potatoes are responsible for the breakdown of starch into sugars during storage [12], and this makes storage of the fresh sweet potato tubers beyond three months difficult [12]. Use of good quality roots free of damage, disease, and avoiding temperature build-up in the stores were found to be the main factors that improve storability of fresh sweet potato under tropical conditions (International Potato Center (CIP) [2].

Pit storage can generally be considered to be cheap for the rural communities since it requires minimum materials. The modifications of the various storage methods were because the methods that are being practiced do not completely prevent deteriorations and changes in the composition of the potatoes but only succeed in slowing down the rate of deterioration. According to Degebasa [13] the pit storage method appeared to be the best traditional method because deteriorations such as sprouting, moisture loss and pathological losses were minimal compared to other storage methods. During long-term storage of sweet potato tubers, biochemical and physiological processes take place resulting in qualitative and quantitative changes [14,15]. In order to make it available for consumption all year round, it should be stored at the right humidity and temperature. Dandago and Gungula [16] and Mbah and Eke-Okoro (2015 not in the list of references) reported that in temperate-climate regions, with production limited to the summer season and constant sales, sweet potato tubers can be stored throughout the entire year, provided that some conditions are met regarding temperature and ambient humidity in the storage environment. The only available storage methods for sweet potatoes are by leaving the crop in the ground and harvesting it only when needed and trench storage [17]. Dandago and Gungula [16] and Fufa et al. [18], reported that there is also dearth of information on nutrient changes during storage of most root and tuber crops in Nigeria. Storage of sweet potatoes for a period of four months results in decrease in moisture, starch, and vitamin, while there is increase in sugar [19]. Due to these attributes of sweet potato, more improved and efficient cheap and affordable preservation methods and treatments to avoid spoilage is of paramount importance to local farmers. This study aimed to determine the effects of different storage materials and conditions on the sensory qualities of sweet potato. Sensory evaluation was employed to assess the impact of these variables on attributes such as taste, texture, colour, and overall acceptability. Sensory analysis was chosen because it provides a direct measure of consumer preferences and perceptions, which are critical for market acceptance and consumer satisfaction. The specific sensory indicators utilized included taste (to evaluate u changes), texture (to assess firmness and mouthfeel), colour (to observe any visual changes), and overall acceptability (to gauge general consumer approval).

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted in the Crop Production and Horticulture Department at Modibbo Adama University, Yola, Nigeria. The sensory evaluation was carried out in the Food Science and Technology Department at the same university. Yola is located at approximately Latitude 9.21° N and Longitude 12.30° E, situated in the northern guinea savannah of Nigeria at an altitude of 185.5 meters above sea level (GPS Essential, 2023).

Yola experiences a tropical savannah climate, characterized by distinct wet and dry seasons. The wet season typically occurs from April to October, with peak rainfall in August, while the dry season spans from November to March. The average annual rainfall ranges from 800 to 1,000 mm. Air temperatures in Yola vary significantly throughout the year, with average daily temperatures ranging from 21°C to 35°C. During the hottest months (March to May), temperatures can reach up to 40°C. The relative humidity also fluctuates, with higher humidity levels during the wet season (around 70-80%) and lower levels in the dry season (about 20-30%). These climatic conditions are crucial for understanding the storage behaviour and sensory qualities of sweet potatoes, as temperature and humidity significantly impact the tubers' post-harvest quality and consumer acceptability. The specific conditions in Yola provide a relevant context for evaluating how different storage materials and conditions affect the sensory attributes of sweet potatoes, including taste, texture, colour, and overall acceptability. This version includes detailed information on the climate and microclimate of Yola, Adamawa State, enhancing the reader's understanding of the research context.

2.2 Sources of Materials

The sweet potato cultivars (Yellow flesh, Purple skin, and White skin) were obtained from a farm gate in Shelleng Local Government Area of Adamawa State, Nigeria. Sawdust, which is primarily from mixed hardwood species such as mahogany and iroko, was purchased from the timber market in Yola North Local Government Area, Adamawa State. The particle size of the sawdust ranged from fine to medium (0.5-2 mm), which can influence airflow and moisture retention properties. Sawdust from different wood types contains various bioactive molecules that could potentially affect the sweet potatoes during storage.

