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Nutritive and anti-nutritive properties of *Boerhavia diffusa* L.

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ABSTRACT

Plant and plant based medicines are the basis of the modern pharmaceuticals, we use today for our various ailments. The present study investigates the qualitative and quantitative analysis of the major bioactive constituents of the medicinally important plant *Boerhavia diffusa* L. The study noticed the presence of alkaloids, tannins, flavanoids, saponin, terpenoid and phenols and absence of cardiac glycoside in the ethanol, chloroform and petroleum ether extracts. The estimation of phytochemicals revealed that the quantities of flavonoids (5.651 g/100 g) and phenols (2.471 g/100 g) were higher than alkaloids (0.232 g/100 g). Moisture content, total fibre, dry weight, bulk density, total ash content, acid soluble and insoluble ash content, water soluble and insoluble content, sulphated ash were determined in the proximate analysis. The high total ash value (23.09%) suggests that the plants are rich sources of minerals since the ash content of a sample is a reflection of the minerals it contains. The Nutritional analysis includes biochemical analysis (carbohydrate, protein, fat and vitamins), mineral analysis (micro elements and macro elements) and anti-nutrient analysis. The carbohydrate (10.56 mg/gm) and protein (5.76 mg/gm) content of the plant was high, though the quantity of fat (1.61 mg/gm) was in a lower concentration. The major element present in the plant is magnesium (142.9 mg/100 g). Since the whole plant is being consumed as part of various treatments, it necessitates the analysis of its nutritional, anti-nutritional, proximate and biochemical composition, which may be helpful to establish a standard natural drug for further research.

Keywords: *Boerhavia diffusa,* phytochemicals, proximate analysis, sulphated ash, antinutrients

1. Introduction

Historically, plants have provided a source of inspiration for novel drug compounds, as plant derived medicines have made large contributions to human health and well-being. Traditional medicine using plant extracts continues to provide health coverage for over 80% of the world's population, especially in the developing world [1].

B. diffusa or red spiderling, a component of several Ayurvedic and traditional ethnomedical preparations, belongs to the family Nyctaginaceae which is commonly known as, punarnava meaning that which rejuvenates or renews the body. The species is used to treat a large number of human ailments as mentioned in Ayurveda, Charaka Samhita and Sushrita Samhita. The plant in whole or its peculiar parts have numerous medicinal properties and are used by endemic and tribal people in India and in Unani medicine in Arab countries. Various phytochemical, pharmacological, experimental and clinical investigations were done on *B. diffusa* by many scientists and researchers to clearly understand the ancient Ayurvedic, endemic and tribal usage of this medicinal plant. Its roots are used for the treatment of jaundice, ascites, internal inflammations, asthma and piles apart from its properties as an antidote for rat poisoning. Its medicinal value as an appetizer and alexiteric was reported by Khare [2]. Pharmacological studies have demonstrated that *B. diffusa* known to possess diuretic, antifertility, antifibrinolytic, immunomodulatory, anti-inflammatory, antidiabetic, anti-viral, aaptogenic, antistress, antimicrobial, hepatoprotective, antiurethritis, antimetastatic and antioxidant activities [3-14]. Phytochemical research has demonstrated the presence of alkaloids and amino acids in *B. diffusa*. However, nutritional evaluation of the species is lacking and hence the present investigation attempts to evaluate the nutritional and antinutritional factors in the species *B. diffusa*.

2. Materials and Methods

The fresh whole plants of *B. diffusa* were collected from a wide population grown in Karyavattom campus, Trivandrum, Kerala during April, 2012. The materials were washed with distilled water and air dried in the shade for two weeks at room temperature. The dried sample was milled into powder using an electric blender. The powder was stored in a sample tube and kept it in a refrigerator for further analysis.

2.1 Plant extraction

Plant extraction was carried out using three solvent systems, namely ethanol, chloroform and petroleum ether. Dried powdered sample (100 gm) was extracted with 500 ml of solvents for 12 hrs. The filtered extract was subjected to phytochemical analysis.

