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Evaluation of free radical scavenging activity, nutritional values and secondary metabolites of Dioscorea dregeana (Kunth) Tuber

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Abstract

The dioecious climber plant Dioscorea dregeana (Kunth.), sometimes referred to as wild yam, has huge underground hairy and fleshy tubers that can reach a diameter of 300 mm. The phytochemical, free radical scavenging activity, proximate composition, and elemental analysis of the wild yam tubers were evaluated. Tannin, phenols, flavonoids, saponins, terpenoids, alkaloids, and steroids were present in the tuber extract while proximate analysis of the tuber showed that it contains carbohydrate 57.24%, protein 7.74%, lipid 9.72%, crude fibre 3.12%, ash 3.07% and moisture 19.11%. The free radical scavenging activity results of the tuber showed moderate antioxidant property even at 1.0 mg/mL (44.82%) when compared with the standard, Vitamin C at 1.0 mg/mL (81.92). The tuber of D. dregeana also had high magnesium content which is essential in human and animal health. Findings from the phytochemical, proximate, and mineral analyses of the tubers of D. dregeana showed that it has good nutritional and medicinal values which can be exploited for use as human and animal feeds as well as in the treatment or management of some diseases.

Keywords: Free radicals, Metabolites, Dioscorea dregeana, Extraction, Phytochemical

1. Introduction

In recent years, plants have become essential for both food and medicine. Many people rely heavily on medicinal plants for remedies and treatments for various diseases, both minor and life-threatening. This has led to a growing demand for these plants worldwide. In addition to their medicinal uses, people are turning to these plants as a way to reduce their reliance on potentially harmful chemical medicines.

Interestingly, many of these essential medicinal plants are commonly used as herbs, spices, seasonings, and preservatives in our daily food preparations. However, we often consume them without realizing the benefits they provide to our bodies. The discovery of artemisinin to cure malaria and taxol to treat cancer are only two examples of medicinal plants' significant contributions to developing contemporary medicines (Chin et al., 2006).

Plants offer a vast array of chemical diversity and possess unique properties that make them valuable sources for new drugs. They have the potential to target various ailments and act through novel mechanisms (Wolfender, 2009). However, their medicinal properties have not been fully utilized, and one of the challenges is the lack of reliable documentation of traditional herbal medicine, as uses vary among different tribal communities.

2. Literature review

One such medicinal plant is *Dioscorea dregeana*, specifically its tuberous roots. These roots have long been used for their antiseptic, anti-inflammatory, and digestive benefits. They can be applied externally as poultices or taken internally as decoctions (Kulkarni et al., 2007). Additionally, the physicochemical properties of *D. dregeana* starch from the tuberous roots have been studied and show promise for use in pharmaceuticals, cosmetics, textiles, and food industries (Afolayan et al., 2021). The Transkel's Pondo people peel and soak it in water for a few days. After boiling, the tuber is consumed as a vegetable or combined with porridge or soul milk. After boiling and peeling the tuber, coastal communities in the Transkei slice and cook the tuber some more until the slices are tender and ready to mash. After that, it is consumed plain, with sweet milk, or both (Abdelmuti, 1991). In all cases, the tuber is eaten only when fresh and under great necessity, owing to its toxicity. Watt and Breyer-Brandwijk opined that, if the tuber slices are not sufficiently soaked in running water, paralysis of the legs and a sort of inebriation is said to follow. This plant is not normally considered a crop but is consumed in times of famine (Watt & Brever-Brandwijk, 1962).

This study aims to evaluate the antioxidant activity, nutritional value, and phytochemical constituents of *D. dregeana* tuber and to find out why it is being called famine tuber. We may investigate the prospective applications of this plant and its root in more detail by comprehending these features. This finding could lead to a less reliance on other nutritious tubers—like yam, potato and cassava as sources of starch and offer a more affordable option for a range of businesses.

Figure 1: Plate 1 - *Dioscorea dregeana* Tuber

3. Research methodology

3.1. Materials and Methods

Extraction process

Night hunters from the Kogi State, Nigeria, community of Akpagidigbo inside the Ofu Local Government Area obtained D. dregeana tubers. Taxonomical identification was done at the National Institute for Pharmaceutical Research and Development (NIPRD) Abuja, Nigeria. Where it was authenticated and assigned voucher number NIPRD/H/7184, a sample specimen was also deposited at the Institute. 500g of ground plant sample (tubers) was exhaustively extracted for at 72 hours using cold maceration using 1000 ml of ethanol as the solvent. The crude extract was obtained, concentrated using a rotary evaporator, and later air-dried to give dried crude extract. It was kept in the refrigerator until required for further analysis.

