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Proximate, Mineral and Phytochemical Composition of *Dioscorea dumetorum* Pax

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ABSTRACT: Proximate, mineral and phytochemical composition of *Dioscorea dumetorum* tubers was investigated using standard procedures. Proximate analysis included in g% dry weight: crude protein (6.44 ± 0.32), crude fat (0.75 ± 0.04), crude fibre (15.00 ± 0.56), total ash (3.45 ± 0.20) and a moisture content of 70.04 ± 2.37 g% wet weight. A low value of 19.36% was recorded for total carbohydrate and 109.95 kcal/100g as calorific content. Mineral analysis revealed this order in concentration K>Mg>Na>Ca>Fe>Mn>Cu>Zn>P. Potassium and magnesium levels were 17,036.00 and 1,630.50 ppm respectively. Phytochemical screening of the tuber revealed the presence of flavonoids, alkaloids, saponins and cardiac glycosides. Tannins and anthraquinones were not detected. The results justify the medicinal use of the tuber and suggest it could contribute to the nutrition of man and animal. Its low calorific content may be beneficial to dieters. © JASEM

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Dioscorea dumetorum (family: Dioscoreaceae) as the common English name (Bitter yam) suggests has a bitter taste and occurs wild throughout Africa, predominantly in the tropics. It has trifoliate (three-branched) compound leaves which differentiate it between other yams having single heart-shaped leaves, and a slender stem that twines anticlockwisely. The stem is covered with hairs and spikes. The tuber is coarse and juicy and is usually produced in clusters. *D. dumetorum* tubers like tubers of other wild plants are widely used in times of food shortage. The fresh tubers of *D. dumetorum* are said to cause poisoning (Bevan and Hirst, 1958). Alkaloids present in the tuber include dioscorine (Bevan and Hirst, 1958), dihydrodioscorine (Purseglove, 1976), dioscoretine (Iwu *et al*., 1990) and dumetorine (Corley *et al.,* 1985). Corley *et al*. (1985) and Iwu *et al*. (1990) have also reported its use for diabetes, as a topical anaesthetic and arrow poison. In Nigeria, the tuber is used in treating diabetes. The efficacy of the aqueous extract of *D. dumetorum* in reducing blood glucose, lipids and ketones in diabetic animals has been reported by Nimenibo-Uadia (2003). This study was designed with the aim of discovering nutritional and nutraceutical potentials of this underutilized tuber by investigating its proximate, mineral and phytochemical composition.

MATERIALS AND METHODS

Plant Materials: Parts of the plant and tubers were collected from *Dioscorea dumetorum* growing in a farm in Agenebode, Edo State, Nigeria and identified at the Plant Biology and Biotechnology Department Herbarium of the University of Benin, Benin City, Nigeria. All samples were harvested as one batch. The tubers were peeled and sliced into thin pieces, sun-dried for about 6 h and then oven-dried at 40 ^{0}C till a constant dry weight was recorded. Dried pieces of tuber were subsequently milled (Corona, Launders Y CI.A. SA) into powder and stored in air tight glass bottles until needed.

Proximate Analysis: Proximate analysis to determine moisture, crude protein, lipid, fibre and ash contents of the tuber were carried out in triplicates according to the methods described by AOAC (2000). Carbohydrate was determined by 'difference' (FAO, 1998). The energy value (kcal/100g) of the tuber was calculated using the Atwater factors of 4, 9 and 4 for protein, lipid and carbohydrate respectively (FAO/WHO/UNU, 1991).

Mineral Assay: Standard methods of AOAC (2000) were employed. The elemental constituents (Ca, Zn, Fe, Mn, Mg, K, Na, and Cu) in *D. dumetorum* tubers were analyzed using atomic absorption spectrophotometer (Model – Solar 969, England) after acid digestion of the sample. Appropriate working standard solutions were prepared for each element. Standard curves were obtained for the various inorganic ions by plotting concentration against absorbance. Total phosphorus was determined using a Hack Dr/200 Spectrophotometer.