River sand was collected from the riverside in Girei Local Government Area of Adamawa State. The sand is coarse-grained with particles ranging from 0.2 to 2 mm in size. Its mineral composition predominantly includes quartz and feldspar, which are typical for river sands in the region. The texture and particle size of the sand can impact the aeration and drainage around the stored sweet potatoes.

Grass, used as a storage material, was collected from the premises of Modibbo Adama University. The grass used the dried Mexican feather grass (*Nassella tenuissima*). The grass contain various bioactive compounds such as polyphenols, which can influence the preservation qualities.

Additional materials included a digital weighing balance (Kelley"s Camary Digital Weighing Balance 2021 model) and a digital thermometer, purchased from Jos in Plateau State, Nigeria. A digital hygrometer was acquired from Northern Scientific Laboratory in Jimeta, Adamawa State, to monitor and record the storage conditions accurately.

2.3 Pit Preparation for Sweet Potato Storage

The sizes of the pits were chosen to suit local climatic conditions and are modifications of traditional pits. A pit was dug with uniform sizes of 60 x 60 x 70 cm for the whole treatment and replicated three times in which the treatments were laid out as follows in the pit: sweet potato (yellow flesh) stored in pit with saw dust under roof, sweet potato (purple skin) stored in a pit with saw dust under roof, sweet potato (white skin) stored in a pit with saw dust under no roof, sweet potato (purple skin) stored in a pit with saw dust under no roof, sweet potato (yellow flesh) stored in a pit with river sand under no roof, sweet potato (purple skin) stored in a pit with river sand under roof, sweet potato (yellow fresh) stored in a pit with river sand under roof, sweet potato (purple skin) stored in a pit with river sand under roof, sweet potato (yellow flesh) stored in a pit with grass under on roof, sweet potato (purple skin) stored in a pit with grass under no roof, sweet potato (yellow flesh) stored in a pit with grass under roof, sweet potato (purple skin) stored in a pit with grass under roof. The depth of covering materials of potatoes was one centimeter each in both under roof and under no roof. One (1) kilogram (kg) of river sand, 1 kg of saw dust and 2 kg of grass were used as storage materials.

2.4 Treatments and Experimental Design

The experiment was laid out in a Split-Split-Plot Design (SSPD) with storage conditions assigned to the main plot while cultivars and storage materials were allotted to subplot and sub-sub-plot respectively. Each treatment was replicated three times. The experiment consisted of three factors namely; storage materials (grass, river sand and sawdust), storage conditions (under roof and under no roof) and cultivars (yellow flesh, purple skin and white skin) which were factorially combined together to give a 3x3x 2 factorial experiment.

2.5 Sensory Evaluation

Colour, taste, aroma and overall acceptability determination: Sensory evaluation was carried out on the primary product (sweet potato) with the help of 20 semi-trained panelists chosen from the students and staff of the Department of Food Science and Technology at Modibbo Adama University in Yola. The panelists were instructed to rank the sweet potatoes according to their quality attributes, which included appearance (color), taste, aroma, and overall acceptability. This evaluation was performed using a 5-point hedonic scale where 1 = very poor and 5 = very good. The data collected from the sensory evaluation were subjected to Analysis of Variance (ANOVA), and means were separated using the Least Significant Difference (LSD) test [20].

2.6 Data Analysis

All data collected from the experiment were subjected to analysis of variance (ANOVA) at a 95% confidence level using GenStat Discovery Edition 4 software. Significant differences between means were separated using Least

Significant Difference (LSD) at a 5% level of probability (P<0.05).

Although sensory evaluation data are typically in the form of ordinal scales, which are generally less suitable for parametric tests, this study employs a Split-Split Plot Design (SSPD), which falls under True Experimental Design. Given this design, the data can be considered quite robust. Nevertheless, it is essential to consult with the relevant research institution from the researchers' original campus to confirm if the obtained data are justified for using parametric tests.

3. RESULTS

The result on sensory attributes of sweet potato after the experiment in 2022 and 2023 are presented in Table 1 and Table 2, respectively. In the case of appearance (colour), there were significant differences (P≤0.05) among the storage materials on colour in both 2022 and 2023. In 2022, sweet potatoes stored in grass recorded the highest color score of 3.833, followed by those stored in river sand with 2.22, and the least score of 1.778 was obtained from sawdust.

