



Influence of Blanching on Some Nutrient and Anti-nutrient Compositions of Bitter Yam (*Dioscorea dumetorum*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author DCN designed the study and wrote the protocol. Author ACCE managed the analyses of the study and the literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Introduction: Bitter yam (*Dioscorea dumetorum*) is essentially underutilized probably due to its characteristic bitter taste. The bitter taste may be related to its nutrient and anti-nutrient mix which could be improved by simple processing methods.

Aim: The study evaluated the influence of blanching on some nutrient and anti-nutrient compositions of bitter yam (*Dioscorea dumetorum*).

Study Design: Bitter yam (*Dioscorea dumetorum*) flour obtained after blanching (at 100°C) for varied time was tested for nutrient and anti-nutrient compositions.

Place and Duration of Study: The study was conducted at the Department of Food Technology, School of Industrial and Applied Sciences, Federal Polytechnic Nekede, Nigeria.

Methodology: The nutrients and anti-nutrients in the blanched and unblanched samples were

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determined by standard methods.

Results: The content in the sample blanched for 18 minutes increased respectively by 1.88% and 1.13% for moisture and carbohydrate, but decreased, by 60.00%, 19.61%, 5.80% and 13.65% for fat, crude fibre, ash and protein relative to control (0 minute). Blanching caused a decrease by 67.43% and 62.26% for alkaloid and tannin in the sample blanched for 18 minutes relative to control. The results were time dependent and significant ($p < 0.05$).

Conclusion: Although the significant reduction in tannin and alkaloid may improve taste, the process reduced many important nutrients and may diminish the keeping quality of the resultant flour. Thus, we recommend the processing method when bitter yam flour is required for immediate use and as a low fat-energy source. Since many nutrients and anti-nutrients (medicinal components) could leach into the blanch water, further study on the utilization of the waste water and other processing methods is warranted.

Keywords: Crude fibre; blanching; alkaloid; yam flour.

1. INTRODUCTION

Inadequate food supply in sub-saharan African and the attendant malnutrition problem necessitated researches aimed at finding alternative food supply from available but less utilized food sources [1,2]. Yam (*Dioscorea spp*) is an important food in many tropical countries [3]. In particular, yam is of nutritional and economic importance to the people in Nigeria and other West African countries. It is rich in starch and allows many recipes. It is mainly boiled or roasted and eaten with oil and to a lesser extent cooked as porridge or pounded and eaten with soup. It is available all year round making it preferable to other unreliable seasonal crops. Bitter yam (*Dioscorea dumetorum*) belongs to the genus *Dioscorea* and family *Dioscoreaceae* [4], and is rich in phyto-nutrients [5,6]. Bitter yam remains underutilized amid potential industrial application [7,8,9].

The reason for the limited use of bitter yam, apart from hard – to –cook defect [10], may be because of its unpalatable bitter taste, and high post harvest spoilage [5]. Thus, bitter yam is usually cooked overnight before eating. To prevent the high post harvest hardening, the tubers were dried and milled into flour. This simple processing measure may affect the compositions of the tubers [11]. Processing methods altered the nutrient contents of some plant foods [12,13]. Earlier, Ezeocha et al. [14] reported that the nutritional and phytochemical properties of the bitter yam flour could be improved by increasing the cooking duration. In similar studies [15,16], soaking prior to drying modified some physicochemical properties of the bitter yam flour. In this regard, there is need to assess the effect of other simple processing

method prior to the traditional method of drying and milling.

Generally, blanching involves halting the cooking process by plunging the food substance into iced water or cold running water after boiling in water for a brief timed interval. Blanching could slow or stop enzymatic actions in the food, remove strong taste and heat labile pathogens in the food, preserve the food quality, inactivate the endogenous toxic factors of foods to enhance tenderization, palatability and nutritional value of food [17]. These warranted this study aimed at investigating the effect of blanching in boiling water (at 100°C) over time prior to oven-drying (50°C) on nutrient and anti-nutrient properties of the resultant bitter yam flour. Anti-nutrients, for instance tannins, may reduce the nutrient utilization and/or food intake by impairing iron availability [18,19] thereby limiting the wider use of many plant foods. The result from this study may (i) provide insight into the research area (ii) provide basis for further studies aimed at improving the nutrient/anti-nutrient properties, the taste and keeping quality of bitter yam flour or (iii) promote the utilization and consumption of bitter yam, which is an underutilized tuber with nutritional, economic and industrial potentials.