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Phytochemical Analysis: Preliminary evidence for the presence of secondary products (tannins, flavonoids, alkaloids, saponins, anthraquinones and cardiac glycosides) in the tuber of *D. dumetorum* was obtained by adapting standard phytochemical procedures (Harborne, 1973; Sofowora, 1993).

Statistical Analysis: Results were expressed as Means ± SEM where appropriate and calculated for three independent determinations of each variable.

RESULTS AND DISCUSSION

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The proximate compositions of *Dioscorea dumetorum* are presented in Figure 1. The least recorded nutrient composition was lipid, while moisture was highest. The moisture value recorded in this study falls within the 65 – 82% range for yams (Eka, 1998), but higher than the 67.3% reported for *D. dumetorum* by Bradbury and Holloway (1988). The high moisture content of the tuber suggests it cannot be stored for long periods of time after harvest. Tubers have never been known as sources of lipids though the value recorded here is higher than the 0.1% reported by Bradbury and Holloway (1988) for more common yam tubers

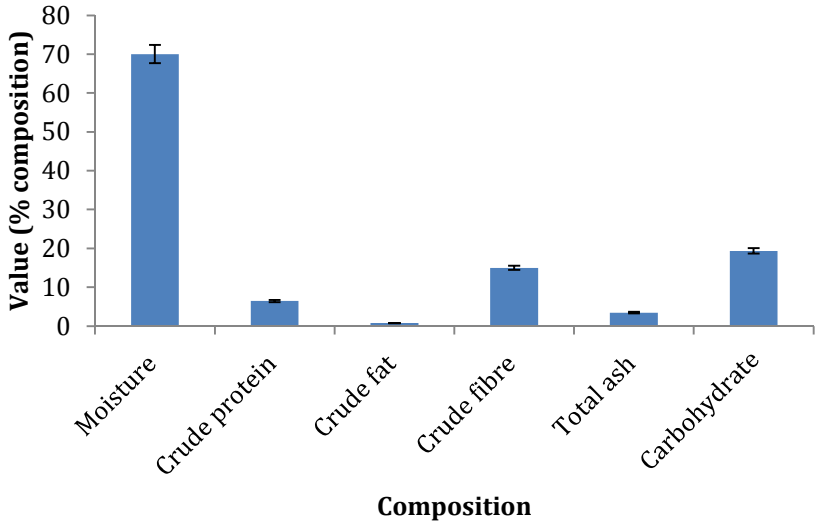

Fig. 1: Proximate Composition of *Dioscorea dumetorum* Pax tuber

The crude protein recorded in this study is more than twice the value of 2.5% reported for *D. dumetorum* by Bradbury and Holloway (1988). Variation in research findings may be due to factors such as age of plant, season of growth, time of harvest, soil nutrient composition and research methodology. In any case, this specie is richer in crude protein than other varieties (Eka, 1998). Though yams are low in protein (Eka, 1998) the higher content recorded in *D. dumetorum* can be exploited for use in malnourished communities.

Crude fibre for *D. dumetorum* recorded in this study was well above the range from 0.6% of *D. rotundata* and *D. cayenensis* to 1.4% of *D. bulbifera* (Eka, 1998). Crude fibre increases stool bulk and moves the waste faster in the gastrointestinal tract which helps prevent digestive tract problems such as diverticulosis and constipation, apart from other health benefits such as decreasing rate of sugar uptake, decreasing blood cholesterol and binding carcinogens (Chaney, 2006).

A relatively high ash value was recorded for *D. dumetorum* in this study, which was higher than the 1.1% reported for *D. dumetorum* and the range of 0.1 – 1.2% reported by Bradbury and Holloway (1988) for more common yams. The ash content is a reflection of the mineral content of the plant part.