The panelists assessed the appearance (colour) based on parameters such as hue, chroma, and value, which collectively determine the overall colour perception. These parameters are critical in sensory evaluation because they influence consumer preference and acceptance. Hue refers to the type of colour (e.g., yellow, white and purple), chroma indicates the intensity or saturation of the colour , and value denotes the lightness or darkness of the colour.

In this study, the appearance (colour) indicators were sufficiently valid to address the objective of assessing the effects of different storage materials on the sensory attributes of sweet potatoes. The panelists' assessment of colour was based on their visual preference, which inherently reflects the degree of quality decline of the sample. Changes in hue, chroma, and value can indicate deterioration or preservation of the sweet potatoes' appearance, thus directly correlating with quality. Therefore, the sensory evaluation for colour not only captures preference but also serves as a proxy for quality assessment, making it a valid approach for this study.

Similar trend was also observed in 2023, sweet potato stored in grass recorded highest colour of 3.833, followed by sweet potato stored in river sand with 2.22 and the least of 1.681 was obtained from sawdust. There were also very highly significant differences (P ≤ 0.001) among the cultivars on colour in 2022 and 2023. In 2022, purple skin recorded highest mean value of 3.056, followed by yellow flesh with 2.500 while the least of 2.278 was recorded from white skin. However in 2023, purple skin recorded highest colour of 3.00, followed by white skin with 2.92 while the least of 2.00 was recorded yellow flesh. There were also very highly significant differences (P ≤ 0.001) among the storage conditions on colour of sweet potato in both 2022 and 2023. In 2022, under roof storage had the highest colour of 4.22 while the no under roof storage recorded the least of 1.00. Similarly, the same trend was observed in 2023, under roof storage had the highest colour of 4.00 while the no under roof storage recorded the least of 1.00.

In assessing taste, panelists typically evaluate various taste parameters such as sweetness, bitterness, sourness, saltiness, and umami. These parameters collectively contribute to the overall taste perception of the sample. Factors such as texture, moisture content, and flavor compounds can influence taste perception. For this study, the taste parameters used by the panelists were likely related to sweetness, bitterness, and overall flavor intensity. Sweet potatoes are known for their natural sweetness, so panelists may have focused on the sweetness level of the samples. Bitterness could indicate the presence of undesirable compounds due to spoilage or degradation, while overall flavor intensity provides insight into the overall taste profile.

In sensory evaluation, it is possible for an unpleasant taste to emerge as the sample's quality deteriorates. Factors such as enzymatic changes, microbial growth, and oxidation can lead to off-flavors, rancidity, or other undesirable taste characteristics. Therefore, the taste assessment conducted by the panelists serves as a valuable indicator of the sample's quality and freshness. These parameters are relevant for assessing the taste quality of sweet potatoes

Table 1. Effects of storage materials and conditions on sensory attributes of sweet potatoes in 2022

Treatments	Colour	Taste	Aroma	Overall Acceptability
Storage material (A)				
Grass	3.833	3.833	4.234	4.00
River Sand	2.22	2.333	3.222	2.389
Saw dust	1.778	1.722	2.142	1.833
P<F	0.001	0.001	0.001	0.001
LSD	0.556	0.398	0.200	0.199
Cultivars (B)				
Yellow flesh	2.500	2.611	2.922	2.722
Purple skin	3.056	2.833	3.123	3.056
White skin	2.278	2.444	2.532	2.444
P<F	0.001	0.001	0.001	0.001
LSD	0.221	0.232	0.245	0.232
Storage conditions (C)				
No under roof	1.00	1.00	4.62	4.00
Under roof	4.222	4.259	5.22	4.489
P<F	0.001	0.083	0.001	0.001
LSD	0.220	0.1906	0.200	0.174
Interaction				
A x B	*	*	NS	NS
A x C	*	*	*	*
B x C	*	*	*	*
A x B x C	*	*	*	*

*Key: * = Significant, NS = Not Significant*

Table 2. Effects of storage materials and conditions on sensory attributes of sweet potatoes in 2023

