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EFFECT OF DRYING ON THE NUTRITIONAL AND ANTI-NUTRITIONAL COMPOSITION OF SWEET AND BITTER CASSAVA

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ABSTRACT

This study investigates the effect of drying on the nutritional and anti-nutritional composition of sweet and bitter cassava (Manihot esculenta). Using standard AOAC methods, four sample types—sweet and bitter cassava in both fresh and dried forms—were analyzed for proximate composition, mineral content, and anti-nutritional factors. The results showed that drying significantly ($p < 0.05$) reduced moisture (by 69.2% in sweet cassava and 67.4% in bitter cassava), hydrogen cyanide (by 34.9% in sweet cassava and 26.2% in bitter cassava), and oxalate levels (by 23.9% in sweet cassava and 20.6% in bitter cassava), while increasing carbohydrates (by 13.3% in sweet cassava and 14.9% in bitter cassava) and lipids (by 74.4% in sweet cassava and 72.6% in bitter cassava). The reduction in hydrogen cyanide and oxalate was more pronounced in the bitter variety. The reduction in hydrogen cyanide and oxalate was more pronounced in the bitter variety ($p<0.05$). The hydrogen cyanide reduces from 129.10 ± 6.00 Mg/100g, to 95.30 ± 6.10 Mg/100g and oxalate 79.43 ± 3.41 Mg/100g to 63.03 ± 2.14 Mg/100g in fresh and dried samples respectively. These findings emphasize the importance of drying as a processing method to enhance the safety and nutrient density of cassava consumed in Nigeria.

Keywords: Cassava, Drying, Nutritional composition, Anti-nutritional factors, Processing

INTRODUCTION

Cassava (*Manihot esculenta*) is a staple food for over 500 million people globally, especially in tropical regions. It exists in sweet and bitter forms based on cyanogenic glucoside content. Although bitter cassava is widely consumed, it contains higher levels of hydrogen cyanide and other anti-nutrients, posing health risks if not processed properly (Oboh et al., 2002; Oyewole, 1995).

Drying is one of the most widely adopted traditional techniques for reducing cassava's moisture and toxicity. It promotes shelf stability and food safety. Prior research has shown that drying reduces moisture and anti-nutritional compounds while concentrating nutrients like carbohydrates (Sarkiyayi & Agar, 2010; Stephen et al., 2017).

However, there is still paucity of data about such finding in cassava grown in local communities and most previous researches were more on nutrients rather than both nutrient and antinutrients. Therefore, this study was aimed to evaluates how drying alters the nutritional and anti-nutritional profile of sweet and bitter cassava varieties grown in our local farms as to domesticate and refresh the findings

MATERIALS AND METHODS

Fresh tubers of sweet cassava (*Manihot esculenta Crantz*) were obtained from a local farm in Gwarzo Local Government Area of Kano State Nigeria, while bitter cassava tubers were collected from Bassa Local Government Area in Plateau State Nigeria. The samples were thoroughly washed, peeled, and sliced into smaller pieces. Each variety was labeled as sweet dry (A), bitter dry (B), sweet fresh (C), and bitter fresh (D) cassava. The sliced tubers were sun-dried for three days, ground using a mortar and pestle, and further milled into fine powder using an electric grinder. Fresh portions of both varieties were also processed for comparative analysis. Botanical identification was conducted at the Department of Plant Science, Bayero University, Kano, with the herbarium number BUKHAN 631 assigned to the samples.

Various standard laboratory apparatus were employed throughout the study, including beakers, crucibles, burettes, conical flasks, Petri dishes, desiccators, volumetric flasks, filter papers, weighing balance, heating mantle, and hot air oven. Specialized instruments such as the micro-Kjeldahl apparatus and atomic absorption spectrophotometer (Shimadzu AA-650 Japan) were used for protein and mineral analyses, respectively. Reagents included hydrochloric acid, sulphuric acid, nitric acid, boric acid, sodium hydroxide, petroleum ether, methyl red, ammonium thiocyanate, and others all of analytically graded and prepared according to standard protocols.