The energy value (109.95 kcal/100g) recorded in this study for *D. dumetorum* is quite low, when compared to the 58.00 kJ/100g for *D. esculenta* (cassava), 347.0 kJ/100g of *D. alata* (water yam) or 300.0 kJ/100g of Irish potato (Eka, 1998). Since tubers are eaten mainly as sources of energy, the lower calorific value for *D. dumetorum* thus makes it a preferable source of energy for people who are on a weight loss diet

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Table 1: Elemental Composition of *Dioscorea dumetorum* Pax tubers

Minerals	Concentration (ppm)
Potassium, K	17,036.00 ± 0.25
Magnesium, Mg	1,630.50 ± 0.00
Sodium, Na	521.00 ± 0.00
Calcium, Ca	484.50 ± 0.00
Iron, Fe	204.75 ± 0.00
Manganese, Mn	55.25 ± 0.00
Copper, Cu	17.40 ± 0.00
Zinc, Zn	10.70 ± 0.00
Phosphorus, P	11.55 ± 0.00

Values are Means ± SEM of triplicate determinations.

Mineral elemental analysis as presented in Table 1 indicates that the level of potassium was the highest, corroborating the report of Bradbury and Holloway (1988) who also reported potassium levels as the highest amongst the minerals analyzed. Potassium assists in muscle contraction and in maintaining fluid and electrolyte balance in body cells (Frossard, 2000). Next in concentration was magnesium, followed by sodium, calcium, iron, and manganese, while concentrations of copper, zinc and phosphorus were quite low. However, Bradbury and Holloway (1988) recorded much higher values for phosphorus than that in this study. The mineral content of the soil in which the tuber grows, time of planting and harvesting as well as the amount of water available in the soil, determine the mineral content of the yam (Frossard, 2000).

Table 2: Phytochemical Screening of Aqueous Extract of *Dioscorea dumetorum* Pax tuber

Component	Test	Result
Tannins	Fe Cl_3	–
Flavonoids	Na OH	+
	$FeCl_3$	+
	Lead Acetate	+
Alkaloids	Dragendorff's	+
	Mayer;s	+
Saponins	Frothing	+
Anthraquinones	Bontrager's	–
Cardiac glycosides	Salkowski's	+
	Keller-Killiani	+

Key: – absent + present

Result of phytochemical screening of the tuber is shown in Table 2. Tannins and anthraquinones were absent, while flavonoids, alkaloids, saponins and cardiac glycosides were present. The presence of these chemicals lends credence to their pharmacological activities. Some alkaloids are among the most powerful poisons known hence the presence of alkaloids (Table 2) justifies the use of *D. dumetorum* as an arrow poison. Cocaine, a drug derived from an alkaloid is a local anaesthetic central nervous stimulant (Leung, 1980). Thus, presence of alkaloids in the tuber explains its use as an anaesthetic. Also, hypoglycaemic alkaloids have been found in a number of plants (Oliver-Bever, 1980), thus justifying the use of *D. dumetorum* in treating diabetic persons. In addition, the current study found the presence of flavonoids (Table 2). Some flavonoids have been shown to have hypoglycaemic activity as well (Evans, 1999).

The presence of saponins reported in this study also justifies the local use of *D. dumetorum* as an antidiabetic agent, as saponins have been reported to have hypocholesterolaemic activity apart from other pharmacological activities. Some of these chemicals are anti-nutritional factors which have been evolved by plants for their own defense, among other biological functions and reduce the optimal utilization of nutrients especially proteins, vitamins and minerals, thus preventing optimal availability of the nutrients in a food and decreasing the nutritive value. However, if consumed at appropriate amounts, they can be advantageous to human and animal health (Gemede and Ratta, 2014). Ascertaining the levels of these antinutrients is thus important.

In conclusion, the present study has shown that *D. dumetorum* tuber Pax contains appreciable levels of crude fibre, protein and minerals such as potassium and magnesium compared to other commonly consumed tubers. 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. The tuber is low in calories and therefore suitable for people who are seeking to lose weight.

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