Proximate, Mineral and Phytochemical Composition of *Dioscorea dumetorum* (Bitter Yam) Commonly Cultivated in South Eastern Nigeria

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**Authors’ contributions**

This work was carried out in collaboration among all authors. Author ENU designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CPN and OJM managed the analyses of the study. Author ENU equally managed the literature searches. All authors read and approved the final manuscript.

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**ABSTRACT**

Standard procedures were used to investigate proximate, mineral, amylose content, gelatinization temperature and phytochemical composition of *Dioscorea dumetorum* (Both cooked and fresh samples). Significant increase (p< 0.05) of protein, fats and oil, moisture and crude fibre contents was observed in the fresh sample as against cooked sample. A value of (43.80%) was recorded in the cooked sample while in the fresh sample the carbohydrate value was 23.15%. There is a significant increase (p< 0.05) of Fe, Mg, Na and P concentration of the fresh sample compared with the cooked sample. Inversely, significant decrease (p> 0.05) of Mn, Ca. and K contents in the cooked sample was recorded in comparison with the fresh plant sample. Gelatinization temperature increased significantly (p< 0.05) in the cooked sample as against fresh. Non-significant increase (p> 0.05) of the amylose content was documented in the cooked sample compared with cooked sample. Phytochemical screening revealed alkaloid, saponin glycosides were steadily present, flavonoid, tannin and phenol were moderately present in the cooked sample. In the same vein, similar observation was made in the fresh sample. Steroids were not detected in...
both samples. Medicinal use of the tuber is hereby justified by the results and suggests it could contribute to the nutrition of man and animals. It could be recommended to diabetic patients and obedience owing to its low starch contents.

Keywords: Dioscorea dumetorum; fresh; cooked; phytochemicals; minerals.

1. INTRODUCTION

Dioscorea dumetorum (family: Dioscoreaceae) as the common English name (Bitter yam) suggests has a bitter taste and occurs predominantly in the wild tropics throughout Africa. Wild forms of D. dumetorum do contain bitter principles, and hence are referred to as bitter yam. It has trifoliate compound leaves which differentiate it from other yams having single heart-shaped leaves, and a slender stem that twines anticlockwise. D. dumetorum stem is covered with hairs and spikes. The tuber is coarse and juicy and is usually produced in clusters.

Bitter yam is not consumed raw because of itchiness, bitterness, or toxicity component in the raw tuber. They are usually detoxified by soaking in a vessel of salt water, in cold or hot fresh water or in a stream. The bitter principle has been identified as the alkaloid dihydrodioscorine while that of the Malayan species, D. hispida, is dioscorine [1]. The alkaloid and saponin contents in yam may contribute to its bitterness or acute toxicity [2]. [3,4] have also reported its use for diabetes, as a topical anaesthetic and arrow poison. Bitter yam serves as food of choice for the diabetic patients and as herb for the treatment of various ailments.

They are native to Africa, Asia and the Americans. Some are also invasive plants often considered a ‘noxious weed’, outside cultivated areas [5]. Yam tuber varies in size from that of a small potato to over 60 kg. About seven hundred and eight (708) species of yam are known [5] and 95% of these crops are grown in Africa [6].

Medicinal property of D. dumetorum is undoubted. Bitter yam is rich in phytonutrients, including protein [7,8] and yet it remains an underutilized tropical tuber [9].

In South-Western Nigeria, it is utilized in the treatment of malaria [10].

This paper focuses on the analyses of mineral, amylose contents and phytochemical composition including the gelatinization temperature of both cooked and raw D. dumetorum (Bitter yam) commonly cultivated in South Eastern Nigeria.

2. MATERIALS AND METHODS

Dioscorea dumetorum tubers (fresh and cooked) were purchased at Ahiaeke, Umudike, Abia State Nigeria. The fresh tubers were peeled and sliced into thin pieces, sun-dried for about 6 h and then oven-dried at 40°C till a constant dry weight was recorded. The cooked tubers were processed in the same manner. Both dried pieces of tubers were subsequently milled (Corona, Launders Y Cl.A. SA) into powder and stored in air tight glass bottles until needed.

Proximate Analysis: Proximate analyses of the samples were determined. Moisture, crude protein, lipid, fibre and ash contents of the tuber were carried out in triplicates according to the methods described by [11]. Carbohydrate was determined by ‘difference’ [12]. The energy value (kcal/100 g) of the tuber was calculated using the water factors of 4, 9 and 4 for protein, lipid and carbohydrate respectively [13].