3.2. Screening for phytochemicals

To identify the functional groups of the chemical components present in the ethanol extract of *D. dregeana* tubers, phytochemical screening was done using established methods (Ayoola et al., 2006). The purpose of this investigation was to identify the different bioactive chemicals that may be responsible for the extract's possible biological action, including flavonoids, phenolics, alkaloids and others.

3.3. Proximate assessment

The moisture content, ash content, crude fat content, and crude fibre content of the tuber sample were assessed using the established methods of Association of Official Analytical Chemists (AOAC, 1984) standard techniques and were carried out in triplicate.

3.4. Evaluation of the free radical scavenging activities

An experiment to measure free radical scavenging efficacy was conducted using a method developed by Chang et al., 2001 (with slight modifications). Concentrations of extract tested are 0.2, 0.4, 0.6, 0.8, and 1.0 mg/mL, while absorbance is measured at 517 nm against a blank solution. Positive control was done using ascorbic acid (Vitamin C) prepared at 0.2, 0.4, 0.6, 0.8, and 1.0 mg/mL concentrations. In terms of hydrogen-donating capacity, the extent of colour change reveals the extent of scavenging capacity of the extract. The free radical scavenging capability of the ethanol extract of *D. dregeana* was calculated using the expression.

$$\%\ Inhibition = \frac{Ab - Aa}{Ab}\ x\ 100$$

A_b is the absorption of the blank sample (without the extract) and A_a is the absorption of the extract.

3.5. Determination of mineral content

The ethanol extract was subjected to phytochemical screens using conventional protocols (Ayoola et al., 2006) to determine the functionality of the chemical contents found in the extracts of the *D. dreg eana* tuber.

4. Results and discussions

Table 1: Phytochemical screening result of *D. dregeana* ethanol extract

Phytochemical	Presence	Phytochemical	Presence
Tannins	+	Terpenoids	+
Phenols	+	Cardiac glycosides	+
Flavonoids	+	Alkaloids	+
Saponins	+	Steroids	+

Table 2: Result of free radical scavenging activity of *D. dregeana* ethanol extract

Concentration (mg/ml)	% inhibition	% inhibition Vit C
0.2	49.89	57.50
0.4	49.26	78.65
0.6	46.93	73.65
0.8	45.69	83.08
1.0	44.82	81.92

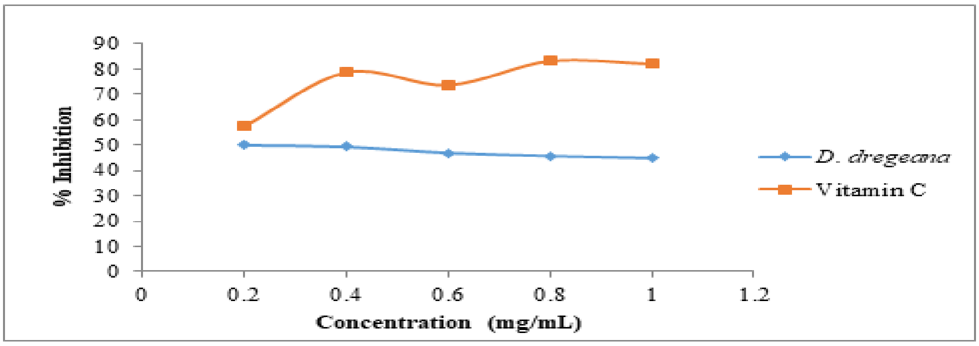

Figure 2: Result of ethanolic extract of free radical scavenging activity of *D. dregeana* compared with vitamin C

Table 3: Result of proximate composition of the *D. dregeana* tuber

parameter	(%)
Moisture	19.11
Protein	7.74
Lipid	9.72
Ash	3.07
Fibre	3.12
Carbohydrate	57.24

Table 4: Result of elemental composition of the *D. dregeana* tuber

Elements	Concentration (mg/kg)
Mg	18.72
Pb	4.34
Cd	0.23
Mn	0.52
Zn	0.53
Cu	0.72
Cr	2.51
Ni	0.22
Fe	0.46

The ethanolic extract of *D. dregeana* tuber was assessed for its proximate analysis, elemental composition, free radical scavenging activity and phytochemical screening. Tables 1-4 present the findings of these analyses, which highlight the extract's presence of a variety of bioactive components and antioxidant qualities.