Proximate composition comprising moisture, ash, lipid, protein, crude fibre, and carbohydrate was determined using methods described by AOAC (1990). Moisture content was obtained by oven-drying at 103°C; ash content by dry ashing in a furnace; lipid content by Soxhlet extraction using petroleum ether; and protein by the Kjeldahl method, with nitrogen content multiplied by a factor of 6.25. Crude fibre was analyzed by sequential acid-base digestion and ashing, while carbohydrate content was estimated by difference. All values were calculated and expressed as percentages on a dry weight basis.

Mineral content analysis involved a dry-ashing method followed by acid digestion using concentrated nitric and hydrochloric acids. The digests were diluted and filtered before being analyzed with an atomic absorption spectrophotometer (Shimadzu AA-650 Japan); essential minerals such as calcium, magnesium, iron, and zinc were quantified while sodium, potassium were quantified using

flame emission spectroscopy. The principle of the AAS technique involves atomizing the sample and detecting light absorption at element-specific wavelengths, with results expressed in mg/100g after appropriate conversion from ppm. Anti-nutritional components namely oxalate, phytate, and hydrogen cyanide (HCN), were also evaluated. Oxalate was determined by acid extraction followed by titration with potassium permanganate, using 1 mL of 0.05 mol/L $KMnO_4$ as equivalent to 2.2 mg of oxalate. Phytate content was assessed by soaking samples in hydrochloric acid and titrating with ferric chloride, applying a 4:6 Fe/P atomic ratio for calculation. Hydrogen cyanide was measured using the alkaline titration method, where samples were acidified and distilled, and the distillate titrated with silver nitrate, with each mL of 0.02M $AgNO_3$ equivalent to 1.08 mg of HCN.

RESULTS AND DISCUSSION

Table 1: Comparison of Sweet Cassava samples

Variable	Mean ± SD g/100g		t-value	p-value
	A	C		
Moisture	11.59 ± 0.66	37.58 ± 0.24	54.52*	<0.0001
Ash	10.87 ± 0.12	5.14 ± 0.13	72.56*	<0.0001
Fiber	7.71 ± 1.14	6.12 ± 0.30	2.89*	0.0301
Lipid	10.67 ± 1.20	6.12 ± 0.30	6.99*	0.0023
Protein	1.83 ± 0.40	1.33 ± 0.20	2.19	0.0691
Carbohydrates	57.33 ± 1.06	44.04 ± 0.25	20.78*	<0.0001
Antinutrients (Mg/100g)				
Oxalate	48.36 ± 4.67	63.53 ± 3.09	-4.63*	0.0091
Phytate	5.98 ± 2.16	4.69 ± 0.16	1.06	0.3412
HCN	74.00 ± 5.90	112.20 ± 5.70	9.83*	0.0006

A: Dry Sweet Cassava, C: Fresh Sweet Cassava, HCN: Hydrogen Cyanide, Values Sharing * Superscript Indicate Significant Differences Between the two Samples at $p < 0.05$

Table 2: Comparison of Bitter Cassava Samples

Variable	Mean ± SD g/100g		t-value	p-value
	B	D		
Moisture	10.82 ± 1.35	33.21 ± 0.28	31.24*	<0.0001
Ash	5.89 ± 0.35	3.89 ± 0.35	6.19*	0.0032
Fiber	8.26 ± 2.60	7.24 ± 0.23	0.98	0.3621
Lipid	9.58 ± 1.10	5.55 ± 0.13	6.99*	0.0023
Protein	2.18 ± 0.28	1.74 ± 0.36	2.02	0.0872
Carbohydrates	63.27 ± 3.49	48.37 ± 0.36	8.44*	0.0011
Antinutrients (Mg/100g)				
Oxalate	63.03 ± 2.14	79.43 ± 3.41	-7.41*	0.0018
Phytate	10.18 ± 0.31	8.97 ± 0.77	2.51*	0.0489
HCN	95.30 ± 6.10	129.10 ± 6.00	-8.72*	0.0009

B: Dry Bitter Cassava, D: Fresh Bitter Cassava, HCN: Hydrogen Cyanide, Values Sharing * Superscript Indicate Significant Differences Between the two Samples at $p < 0.05$

RESULTS AND DISCUSSION

Drying is a widely used post-harvest method that improves shelf-life and concentrates nutrients by removing moisture. In this study, drying reduced the moisture content in sweet cassava by 69.2% (from 37.58% to 11.59%) and in bitter cassava by 67.4% (from 33.21% to 10.82%). This significant decline is consistent with Oluwole et al. (2013), who demonstrated that drying enhances cassava's microbial safety by lowering water activity.

