

EFFECTS OF PRE-STORAGE TREATMENTS ON THE PHYSICOCHEMICAL AND PROXIMATE PROPERTIES OF SWEET POTATO (*Ipomoea batatas*) TUBERS

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ABSTRACT

Sweet potatoes (*Ipomoea batatas*) is highly perishable despite its high nutritional value, this poses great challenges in post-harvest handling. This study investigated the effects of cooking, sun-drying and storage on the proximate properties of sweet potato tubers using standard analytical methods. The processing resulted in weight loss (7.26 - 26.43%), colour alterations (from creamy white or yellow to white or greyish-white), and texture modifications. Proximate analyses revealed variations in dry matter (92.73 - 97.56%), ash (2.44 - 7.27%), moisture (0.16 - 0.28%), crude fat (5.40 - 8.74%), crude protein (13.44 - 2.80%), carbohydrate (73.06 - 84.81%) as well as a significant difference ($p > 0.05$) in the energy values of the samples. These results provide insights into the impact of cooking, sun-drying and storage on the physicochemical and nutritional attributes of sweet potatoes. thereby contributing to improved post-harvest management strategies.

Introduction

Sweet potatoes (*Ipomoea batatas* L.) are a versatile and nutritious root crop that plays significant roles in global food security as they are widely consumed as a rich source of carbohydrate, vitamins, and dietary fibre (Woolfe, 2010). Their high nutritional value makes them an essential crop especially in Nigeria and other developing countries. Sweet potatoes' high yield potential, adaptability to various climatic conditions, and rich nutritional profile make them an attractive option for addressing malnutrition and food shortages (Wang *et al.*, 2019). However, the tuber is highly perishable, with a tendency to spoil within a few days after harvest. When stored under unsuitable conditions, the rapid deterioration may be due to its

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High moisture content, enzymatic activities and high susceptibility to microbial growth (Ziska *et al.*, 2015) and this poses challenges in post-harvest handling, storage, and distribution which often lead to substantial economic losses and food insecurity (Tumwegamire *et al.*, 2018).

Consequently, the development and implementation of effective preservation methods have become increasingly important to extend the shelf life of sweet potatoes while maintaining their nutritional quality and sensory attributes. Recent advancements in food preservation technologies have provided new opportunities to addressing the challenges associated with sweet potato storage and distribution. These methods aim to inhibit microbial growth, reduce enzymatic activity, and minimize physical and chemical changes that can compromise the quality and safety of the tubers (Oner & Wall, 2020).

However, the impact of various preservation techniques on the proximate composition and sensory properties of sweet potatoes remains a subject of ongoing research within the scientific community. The proximate composition of sweet potatoes, including moisture, protein, fat, fibre, ash content and energy, plays a crucial role in determining their nutritional value and overall quality (Olatunde *et al.*, 2017). Careful study of how different preservation methods affect sensory and proximate composition is essential for optimizing storage conditions of sweet potato tubers throughout their shelf life. Furthermore, Waghmare and Annapure (2018) opine that; the relationship between diverse preservation techniques and the physicochemical properties of sweet potatoes has significant implications for their sensory characteristics and consumer acceptability. Among many post-harvest treatments, heat treatment (cooking) and drying are two essential processing techniques traditionally employed in Nigeria to extend the shelf life and preserve both proximate and sensory qualities of sweet potato tubers.

This paper aimed to critically examine the effects of cooking, sun-drying and storage on the proximate composition and sensory appeals of sweet potato tubers. It also seeks to provide valuable insights into the most effective strategies for maintaining the quality of sweet potatoes, offering recommendations for future research directions and practical applications in the food industry.

METHODOLOGY

Sweet potatoes tubers were purchased from a local market in Bida, Nigeria; thoroughly washed to free them of dirt, allowed to drain water, and then separated into two equal parts of 14 kg each. A part was subjected to cooking for about 15 minutes at moderate

heat, it was allowed to cool, then sliced into smaller sizes before it was divided again into two equal parts. the uncooked sample was also sliced into smaller sizes then divided into two. The four samples were separately sun-dried until constant weight was achieved, and the difference in weight between the cooked dried and the dried uncooked samples was determined. The dried samples (one of cooked and one uncooked) were stored in plastic containers with lid for 90 days, while the unstored sample (which serves as the control) was analysed immediately. The physical changes in weight, colour and texture were monitored. The samples were blended separately and subjected to proximate analyses using the standard methods of Association of Official Analytical Chemists (AOAC, 2016) for crude protein, ash, moisture, crude fibre, fat content, carbohydrate, and energy.

Determination of change in physicochemical properties were done through standard methods and physical observations, the differences in weight was determined by weighing the samples at different points and determining the percentage loss of weight:

Weight before heat treatment and drying = W_0

Weight after heat treatment and drying = W_1

$$\text{Percentage weight loss} = \left(\frac{W_0 - W_1}{W_0} \times 100 \right) \%$$

Data collected were subjected to descriptive statistical analysis using IBM's Statistical Package for Social Sciences (SPSS, 2020) and the differences between the means were evaluated according to Montgomery (2019).