2. MATERIALS AND METHODS

2.1 Source and Preparation of Materials

Bitter yam tubers were purchased from Owerri relief market in Imo State, south-eastern Nigeria. The equipment used, including milling machine, weighing balance thermometer, shaker and centrifuge machine, were obtained from the laboratory of Food Science and Technology Department, Federal Polytechnic Nekede Owerri,

Imo State. All the chemicals used were of analytical grade.

2.2 Preparation of the Bitter Yam Flour Samples

Wholesome bitter yam tubers were sorted out, washed in tap water, peeled, sliced into cubes of 25 mm±2 mm thickness with a chipping machine and weighed. The chips were shared into seven equal parts, based on weight. One part was not blanched (0 minute) and served as the control. To evaluate the effect of blanching time on the nutrient and anti-nutrient compositions of the bitter yam flour, six parts were respectively processed by blanching (at 100°C) for 3, 6, 9, 12, 15 and 18 minutes and then dewatered. All (the seven parts) were separately dried to a constant weight in a moisture extraction oven (Gallenkamp 1H-100) set at 50°C, cooled for 30 minutes and milled (in a laboratory mill, Thomas Wiley mill model ED-5) into flour. The separate samples flour was packed in labeled glassware covered with a stopper cork prior to analysis. The experiment was carried out at six blanching time (3, 6, 9, 12, 15 and 18 minutes) at three replicates (6 × 3 = 18 replicates).

2.3 Proximate Analysis

The tannin content determination was by the Follin-Dennis spectro photometric method as described by Pearson [20]. The absorbance of the developed color was measured at 760 nm wavelength with the reagent blank set at zero, using GENWAY Model 6000 electronic spectrophotometer. The moisture content was

determined by the method of James [21]. The carbohydrate content was determined by the Nitrogen free extractive (NFE) method described by Pearson [20].

The protein content determination was by the method of Kjeidahl as described by James [21] while that of the fat content was by the continuous solvent extraction method as described by Pearson [20] and James [21]. The crude fibre content was determined by the method described by James [21]. The total ash content was determined by the furnace incineration gravimetric method [22]. The alkaloid content was determined by the alkaline precipitation method [23].

2.4 Data Analysis

Collected data were subjected to statistical Analysis of Variance (ANOVA) with the statistical package for social sciences (SPSS) for Windows version 16. The Bonferroni *post hoc* test was used to identify the means that differ significantly at $p < 0.05$. Results were expressed as Mean ± standard deviation (SD).

3. RESULTS AND DISCUSSION

The peak effect was recorded in the sample blanched for 18 minutes, which increased respectively by 1.88% (9.60^d±0.01 to 9.78^c±0.05) and 1.13% (78.83^g±0.01 to 79.72^c±0.02) for moisture and carbohydrate, but decreased, by 60.00% (0.50^a±0.01 to 0.20^e±0.03) for fat relative to control (0 minute) (Table 1).

Table 1. Moisture, fat and carbohydrate content of blanched bitter yam flour

Blanching time (mins)	Moisture content (%)	Relative increase in moisture content (%)	Crude fat (%)	Relative decrease in crude fat content (%)	Crude carbohydrate (%)	Relative increase in crude carbohydrate content (%)
0	9.60 ^d ±0.01		0.50 ^a ±0.01		78.83 ^g ±0.01	
3	9.62 ^d ±0.00	0.21	0.33 ^d ±0.18	34.00	78.94 ^f ±0.01	0.14
6	9.63 ^b ±0.06	0.31	0.27 ^b ±0.01	46.00	79.06 ^e ±0.01	0.29
9	9.68 ^b ±0.03	0.83	0.24 ^c ±0.18	52.00	79.15 ^d ±0.04	0.41
12	9.72 ^b ±0.02	1.25	0.23 ^d ±0.02	54.00	79.56 ^c ±0.01	0.93
15	9.74 ^a ±0.01	1.46	0.22 ^c ±0.01	56.00	79.71 ^b ±0.01	1.12
18	9.78 ^c ±0.05	1.88	0.20 ^e ±0.03	60.00	79.72 ^c ±0.02	1.13

Values are mean±standard deviation of triplicate determinations. Values on the same column with different superscripts means that the difference is statistically significant ($P < 0.05$)

Blanching prior to oven drying resulted in a time dependent and significant decrease ($p < 0.05$) in the crude protein ($6.74^a \pm 0.03$ to $5.82^e \pm 0.01$), ash ($3.79^a \pm 0.01$ to $3.57^f \pm 0.01$) and fibre ($1.02^a \pm 0.02$ to $0.82^e \pm 0.01$) content of the bitter yam flour. This represents a decrease by 13.65%, 5.80% and 19.61% respectively in the sample blanched for 18 minutes relative to control (Table 2).