Ash content increased in sweet cassava by 111.4%, indicating a concentration effect due to water loss, consistent with Stephen et al. (2017). In contrast, bitter cassava showed a 51.4% increase in ash, which may suggest minor mineral leaching during pre-drying preparation, corroborating findings by Adewumi and Odunfa (2010).

Lipid content rose by 74.4% in sweet cassava and 72.6% in bitter cassava after drying. This aligns with Oboh et al. (2002) and Okafor et al. (2020), who noted that lipids, being non-volatile, appear concentrated after moisture removal, even though cassava is inherently low in fat.

Protein content increased modestly in both varieties (37.6% in sweet and 25.3% in bitter cassava), though not statistically significant. This aligns with Ayenor et al. (2002), who observed similar marginal protein gains due to drying.

Carbohydrate content, a key energy-yielding nutrient, increased by 30.2% in sweet cassava and 30.8% in bitter cassava post-drying. This supports findings by Oduro et al. (2008) and Ubalua (2007), who emphasized cassava's starch concentration following drying.

Crude fiber content increased slightly in sweet cassava (26%) and in bitter cassava (14%), though these were not statistically significant. Similar trends were reported by Iwuoha and Eke (1996), who attributed such shifts to structural rigidity post dehydration.

From a food safety perspective, hydrogen cyanide (HCN) levels reduced by 34.1% in sweet cassava (from 112.2 to 74.0 mg/100g) and by 26.2% in bitter cassava (from 129.1 to 95.3 mg/100g). This significant reduction confirms prior findings by Iliya and Madumelu (2019), Onabolu et al. (2002), and Cardoso et al. (2005), who showed that drying effectively detoxifies cyanogenic compounds, especially in bitter cassava.

Oxalate levels, which reduce calcium absorption, dropped by 23.9% in sweet cassava and 20.6% in bitter cassava after drying. These results agree with earlier studies noting that thermal processing reduces anti-nutritional factors, improving mineral bioavailability (Cardoso et al., 2005).

Phytate content, however, changed inconsistently: increasing by 27.5% in sweet cassava and 13.5% in bitter cassava. This

aligns with Ogunlade et al. (2011), who indicated that phytate is heat-resistant and not easily reduced by drying alone, thus requiring fermentation or enzymatic treatments for effective reduction.

Overall, these findings reaffirm the effectiveness of drying in enhancing the nutritional profile and safety of cassava, especially in bitter varieties that naturally contain higher levels of anti-nutrients. Therefore, the results collectively affirm that drying enhances the safety and nutritional density of cassava. The process is especially effective in detoxifying bitter cassava and concentrating energy-yielding nutrients, making it a critical step in cassava processing technologies.

CONCLUSION

Drying significantly ($p < 0.05$) altered the nutritional and anti-nutritional composition of both sweet and bitter cassava. It reduced moisture content by over 67%, effectively concentrating macronutrients such as carbohydrates and lipids. Carbohydrate levels increased by 30.2% in sweet cassava and 30.8% in bitter cassava, while lipid content rose by 74.4% and 72.6% respectively. Most notably, drying reduced hydrogen cyanide (HCN) by 34.1% in sweet and 26.2% in bitter cassava, and oxalate by 23.9% and 20.6% respectively, enhancing food safety. However, the relatively minor changes in phytate content suggest the need for complementary processing methods. These findings emphasize that traditional sun drying remains a cost-effective, accessible strategy to improve the safety and nutritional quality of cassava, especially in rural and semi-urban communities.

RECOMMENDATIONS

i. Promote drying as a key post-harvest strategy in cassava-processing communities, especially for bitter varieties.
ii. Combine drying with other techniques like fermentation or soaking to reduce heat-resistant anti-nutrients like phytate.
iii. Educate farmers and processors on optimized drying conditions to retain nutrient value and minimize losses.
iv. Invest in low-cost drying technologies that improve efficiency while preserving nutritional quality.
v. Conduct further research on varietal differences in response to drying to enhance cassava safety and quality.

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