2.2 Phytochemical profile (Qualitative and Quantitative methods)

Qualitative phytochemical analysis was carried out according to the methods described by Harborne and Trease and Evans [15-16]. The quantitative phytochemical analysis was done for estimating the amount of alkaloid, saponins, tannins, phenolics and flavonoids using standard protocols [17-18].

2.3 Proximate analysis

The proximate analysis included moisture content, bulk density, foaming index, total ash content, and properties like acid soluble-insoluble ash, water soluble-insoluble ash, sulphated ash, water soluble extractive and alcohol soluble extractive and were evaluated according to the standard protocols of the Association of Official Analytical Chemist [19].

2.4 Elemental analysis

The powdered sample was digested using nitric acid- per chloric acid mixture for 24 hours. This was then filtered using Whatman # 42 filter paper and the filtrate was used to determine the minerals, including both macro and micro elements using Atomic Absorption Spectroscopy (AAS) [20].

2.5 Biochemical analysis: Quantity of carbohydrate [21], lipid [22], protein [23] and the vitamins like ascorbic acid (Vitamin C), thiamine (Vitamin B_1) and tocopherol (Vitamin E) were estimated [24-25].

2.6 Anti nutritional analysis

The anti-nutritional factors like saponin and tannin contents were estimated [17].

3. Results and Discussion

3.1 Phytochemical profile

The qualitative analysis (Table 1) of the ethanolic, chloroform and petroleum ether extracts of *B. diffusa* revealed presence of alkaloid, flavanoid, terpenoid, steroid, tannin, phlobatannin and phenolic compounds, whereas cardiac glycosides were absent. Presence of phlobatannin was only in the ethanolic extract while saponin was present in the chloroform extract. It was observed that almost all the phytochemicals analysed qualitatively were present in ethanolic extract. Moreover, the highest yield was also observed in ethanol extract and hence this was selected for further studies. The estimation of phytochemicals revealed that the quantities of flavonoids (5.651 g/100 g) and phenols (2.471 g/100 g) were higher than alkaloids (0.232 g/100 g). These results expose that the plant has quite a number of chemical constituents, which may be responsible for many pharmacological actions and have protective or disease preventive properties too Alkaloids are beneficial chemicals to plants with predator and parasite repelling effects [26]. As flavonoids having antioxidant property, it protects tissues against oxygen free radicals, they have a role in prevention of atherosclerosis, cancer, chronic inflammation and may inhibit aging. The polyphenols possess anti parasitic activity and monoterpenes have been reported to constitute anti-spasmodic, anti-neoplastic and anti-viral activities [27]. The presence of these phytochemical constituents revealed that the species may be used as a basic medicinal agent for analgesic, antispasmodic, antibacterial, anti-cancer, anti-inflammatory and anti-oxidant properties. The phytochemical profile of the species gives an insight into its value as a medicinal as well as highly nutritious one, safe for consumption both as a medicine and as a natural source for antioxidant and antioxidant promoting activities.

Table 1: Phytochemical Constituents of *B. diffusa*

S.No	Phytochemicals	Test	Methanol Extract	Chloroform extract	Petroleum ether extract	Water extract
1	Alkaloid	Dragendorff's test Mayer's test	+++ -	++ +	+ +	++ +
2	Flavonoid	Shinoda test	+++	++	++	-
3	Terpenoid	Salkowski test	++	-	-	+
4	Tannin	$FeCl_3$ test	++	-	+	++
5	Phloba tannin	HCl test	+	-	-	-
6	Saponin	Chloroform &H2SO4 test	-	++	-	-
7	Coumarin	Alkaline test	++	++	+	-
8	Steroid	Liebermann Burchard test	+++	++	++	+++
9	Glycosides	Molish's test	-	-	-	-
10	Phenolic compounds	Ferric chloride test	++	++	++	++

3.2 Proximate analysis

The results of the proximate composition are shown in Table 2. The proximate analysis showed the moisture content of *B. diffusa* is 78.9% (w/w). It indicates a low shelf life of the fresh plant and hence long storage would lead to spoilage due to its susceptibility to microbial attack. This supports the practice of storage in dry form by users. Moisture content is among the most vital and mostly used measurement in the processing, preservation and storage of

food [28].