RESULTS AND DISCUSSION

The results obtained from this study are presented below.

The physico-chemical properties of processed stored sweet potato tubers are presented in Table 1.

Table 1: Weight loss, colour and texture changes to sweet potatoes (*Ipomoea batatas*) from pre-storage processing

Sample	Percentage Weight loss due to drying	Colour change due to drying		Texture change due to drying
		From	To	
SUDS	16.86 ± 0.49^c	Creamy white	White	Hard - hard and tough
SCDS	15.55 ± 0.49^b	Yellow	Greyish-white	Edible soft - chewy
UCDS	6.05 ± 0.36^a	Creamy white	Greyish-white	Hard - chewy

Sample	Percentage Weight loss due to drying	Colour change due to drying		Texture change due to drying
		From	To	
UUDS	26.48 $\pm$ 0.08 ^d	Yellow	White	Edible soft - hard and tough

Note: All readings are Mean $\pm$ standard deviation of triplicate (n=3). Means that share the same superscripted letters (a, b, c, d) in the same column are not significantly different (p<0.05),

SUDS = Stored Uncooked Dried sample, SCDS = Stored Cooked Dried Sample, UCDS = Unstored Cooked Dried sample, UUDS = Unstored Uncooked Dried Sample.

Heat processing and sun-drying of sweet potatoes resulted in physical changes that affected their weight, colour, and texture.

Weight Loss due to Drying:

The data shows significant weight losses (p<0.05) in sweet potatoes tuber samples due to heat treatment and sun-drying in the different treatments. The highest percentage weight loss (26.48 $\pm$ 0.08%) was observed in the UUDS sample, while the least (6.05 $\pm$ 0.36%) was in the UCDS sample. Cooking positively and significantly affected moisture loss than non-cooking. This weight loss is primarily attributed to moisture removal during drying combined with change in the components brought about by heat treatment. According to a recent study by Zhang *et al.* (2019), the drying process in sweet potatoes can lead to a significant moisture content reduction from 70-80% to 10-15%, resulting in substantial weight loss.

Colour Changes:

Cooking and drying resulted in noticeable colour changes in all the sweet potato samples. The uncooked dried samples (SUDS and UUDS) changed from their original colours (creamy white and yellow, respectively) to white. While in contrast, cooking before drying (SCDS and UCDS) resulted in greyish-white products after sun-drying. These colour changes can be attributed to enzymatic and non-enzymatic browning reactions. Mu *et al.* (2019) reported that the drying temperature and method adopted have substantial influence on colour changes in sweet potatoes, higher temperatures lead to more pronounced colour alterations. Thus, the cooked samples had deeper colours than the uncooked.

Texture Changes:

There was change in texture in all samples after drying. Generally, cooking resulted in chewy samples, while not cooking tended to be tough. These textural changes are consistent with findings by Onwude *et al.* (2019), who reported that drying methods significantly affect the textural properties of sweet potatoes, often resulting in increased hardness and chewiness and this may make it a bit more difficult to process further before consumption.

The proximate properties of processed stored sweet potato tubers are presented in Table 2.

Table 2. Effects of pre-storage cooking on the Proximate Compositions of Sweet Potato tubers

SAMPLE TREATMENT	DRY MATTER (%)	ASH CONTENT (%)	MOISTURE (%)	CRUDE FAT (%)	CRUDE PROTEIN (%)	CRUDE FIBRE (%)	CARBOHYDRATE (%)	ENERGY VALUE (K/Cal)
SUDS	97.41±0.21 ^c	2.59±0.21 ^a	0.16±0.00 ^a	5.40±0.03 ^a	6.61±0.06 ^b	0.43±0.00 ^a	84.81±0.24 ^c	414.25±1.01 ^b
SCDS	95.87±0.30 ^b	4.14±0.30 ^b	0.17±0.00 ^a	8.74±0.11 ^d	13.44±0.56 ^c	0.46±0.01 ^a	73.06±0.95 ^a	424.62±0.62 ^d
UCDS	92.73±0.04 ^a	7.27±0.04 ^c	0.19±0.00 ^a	6.92±0.25 ^c	2.80±0.49 ^a	0.49±0.01 ^a	82.33±0.30 ^b	402.81±1.44 ^a
UUDS	97.56±0.02 ^c	2.44±0.02 ^a	0.28±0.02 ^b	6.37±0.00 ^b	7.05±0.06 ^b	0.76±0.04 ^b	83.10±0.01 ^b	417.95±0.31 ^c

Note: All readings are Mean ± standard deviation of triplicate (n=3). Means that share the same superscripted letters (a, b, c, d) in the same column are not significantly different ($p \leq 0.05$), SUDS = Stored Uncooked Dried sample, SCDS = Stored Cooked Dried Sample, UCDS = Unstored Cooked Dried sample, UUDS = Unstored Uncooked Dried Sample.