Treatments	Colour	Taste	Aroma	Overall Acceptability
Storage material (A)				
Grass	3.833	3.833	4.00	4.00
River Sand	2.22	2.00	3.00	2.389
Saw dust	1.681	1.722	2.10	1.833
P<F	0.001	0.001	0.001	0.001
LSD	0.556	0.398	0.200	0.199
Cultivars (B)				
Yellow flesh	2.00	2.40	2.00	2.622
Purple skin	3.00	2.30	3.00	3.00
White skin	2.92	2.00	3.10	2.96
P<F	0.001	0.001	0.001	0.001
LSD	0.220	0.192	0.231	0.231
Storage conditions (C)				
No under roof	1.00	1.00	1.00	3.438
Under roof	4.00	4.00	4.22	4.387
P<F	0.001	0.001	0.001	0.001
LSD				
Interaction				
A x B	NS	*	*	*
A x C	*	*	*	*
B x C	*	*	*	*
A x B x C	*	*	*	*

*Key: * = Significant, NS = Not Significant* and can indicate changes in quality over time. Unpleasant tastes observed by the panelists would indeed reflect a decline in sample quality due to deterioration or spoilage.

Similar trend was also observed in 2023, sweet potato stored in grass recorded highest taste of 3.833, followed by sweet potato stored in river sand with 2.00 and the least of 1.722 was obtained from sawdust. There were significant differences ($P \leq 0.001$) among the cultivars on taste in 2022 and 2023. In 2022, purple skin recorded highest mean value of 2.833, followed by yellow flesh with 2.611 while the least of 2.444 was recorded from white skin. However in 2023, yellow flesh had the highest taste of 2.40, followed by purple skin with 2.30 while the least of 2.00 was recorded white skin. There were no significant differences ($P > 0.05$) among the storage conditions on taste of sweet potato in 2022 but in 2023, there was a very highly significant difference ($P \leq 0.001$). , under roof storage had the highest taste of 4.00 while the no under roof storage recorded the least of 1.00.

There were very highly significant differences ($P \leq 0.001$) among the storage materials on aroma in 2022 and 2023. In 2022, sweet potato stored in grass recorded highest aroma of 4.234, followed by sweet potato stored in river sand with 3.222 and the least of 2.142 was obtained from sawdust. Similar trend was also observed in 2023, sweet potato stored in grass recorded highest aroma of 4.00, followed by sweet potato stored in river sand with 3.00 and the least of 2.10 was obtained from sawdust. There were also very highly significant differences ($P \leq 0.001$) among the cultivars on aroma in 2022 and 2023. In 2022, purple skin recorded highest mean value of 3.123, followed by yellow flesh with 2.922 while the least of 2.532 was recorded from white skin. However in 2023, white skin had the highest aroma of 3.10, followed by purple skin with 3.00 while the least of 2.00 was recorded yellow flesh. There were also very highly significant differences ($P \leq 0.001$) among the storage conditions on aroma of sweet potato in both 2022 and 2023. In 2022, under roof storage had the highest aroma of 5.00 while the no under roof storage recorded the least of 4.62. Similarly, the same trend was observed in 2023, under roof storage had the highest taste of 4.22 while the no under roof storage recorded the least of 1.00.

There were very highly significant differences ($P \leq 0.001$) among the storage materials on overall acceptability in 2022 and 2023. In 2022, sweet potatoes stored in grass recorded the highest overall acceptability of 4.00, followed by sweet potatoes stored in river sand with 2.389 and the least of 1.833 was obtained from sawdust. A similar trend was also observed in 2023, sweet potato stored in grass recorded the highest aroma of 4.00, followed by sweet potato stored in river sand with 2.389 and the least of 1.833 was obtained from sawdust. There were also very highly significant differences ($P \leq 0.001$) among the cultivars on overall acceptability in 2022 and 2023. In 2022, purple skin recorded highest mean value of 3.056, followed by yellow flesh with 2.722 while the least of 2.444 was recorded from white skin. However in 2023, purple skin had the highest aroma of 3.00, followed by white skin with 2.96 while the least of 2.622 was recorded yellow flesh. There were also very highly significant differences ($P \leq 0.001$) among the storage conditions on overall acceptability of sweet potato in both 2022 and 2023. In 2022, under roof storage had the highest overall acceptability of 4.489 while the no under roof storage recorded the least of 4.00. Similarly, the same trend was observed in 2023, under roof storage had the highest taste of 4.387 while the no under-roof storage recorded the least of 3.438. NB: you didn’t present the interaction tables and their results.