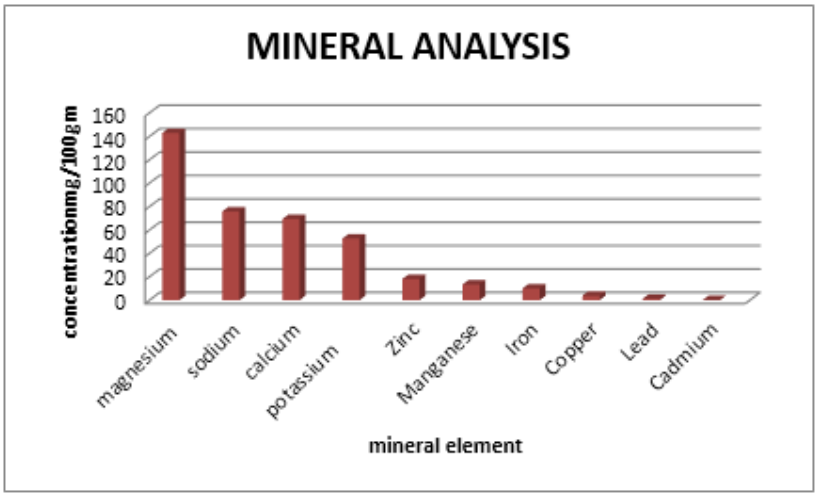
Table 2: Proximate and Nutrient Composition in *B. diffusa*

Parameters	Concentration
Moisture %	78.9
Fibre %	2.4
Bulk density g/ml	0.34
Foaming index %	>100
Total ash content %	23.09
Acid soluble ash %	19.4
Acid insoluble ash %	0.6
Water soluble ash %	4.70
Water insoluble ash %	15.30
Sulphated ash	1.35
Alcohol soluble extractive %	6.60
Water soluble extractive %	16.35

The percentage of fibre content of the plant was high (2.4%), nutritionally it had been reported that food fibre aids absorption of trace elements in the gut and reduce absorption of cholesterol [29]. The plant showed low bulk density (0.34 g/ml). The ash value was determined from measures like total ash, acid-insoluble ash, water soluble ash and sulphated ash. The high total ash value (23.09%) suggests that the plants are rich sources of minerals since the ash content of a sample is a reflection of the minerals it contains. The total ash is particularly important in evaluation of purity and identity of drugs mainly the presence or absence of foreign inorganic matter [30]. Acid-insoluble ash (0.6%) is the part of total ash, which is insoluble in diluted HCl and measures the amount of silica present in it. Water soluble ash (4.7%) is the water soluble portion of total ash. Water soluble extractives values (16.35%) were more when compared to alcohol soluble extractives (6.60%). Higher water-soluble extractive value implies that water is a better solvent of extraction for the formulation than ethanol [31].

3.3 Elemental analysis (macro and micro elements)

Mineral analysis showed that *B. diffusa* is a rich source of macro minerals like magnesium, sodium, calcium and potassium (fig 1).The major element present in *B. diffusa* is Magnesium (142.9 mg/100 g), it could help to lower the blood pressure. In the therapeutic use of this nutrient, the daily dosage is 420mg/day Sodium and potassium (75.9, 52.7 mg/100 g respectively) are involved in maintaining water balance and acid-base balance and is the major extra cellular and intracellular mineral respectively. They are also involved in the transport of some non-electrolytes. Calcium and magnesium are majorly found in the skeleton. Calcium is essential for the formation and maintenance of bone and for the blood clotting and muscle contraction processes. High quantity of the mineral calcium (69.4 mg/100 g) in the plant indicates its ability to regulate or control the osmotic balance of the body fluid and body pH. The species was also rich in micro elements like zinc, manganese and iron. However, the microelements like lead (1.25 mg/100 g), copper (3.9 mg/100 g) and cadmium (0.28 mg/100 g) were only in trace amounts (Graph 1). The presence of three essential elements, namely iron, manganese and zinc indicates the efficient enzymatic metabolism in *B. diffusa* and low concentrations of the heavy metals such as lead, cadmium and copper suggest its utility in consumption [32].