Dry Matter Content:

Table 2 indicates that the dry matter content of sweet potatoes is affected by cooking. The uncooked samples had significantly ($p < 0.05$) higher dry matter contents (UUDS, 97.56%; SUDS, 97.41%) than for the cooked samples. Stored cooked samples retained significantly higher dry matter (SCDS, 95.87%) ($p < 0.05$) than the unstored cooked dried samples (UCDS, 92.73%) which retained the least dry matter in all the samples tested. This may probably be associated with the earlier observation that cooking resulted in a chewier outcome than in uncooked samples. Thus, the significant difference in the dry matter between SCDS and UCDS showed the effect of cooking on the quality of stored sweet potatoes due to higher moisture loss during storage.

Ash Content:

As observed with the dry matter, cooking generally resulted in higher ash content than storage effect on the samples (UCDS, 7.27%; SCDS 4.14%), while SUDS and UUDS had lower values (2.59% and 2.44%) respectively. These findings are consistent with those of Oke and Workneh (2013), who observed variations in mineral content based on processing methods.

Moisture Content:

Cooking and storage had significantly greater effect and resulted in lower Moisture content than in the uncooked and unstored samples. The low moisture content which is equivalent to low water activity (aw) is crucial for extending the shelf life and preventing microbial growth in stored samples. This is as was observed by Tumwegamire *et al.* (2016).

Crude Fat:

Cooking affected the fat contents of sweet potatoes as it generally resulted in higher fat (SCDS, 8.74%; UCDS, 6.92%) in cooked than from the uncooked samples (UUDS, 6.37%; SUDS 5.40%). This could be due to the concentration of fats during the cooking and drying process. These results suggest that fat concentration is higher when sweet potatoes are subjected to drying after cooking, a finding in agreement with studies that highlight lipid preservation in dried foods (Adeleke and Odedeji, 2020).

Crude Protein:

Cooking, drying and storage significantly demonstrated the highest crude protein content (SCDS, 13.44%), over those of other treatments. Cooking without storage however showed the least protein content (UCDS, 2.80%). The protein contents in the uncooked, dried samples were not significantly affected by storage (UUDS, 7.05% and SUDS, 6.61%). It is probable that the cooking and drying processes denatured and reduced the protein content initially. The protein content can be affected by cooking and preservation methods, with potential losses occurring during thermal processing (Liu *et al.*, 2016)

Crude Fibre:

Cooking and storage were shown to have significantly reduced the fibre contents of sweet potatoes (0.43-0.49%) compared with uncooked and unstored dried potatoes (UUDS, 0.76%). Cooking is here shown to impact minimally on fibre content than

storage. These findings are consistent with those of Eleazu and Ironua (2015), who reported that processing methods can affect the fibre content of sweet potatoes.

Carbohydrate Content:

Uncooked dry potatoes generally recorded higher carbohydrate contents (SUDS, $84.81 \pm 0.24\%$; UUDS, $83.10 \pm 0.01\%$) than the cooked and dried samples (UCDS, $82.33 \pm 0.30\%$; SCDS, $73.06 \pm 0.95\%$); however, no significant difference was recorded from the unstored samples, whether cooked or uncooked. Storing cooked sweet potatoes significantly reduced the carbohydrate content, but not below desirable level. This is consistent with findings by Oke and Workneh (2013), who observed changes in carbohydrate content of sweet potatoes due to different processing techniques particularly protein and fat.

Energy Value:

Energy value was significantly highest in the potato samples that were cooked and stored (SCDS, 424.62 K/Cal), and lowest in samples that were cooked and unstored (UCDS, 402.81 K/Cal). The higher energy value in SCDS could be attributed to its higher fat and protein content. These point to added advantages from cooking and storage in sweet potatoes over uncooked samples. These findings agree with those of Eleazu and Ironua (2015), who reported that processing methods can significantly affect the energy value of sweet potatoes.

The beauty of this study is that the stored potato tubers were preserved from spoilage for 90 days; and these processes can be handled by the rural populace without specialized equipment and storage gadgets.

CONCLUSION

Cooking, drying and storage of sweet potatoes induce significant physical changes including weight loss, colour alterations, and texture modifications. These processing as well significantly impacted the proximate and dietary compositions of sweet potato tubers (*Ipomea batatas*). Uncooked sweet potato either stored or unstored showed similar compositions, with higher dry matter and carbohydrate contents which indicate that minimal processing is preferable for maintaining nutrient density. The proximate composition of sweet potatoes subjected to cooking and sun-drying reveals significant variations in nutritional content and thus highlights the impact of processing techniques on food quality and nutritional value.

RECOMMENDATION

Further research could explore the impact of these preservation methods on micronutrient content and their bioavailability.

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