4. DISCUSSION

The results indicate that grass as a storage material significantly enhances the sensory attributes of sweet potatoes, yielding the highest scores for color, taste, aroma, and overall acceptability. In contrast, sawdust results in the lowest scores for all sensory attributes. This aligns with the findings of, (CIP. (2020), who reported that organic materials like grass provide better storage conditions by maintaining higher humidity and preventing desiccation, which is crucial for preserving the quality of sweet potatoes.

The study reveals that the purple skin cultivar scores highest in sensory attributes, followed by yellow flesh and white skin cultivars. These findings are consistent with previous research indicating that anthocyanin-rich cultivars (such as purple skin) tend to have better sensory qualities due to their higher antioxidant content, which contributes to improved taste and aroma [21]. This also supports the hypothesis that the visual appeal of colored flesh can influence perceived taste and overall acceptability [22].

Storage conditions significantly affect sensory attributes, with "under roof" storage providing superior results compared to "no under roof" conditions. The results are in line with the findings of Rees [23], who demonstrated that controlled storage environments (e.g., under roof) help in maintaining optimal temperature and humidity levels, thereby preserving the sensory qualities of stored sweet potatoes.

The significant interactions between storage materials, cultivars, and storage conditions suggest a complex interplay affecting the sensory quality of sweet potatoes. This complexity underscores the need for integrated storage strategies that consider multiple factors simultaneously. The study by Tomlins [24] also highlighted the importance of considering such interactions, noting that optimal post-harvest management requires a holistic approach to preserve the nutritional and sensory attributes of sweet potatoes.

Grass is an optimal storage material due to its ability to maintain humidity and prevent spoilage, enhancing the sensory quality of sweet potatoes. Purple skin sweet potatoes are superior in sensory attributes, likely due to their higher antioxidant content and visual appeal. Storage under roof is essential for maintaining sensory quality, providing a controlled environment that mitigates adverse effects of temperature and humidity fluctuations. The significant interactions between factors highlight the need for a comprehensive approach in post-harvest management of sweet potatoes.

The findings is in agreement with CIP, 2020 and Tumuhimbise [25] regarding the benefits of using organic materials for storage and Sun [21] and Ishiguro [22] concerning the sensory superiority of anthocyanin-rich cultivars. Additionally, the importance of controlled storage conditions as emphasized by Rees [23] is corroborated by the current study. The recognition of complex interactions mirrors the conclusions of Tomlins [24], reinforcing the necessity of considering multiple variables in post-harvest storage strategies.

The study evaluates the effects of storage materials, cultivars, and storage conditions on the sensory attributes of sweet potatoes in 2023, building on the findings from 2022.

Grass gave the highest scores for all sensory attributes (Colour: 3.833, Taste: 3.833, Aroma: 4.00, Overall Acceptability: 4.00); River Sand gave moderate scores (Colour: 2.22, Taste: 2.00, Aroma: 3.00, Overall Acceptability: 2.389). While Saw Dust gave lowest scores (Colour: 1.681, Taste: 1.722, Aroma: 2.10, Overall Acceptability: 1.833).

Grass as a storage material significantly enhances the sensory quality of sweet potatoes. The high scores across all sensory attributes indicate that grass provides optimal conditions for preserving color, taste, aroma, and overall acceptability. This finding is consistent with Tumuhimbise [25], who reported that grass maintains higher humidity levels, reducing dehydration and spoilage of sweet potatoes .

Yellow Flesh Scored (Colour: 2.00, Taste: 2.40, Aroma: 2.00, Overall Acceptability: 2.622). The highest scores (Colour: 3.00, Taste: 2.30, Aroma: 3.00, Overall Acceptability: 3.00) is from Purple Skin. While White Skin obtained the scores (Colour: 2.92, Taste: 2.00, Aroma: 3.10, Overall Acceptability: 2.96).

The purple skin cultivar consistently scores highest in sensory attributes, followed by white skin and yellow flesh cultivars. This supports findings by Sun [21], which demonstrated that anthocyanin-rich cultivars like purple skin have superior antioxidant properties, enhancing taste and aroma. Ishiguro [22] also found that the visual appeal of colored flesh cultivars positively influences consumer preference and perceived taste. Findings under No under roof, gave the lowest scores for Colour, Taste, and Aroma (1.00 for each), moderate score for Overall Acceptability (3.438). and the Under roof gave highest scores for all attributes (Colour: 4.00, Taste: 4.00, Aroma: 4.22, Overall Acceptability: 4.387).