Graph 1: Macro & Micro elemental analysis of B. *diffusa*

3.4 Biochemical analysis

The nutritive parameters included estimation of carbohydrate, lipid, protein and vitamins like ascorbic acid (vitamin C), thiamine (vitamin B_1) and tocopherol (vitamin E). The high amount of carbohydrate (10.56 mg/gm) and protein (5.76 mg/gm) observed in the study suggest that the species can be used as a good source of carbohydrate and protein. According to Pamela *et al.* [33], the main role of carbohydrates is to provide energy for the body, especially the brain and nervous system and proteins from plant sources have lower quality, but their combination with many other sources of protein such as animal protein may result in adequate nutritional value. However, the fat content was found to be relatively low (1.61 mg/gm) when compared with their concentrations in other plants as reported by Javid Hussain [34]. Analysis of vitamins showed that the quantity of ascorbic acid (0.20mg/gm), thiamine (0.24 gm/gm) and tocopherol (0.16mg/gm) was high in *B. diffusa*. Natural ascorbic acid is a major water- soluble antioxidant reacts enzymatically and non-enzymatically with reactive oxygen species, thus it plays an important role in preventing aging and cancer in mammals. Lack of ascorbic acid impairs the normal formation of intercellular substances in the body like collagen, bone matrix and tooth dentine [35]. Tocopherol is a lipid soluble antioxidant,

protecting cell membranes from oxidation and thiamine helps to convert carbohydrate into energy and is essential for the functioning of the heart, muscles, and nervous system [36]. Proximate and nutrient analyses of edible plant and vegetables play a crucial role in assessing their nutritional significance [37].

Table 3: Biochemical characterisation

Carbohydrate mg/gm	10.56
Protein mg/gm	5.76
Fat mg/gm	1.61
Ascorbic acid mg/gm	0.20
Thiamine mg/gm	0.24
Tocopherol mg/gm	0.16

3.5 Anti-nutritional analysis

Anti-nutrient analysis revealed moderate amount of tannin (16mg/gm) and saponin (1.59%) in *B. diffusa*. These two compounds are considered as anti-nutrients because of many reasons. Price *et al.* [38] reported that saponin reduces the uptake of certain nutrients, including glucose and cholesterol at the gut through intraluminal physicochemical interaction and it reduces cholesterol levels and thus lowers the metabolic burden of the liver. Tannins are polyhydric phenols that form insoluble complexes with proteins, carbohydrates and lipids leading to the reduction in digestibility of nutrients [39]. Antinutrients typically don't cause a problem in a person's diet unless he or she eats only a few different foods. Also, cooking food or other processes such as fermentation and malting may increase the nutritive content of foods by inactivating or reducing levels of antinutrients. The concentrations of saponin and tannins in *B. diffusa* was however not alarming when compared with their concentrations in other foodstuffs as reported by Chakraborty and Eka [40].

4. Conclusion

The phytochemical and nutritional evaluation of *B. diffusa* indicates a high nutritive and the pharmacological value of the plant. The plant screened for phytochemical constituent seemed to have the potential to act as a source of useful drugs and also to improve the health status of the consumers as a result of the presence of various compounds that are vital for good health. Based on the results of the present investigation, it can be concluded that this plant can be considered as an ideal candidate for a holistic medical application. A detailed study will throw the neutracuetical significance of the species, which in turn will focus the investigation of drugs with multifaceted effects.

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