Tannins, saponins, alkaloids, terpenoid, steroids and cardiac glycosides and flavonoids were all present as secondary metabolites (Table 1). These metabolites are vital to human health, especially flavonoids and phenols have antibacterial, anti- inflammatory and anti- cancer effects in addition to serving as antioxidants. Alkaloids act as stimulants and pain relievers and may have therapeutic uses in the treatment of hypertension. Tannins, on the other hand, have the ability to heal wounds and act as antioxidants (Fadeyi et al., 2020). Furthermore, the extract's saponins exhibit a variety of pharmacological properties, such as cytotoxicity, anti- allergic, anti-tumour and anti-fungal properties. *D. dregeana* can be utilized as a natural therapeutic source to treat and manage a range of ailments because it contains various bioactive compounds. Protecting cells from oxidative stress and free radical damage require the presence of antioxidants. The ethanol extract of the tuber demonstrated significant free radical scavenging activities at lower doses, similar to the reference vitamin C, as seen in Table 2 and Figure 1. Nevertheless, in contrast to the norm, its antioxidant activity dropped at larger concentration. The observed antioxidant activity of the extract can be attributed to the presence of phenols and flavonoids, which are known natural antioxidants. These compounds can decolorize DPPH solutions due to their high hydrogen-donating capacity, acting as free radical scavengers and primary antioxidants (Afolayan et al., 2023).

The proximate analysis of the tuber (Table 3) revealed a nutrient-rich profile, characterized by moderate moisture content (19.11) while the moisture content impacts its culinary uses and storage properties. Adequate moisture content is crucial for maintaining the freshness, quality, and texture of food products, making it a valuable resource for various applications. It has 3.07 % of ash content. The mineral content supports physiological processes like bone health, nerve function, and enzyme activity. Despite not providing nutrients or energy, crude fibre is a valuable source of dietary fibre. The notable value of 3.12% is impressive and suggests potential benefits for intestinal and colon health (Fagbohun et al., 2012), a diet rich in dietary fibre can positively impact intestinal and colon physiology, promoting a healthy digestive system with a moderate amount of crude lipids (9.72%). Lipids are important for providing energy, serving as structural components of cell membranes, and aiding in the absorption of fat-soluble vitamins. The presence of lipids adds to its overall nutritional profile and potential dietary benefits. Substantial protein content (7.74%), the high protein content, exceeding that of other tubers like potato and corn, enhances its potential use in the food industry (Idowu et al., 2012). Protein is crucial for muscle growth, tissue repair, and various metabolic functions. This remarkable protein content makes the tuber an attractive raw material for the food industry (Idowu et al., 2012). High carbohydrate content (57.24%), as a carbohydrate-rich tuber, *D. dregeana* offers a potential source of energy fuel, essential for bodily functions and organic compound synthesis (Kaushik et al., 2022). These proximate components are essential for human health and provide energy and essential nutrients for bodily functions (Jisika et al., 2010). Also, the mineral composition (Table 4) analysis revealed the presence of several minerals: Mg (18.72 mg/kg), Pb (4.34 mg/kg), Cd (0.23 mg/kg), Mn (0.52 mg/kg), Zn (0.53 mg/kg), Cu (0.72 mg/kg), Cr (2.51 mg/kg), Ni (0.22 mg/kg), and Fe (0.46 mg/kg). These findings suggest that *D. dregeana* could serve as a source of essential nutrients. However, it's crucial to note the significant quantity of lead detected, which could pose health risks. Lead exposure is associated with neurological and behavioural effects that may be irreversible. There is no known safe blood lead content; even 3.5 μg/dL levels can cause learning challenges, behavioural problems, and lower intellect in kids (Kaushik et al., 2022).

5. Contribution of the research to the knowledge

Nutritional, phytochemical and antioxidant potentials of *D. dregeana* tuber has been highlighted in this research work. The results showed the tuber as a promising source of therapeutic agents, a good source of magnesium and carbohydrate especially starch if properly studied and exploited.

6. Conclusion

Further studies will be needed for biological evaluation of the extracts of the tuber against some pathogenic organisms to establish its activity and also relate the specific phytochemicals present with any observed activity. As a result of presence of some heavy metals in the tuber, it is advisable not to eat it raw in order to avoid lead poisoning.

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