Storage conditions significantly impact sensory attributes, with under roof storage yielding superior results. This agrees with Rees [23], who highlighted the importance of controlled storage environments in maintaining optimal temperature and humidity levels, essential for preserving the quality of sweet potatoes . The significant differences indicate that exposure to elements without protection severely degrades sensory quality. The significant interactions between storage materials, cultivars, and storage conditions underscore the complexity of factors affecting sweet potato quality. These interactions suggest that the best outcomes are achieved through a combination of optimal storage materials, cultivars, and conditions. Tomlins [24] emphasized the necessity of considering such interactions in post-harvest management to preserve the nutritional and sensory attributes of sweet potatoes.

Grass is the best storage material for sweet potatoes, consistently providing the highest scores for color, taste, aroma, and overall acceptability. This is due to its ability to maintain appropriate humidity levels and reduce spoilage. The purple skin cultivar is superior in sensory attributes, likely due to its higher anthocyanin content, which enhances taste, aroma, and overall acceptability. This cultivar should be prioritized for both production and storage. Storage under roof is essential for maintaining sensory quality. Controlled environments protect sweet potatoes from temperature and humidity fluctuations, which are detrimental to their quality.

The study highlights the importance of considering the combined effects of storage materials, cultivars, and storage conditions. Optimal post-harvest management requires an integrated approach that addresses all these factors simultaneously to ensure the best quality of sweet potatoes. The effect of storage conditions on the sensory attributes of boiled sweet potatoes was examined. Sweet potatoes stored under roof conditions generally recorded higher mean scores across sensory attributes compared to those stored under no roof. This implies that proper storage conditions are essential for maintaining the sensory quality of stored sweet potatoes. This result confirms the postulation of Jiru and Usmane [26], who reported that during storage, both chemical composition and organoleptic characteristics changed because of storage conditions. Similarly, Sugri et al. [27] narrated that storage conditions affect some organoleptic attributes; notable among them is the texture? of the sweet potato tuber. The significant impact of storage materials on the sensory attributes of sweet potatoes aligns with previous studies. For instance, Jiru and Usmane [26] found that storage in sawdust resulted in better retention of colour and taste compared to other materials like sand or mud.

The variation in sensory scores among cultivars underscores the importance of cultivar selection in sweet potato storage. The preference for purple-skin sweet potatoes observed in this study resonates with research conducted by Smith [28], who reported that purple-fleshed sweet potatoes exhibited higher levels of antioxidants and flavour compounds, potentially contributing to their superior sensory appeal. However, the lower scores for white-skinned cultivars in this study contradict findings from Park [29], who found that certain white-fleshed sweet potato cultivars exhibited desirable sensory attributes, emphasising the need for further investigation into cultivar-specific factors influencing sensory quality.

The influence of storage conditions on sensory attributes, particularly the superiority of under-roof storage, aligns with the findings of Phillip et al. [30], who demonstrated that controlled environmental conditions, including temperature and humidity, contributed to better colour retention and reduced spoilage in stored sweet potatoes. While the present study did not observe significant differences in taste between storage conditions in 2022, the overall trend suggests that under roof storage provides more favourable conditions for maintaining sensory quality.

The significant interactions observed between storage materials, cultivars, and storage conditions emphasise the complex interplay of these factors in determining sweet potato sensory attributes. This aligns with the findings of Wang et al. [31], who highlighted the interactive effects of storage environment and cultivar genotype on sweet potato quality traits. Understanding these interactions is crucial for optimising storage practices and enhancing sweet potato quality throughout the supply chain. Therefore, the findings of this study underline the importance of considering storage materials, cultivars, and storage conditions in sweet potato storage management to preserve sensory quality. By leveraging insights from this research and existing literature, stakeholders can implement strategies to enhance sweet potato quality and marketability.

The yellow flesh cultivar received relatively high scores across all sensory attributes compared to other cultivars stored in grass. This aligns with previous studies indicating that the yellow flesh cultivar tends to exhibit favourable sensory qualities, possibly due to its flavour profile and texture [28]. The purple skin cultivar showed the highest scores for colour, taste, aroma, and overall acceptance among all cultivars stored in grass. This suggests that purple-skin sweet potatoes stored in grass maintain their sensory quality exceptionally well, possibly due to factors such as antioxidant content and flesh texture [30]. The white skin cultivar received comparatively lower scores across sensory attributes. This could indicate that white-skin sweet potatoes may be more susceptible to sensory deterioration during storage in grass compared to other cultivars, possibly due to differences in starch content or susceptibility to microbial spoilage [29].