3. RESULTS AND DISCUSSION

Processing method influences the functional compositions; hence quality, acceptability and utilization of foods Fig. 1 represent the proximate compositions of Dioscorea dumetorum (bitter yam). There is a significant increase (p< 0.05) of carbohydrate value for the cooked tuber compared with the fresh tuber. Therefore, processing by cooking in water is recommended when the target is to increase the carbohydrate value of the bitter yam. Significant increase (p< 0.05) in the ash value was observed in the cooked sample as against fresh. This could be attributed to high mineral contents of the plant. The result was in line with [14] and [15] who reported high ash value of D. dumetorum. Protein, fats and oil, moisture and crude fibre contents increased significantly (p>0.05) in the fresh sample as against cooked sample. The decrease of these nutrients in the cooked sample could be attributed to the fact that processing
method influences the functional compositions, hence quality of the food. Bitter yam is not consumed raw because of itchiness, bitterness, or toxicity component in the raw tuber. Therefore, cooking or soaking methods of processing might not be avoided in view of improving these properties.

The high moisture content of the fresh tuber suggests it cannot be stored for long periods of time after harvest. Fats and oil were detected but tubers have never been known as sources of lipids though the value recorded here is higher than the 0.1% reported by [15] for more similar yam tubers.

Mineral elemental determination presented in Fig. 3 indicates that the level of Magnesium and sodium were the highest, contradicting the report of [14,15] who reported potassium levels as the highest amongst the minerals analyzed. Magnesium is a cofactor of some enzymes and enhances its biological activity. Potassium significantly (p>0.05) increased in cooked sample compared with the fresh tuber. Potassium plays a vital role in muscle contraction and in maintaining fluid and electrolyte balance in body cells [16]. Similar trend occurred in calcium concentration as against the fresh sample while iron, and phosphorous concentration was high in fresh tuber.

![Fig. 1. Proximate composition of the D. dumetorum](image)

Table 1. Qualitative composition of fresh D. dumetorum

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Ethanol extract</th>
<th>Aqueous extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloid</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Saponin</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Flavonoid</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Glycoside</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tannin</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Phenol</td>
<td>++</td>
<td>-</td>
</tr>
</tbody>
</table>

+++ = Steadily present
++ = Moderately present; + = mildly present
- = Not detected


Fig. 2. Phytochemicals of the *D. dumetorum*

![Phytochemicals of the *D. dumetorum*](image1)

Fig. 3. Mineral composition of the *D. dumetorum*

![Mineral composition of the *D. dumetorum*](image2)
Fig. 4. Gelatinization temperature of *D. dumetorum*

Fig. 5. Amylose contents of the *D. dumetorum*
Table 2. Qualitative phytochemical composition of cooked D. dumetorum

<table>
<thead>
<tr>
<th>Phytocemicals</th>
<th>Ethanol extract</th>
<th>Aqueous extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloid</td>
<td>++</td>
<td>+</td>
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<tr>
<td>Saponin</td>
<td>+++</td>
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<tr>
<td>Flavonoid</td>
<td>+</td>
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<tr>
<td>Glycoside</td>
<td>++</td>
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</tr>
<tr>
<td>Steroids</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tannin</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Phenol</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

+++ = Steadily present
++ = Moderately present
+ = Mildly present; - = Absent

Table 2 shows the result of phytochemical screening of D. dumetorum. Tannins, phenol and steroids were not detected in both aqueous extracts of fresh and cooked sample. Flavonoids, alkaloids, saponins and glycosides were present in ethanol extracts of both flesh and cooked samples. The credence to their pharmacological activities was buttressed by the presence of these chemicals and is justified by the presence of alkaloids. Cocaine, a drug derived from an alkaloid is a local anaesthetic central nervous stimulant [17]. This explains its use as an anaesthetic. Flavonoid was found in the study. Some flavonoids have been shown to have hypoglycemic activity as well [18]. Saponins were detected in both ethanol extracts of the fresh and cooked tubers of the plant. Therefore, this is in line with the use of D. dumetorum as an antidiabetic agent, as saponins have been reported to have hypcholesterolaemic activity apart from other pharmacological activities of the compounds. Plants use some of these chemicals for their own defense, among other biological functions. Non-significant increase (p> 0.05) of the amylose content of fresh sample was recorded when compared with cooked sample. [19] have reported differences in amylose and amylpectin contents as bases for significant differences in starch properties and functionality. This may account for corresponding decrease in swelling powers of the starch samples relative to their amylose contents. Gelatinization temperature increased significantly (p< 0.05) in the cooked sample as against fresh.

4. CONCLUSION

The study has shown that D. dumetorum tuber (both cooked and fresh) contains appreciable levels of crude fibre, protein and minerals in different proportions. The study further revealed that it contains phytochemicals such as flavonoids, alkaloids, saponins and glycosides which could be extracted for human use and may be responsible for its antidiabetic and other pharmacological activities. However, fresh tuber could have been recommended if not because of itchiness, bitterness, or toxicity component in the raw tuber which necessitates its procession before consumption. The tuber is low in calories and therefore suitable for diabetics and obedience.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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