A time dependent and significant decrease ($p < 0.05$) in the alkaloid ($1.75^a \pm 0.01$ to $0.57^f \pm 0.01$) and tannin ($2.12^a \pm 0.00$ to $0.80^g \pm 0.01$) contents of the bitter yam flour, which represents a decrease by 67.43% and 62.26% respectively was recorded in the sample blanched for 18 minutes relative to control (Table 3).

Results of this study demonstrated a time dependent and significant ($p < 0.05$) effect on the studied nutrient and anti-nutrient properties of the bitter yam flour. This is an indication that blanching (100°C) affected the content value of the studied properties of the bitter yam flour irrespective of the blanching time. The crude carbohydrate content range ($78.83^g \pm 0.01\%$ to $79.72^c \pm 0.02\%$) of the resultant bitter yam flour samples compares with the range (66.72% to 71.52%) obtained by Owuamanam et al. [7] and that reported earlier [14]. The upper range value ($79.72 \pm 0.02\%$) was higher than the value for

Citrus sinensis peels ($54.17 \pm 1.09\%$) and seeds ($67.83 \pm 0.32\%$) reported by Egbonu and Osuji [24]. The carbohydrate content increased ($p < 0.05$) with blanching time, suggesting that blanching will probably enhance the carbohydrate-energy content of the bitter yam flour. Carbohydrates, by supplying easily metabolized energy 'spare protein' from serving as a source of energy. This is desirable in view of the energy need by the rural populace.

Moisture, the measure of the water content of a material, is an index of water activity [25] and an important factor in food quality, preservation and resistance to deterioration [26]. The moisture content for the control ($9.60^d \pm 0.01$) compares with the control value (12.41%) obtained by Owuamanam et al. [7] but higher than the values ($5.12 \pm 0.01\%$, $3.81 \pm 0.00\%$) respectively for *Citrullus lanatus* (watermelon) rind and seed [27]. Reduced moisture content ensured the inhibition of microbial growth [28] and enhanced the keeping/storage quality of food [29]. Thus, the time dependent increase in the moisture content observed in this study suggests that blanching probably enhanced the retention of the moisture content of the bitter yam, and that the resultant flour may have poor stability and storage quality [30,31].

Table 2. Protein, ash and fibre content of blanched bitter yam flour

Blanching time (mins)	Protein content (%)	Relative decrease in protein (%)	Crude ash (%)	Relative decrease in crude ash (%)	Crude fibre (%)	Relative decrease in crude fibre (%)
0	$6.74^a \pm 0.03$		$3.79^a \pm 0.01$		$1.02^a \pm 0.02$	
3	$6.42^b \pm 0.01$	4.75	$3.71^b \pm 0.01$	2.11	$0.94^b \pm 0.00$	7.84
6	$6.38^c \pm 0.05$	5.34	$3.68^c \pm 0.01$	2.90	$0.92^b \pm 0.00$	9.80
9	$6.33^d \pm 0.01$	6.08	$3.65^d \pm 0.00$	3.69	$0.89^c \pm 0.01$	12.75
12	$6.32^d \pm 0.01$	6.23	$3.63^e \pm 0.03$	4.22	$0.85^d \pm 0.01$	16.67
15	$5.83^e \pm 0.05$	14.77	$3.62^e \pm 0.04$	4.49	$0.85^d \pm 0.01$	16.67
18	$5.82^e \pm 0.01$	13.65	$3.57^f \pm 0.01$	5.80	$0.82^e \pm 0.01$	19.61

Values are mean \pm standard deviation of triplicate determinations. Values on the same column with different superscripts means that the difference is statistically significant ($P < 0.05$)

Table 3. Alkaloids and tannins content of blanched bitter yam flour

Blanching time (mins)	Alkaloids content (%)	Relative decrease in alkaloids (%)	Tannins (%)	Relative decrease in tannins (%)
0	$1.75^a \pm 0.01$		$2.12^a \pm 0.00$	
3	$1.40^b \pm 0.02$	20.00	$2.09^b \pm 0.03$	1.42
6	$1.28^c \pm 0.10$	26.86	$1.87^c \pm 0.01$	11.79
9	$1.14^d \pm 0.03$	34.86	$1.52^d \pm 0.02$	28.30
12	$0.90^e \pm 0.01$	48.57	$1.11^e \pm 0.01$	47.64
15	$0.57^f \pm 0.10$	67.43	$0.91^f \pm 0.02$	57.07
18	$0.57^f \pm 0.01$	67.43	$0.80^g \pm 0.01$	62.26