The yellow flesh cultivar showed moderate scores across sensory attributes, indicating a relatively average sensory profile compared to other storage materials. This contrasts with the higher scores observed for the yellow flesh cultivar stored in the grass, suggesting that storage material significantly influences sensory outcomes. Purple skin and white skin cultivars exhibited variable sensory scores, with some attributes scoring higher than others. This variability underscores the importance of considering both cultivar and storage material interactions in determining sensory quality.

All cultivars received lower scores across sensory attributes compared to other storage materials. Sawdust storage appears to have a detrimental effect on sensory quality, as evidenced by the consistently lower scores across all cultivars and sensory attributes. This aligns with findings by Jiru and Usmane [26] who reported that sawdust storage resulted in inferior sensory attributes compared to other materials. The ? the interaction between storage materials and cultivars significantly affects sensory attributes, highlighting the importance of considering both factors in sweet potato storage management. In the final analysis, the interaction between storage materials and cultivars significantly influences the sensory quality of stored sweet potatoes. Grass storage, particularly for purple skin cultivars, appears to preserve sensory quality effectively, while sawdust storage leads to inferior sensory outcomes across all cultivars. These findings underscore the importance of selecting appropriate storage materials to maintain sweet potato sensory quality. NB: No result and discussion on interaction

The Tables 1 and 2 presents the interaction between storage materials and storage conditions on sensory evaluation during the 2022 season. Results indicated that 'No Roof' received the lowest scores across all sensory attributes. This suggests that storing sweet potatoes in grass without a roof exposes them to unfavourable environmental conditions, leading to sensory deterioration. Lack of protection from elements like sunlight, moisture, and pests may contribute to this decline in sensory quality [30]. The under-roof condition showed significantly higher scores for all sensory attributes compared to the no-roof condition. This indicates that providing a roof over grass storage improves sensory quality, likely by protecting it from adverse environmental factors. This finding aligns with previous research highlighting the importance of controlled storage environments in preserving the sensory attributes of stored produce [30].

No Roof and Under Roof Conditions yielded similar sensory scores, indicating that the storage condition did not significantly impact sensory quality in river sand storage. This suggests that river sand may provide some inherent protection against environmental factors, irrespective of whether a roof is present or not. However, the sensory scores remained relatively low, suggesting that river sand storage may not be optimal for preserving sweet potato quality compared to other materials. Similar to river sand storage, sawdust storage did not exhibit significant differences in sensory scores between no roof and under roof conditions. However, the overall sensory scores were slightly higher compared to river sand storage, indicating that sawdust may offer better protection against environmental factors. Nonetheless, the scores are still relatively low, suggesting that sawdust storage alone may not be sufficient to maintain optimal sensory quality [32,33].

The interaction between storage materials and storage conditions significantly affects sensory attributes, emphasising the importance of considering both factors in sweet potato storage management. The interaction between storage materials and storage conditions plays a crucial role in determining the sensory quality of stored sweet potatoes. Grass storage with a roof provided the best sensory quality, highlighting the importance of controlled storage environments in preserving sensory attributes. River sand and sawdust storage exhibited lower sensory scores, suggesting that additional measures may be necessary to optimise sensory quality in these storage conditions [34,35].

5. CONCLUSION

The study revealed, the comprehensive investigation into the effects of storage materials, cultivars, and storage conditions on sensory attributes during the 2022–2023 dry seasons provides valuable insights for optimising storage practices. The findings underscore the significant influence of storage materials on sensory attributes. Grass storage emerges as a favourable option for better sensory attributes compared to other materials like river sand or sawdust. The study further highlights the importance of cultivar selection, purpule skin sweet potatoes consistently displaying superior attributes across different storage setups. Therefore, the differences seen between storage materials, cultivars, and storage conditions show how important it is to have comprehensive storage protocols that consider these different factors to get the best storage results and reduce postharvest losses. By leveraging the insights from this study, stakeholders can develop targeted storage management strategies tailored to specific storage environments and crop characteristics, ultimately enhancing the quality and marketability of stored sweet potatoes throughout the supply chain.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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