Values are mean \pm standard deviation of triplicate determinations. Values on the same column with different superscripts means that the difference is statistically significant ($P < 0.05$)

Crude ash content ($3.79^a \pm 0.01$ - $3.57^f \pm 0.01$) obtained in the study compares with that reported earlier [7,16]. The crude ash content also compares with the values reported for African bread fruit (*Treculia africana*) boiled with various food wastes ash infusions [32]. For the sample blanched for 18 minutes, the crude ash content ($3.57^f \pm 0.01$) decreased ($p < 0.05$), suggesting reduced mineral content perhaps due to leaching. Crude fibre, a measure of the quantity of indigestible cellulose, pentosans, lignins, and such components in food [26], decreased ($p < 0.05$) in a time dependent manner. The value ($1.02^a \pm 0.02$ to $0.82^e \pm 0.01$) is below the range (2.7% to 7.9%) in bitter yam [7] and other processed foods [33,34]. The difference could be due to differing processing methods. Food fibre aids digestion and protects the body against colon cancer, diabetes and cardiovascular illnesses [35]. Thus, the reduction suggests the poor digestibility and low potential for body protection of the resultant bitter yam flour.

Protein supply could not meet the increasing world population demand [36] and protein deficiency cannot be ignored, hence the need for processing methods that could increase the protein availability of foods. This is because protein is an important nutrient that enhances body growth and repair, and serves as a source of energy during starvation [37]. The protein content of the resultant bitter yam flour decreased with increasing blanching time. The decrease may be due, either, to the increase in moisture content [25] as recorded in this study or to the denaturation of the protein. The result is comparable to that of Owuamanam et al. [7], and suggests that blanching as in this study might not favor the preservation of protein in the resultant bitter yam flour.

Fat supplies more energy than the same weight of carbohydrate or protein and provides a source for the fat-soluble vitamins A, D, E and K [37]. Fat content decreased with blanching time, suggesting reduced fat-energy capacity of the bitter yam flour. The fat content observed in this study does neither compares with that of Owuamanam [7] nor agrees with the suggestion that increased moisture content (as observed in this study) resulted in increased free fatty acids and fat content [31]. We attributed the peculiar decrease in fat content observed in this study to the processing method. Possibly, volatile fatty acids evaporated with the blanch steam, resulting in the decrease. The reduction of fat

may enhance the storage life of the flour due to reduced chance for rancid flavor development, but may reduce the fat-energy capacity of the resultant bitter yam flour.

Anti-nutritional factors, including alkaloids and tannins, are heat labile [38], volatile and could be toxic [39,19,40]. The present study demonstrated a time dependent reduction in the studied anti-nutrient factors, suggesting that complete elimination of these anti-nutrients in the bitter yam flour may be achieved with increasing blanching time. The alkaloids and tannins contents in the sample blanched for 0-9 minutes compared with the respective value obtained for *Citrullus lanatus* rind whereas the contents in the sample blanched for 12-18 minutes compared with the respective value obtained for *Citrullus lanatus* seed [41]. In particular, the significant reduction in tannin content suggests reduced toxic potential [42], hence improved safety of the bitter yam flour with increasing blanching time. A decrease in tannin content with increasing processing time was attributed to solubility of tannins in water [43] and to their enhanced leaching into water [44]. Earlier study [45] seemingly supported the present results. Aside from reducing the toxicity, the reduction of these anti-nutrients following blanching may reduce the medicinal potentials of the bitter yam flour, hence should be exploited with caution. Generally, the results imply that bitter yam flour obtained in this study may serve as low fat-energy food source, with possibly diminished stability/keeping quality, medicinal potential, toxicity and bitter taste. These implications however, warrant further investigation.

4. CONCLUSION

Thus, blanching prior to oven drying significantly diminished the fat, alkaloid, tannin, crude fibre and protein contents of the resultant bitter yam flour in a time dependent manner. Although the observed effect on tannin and alkaloid contents may improve taste, the process reduced many important nutrients and may diminish the keeping quality of the resultant flour. Thus, we recommend the processing method when bitter yam flour is required for immediate use and as a low fat-energy source. Since many nutrients and anti-nutrients (medicinal components) could leach into the blanch water, further study on the utilization of the waste water and other processing methods is warranted.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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