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NUTRITIONAL EVALUATION OF LEAVES OF *BOERHAAVIA DIFFUSA* L. AND *ANDROGRAPHIS PANICULATA (BURM.F.)*WALL. EX NEES: IMPLICATIONS FOR NUTRACEAUTICAL APPLICATIONS

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ABSTRACT

Fresh leaves of *Boerhaavia diffusa* and *Andrographis paniculata* were evaluated for nutritional and anti-nutritional compositions. The results showed that both plant leaves contained saponins, alkaloids and flavonoids. The proximate analysis and vitamin C of *B. diffusa* and *A. paniculata* included moisture (76.04% and 73.02%), carbohydrate (17.14% and 12.16%) and vitamin C (40.00 and 45.01mg/100g), respectively. The mineral contents of the *B. diffusa* and *A. paniculata* leaves were found to be P (151.45 and 250.13mg/100g), Na (160.21 and 152.50mg/100g), Ca (218.24 and 318.62mg/100g) and Mg (8.93 and 7.68 mg/100g) respectively. The vitamin and mineral compositions obtained from the analysis suggested that the leaves of these two plants are a good source of vitamin C where as the presence of macro-and micro-nutrients in both the plants leaves make them strongly suitable to be incorporated into human nutrition. The presence of phytochemicals and vitamin C also suggested the anti-oxidant property of these two medicinal plants.

KEYWORDS: ***Boerhaavia diffusa*, *Andrographis paniculata*, proximate and chemical compositions**.

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INTRODUCTION

Medicinal plants are of great importance to the health of individuals and communities. The beneficial medicinal effects of plant materials typically results from the combinations of secondary metabolites such as alkaloids, steroids, tannins, phenolic compounds, flavonoids, resins, fatty acids and gums. They are capable of producing definite physiological action on body[1,2]. Many medicinal plants are used as spices and food plants. They are also sometimes added to foods meant for pregnant and nursing mothers for medicinal purposes[3,4]. Vegetable is basically any part of a plant, be it leaves, roots, seeds or fruits that can be eaten. This food of plant origin contains many bioactive compounds and thus serves as an important source of minerals, vitamins and certain hormone precursors in addition to protein and energy sources[5]. Leafy vegetables have continued to provide populations with limited access to meat or fish, a rich source of proteins and micronutrients essential for pregnant and lactating mothers, as well as young and growing children[6]. Studies have shown that vegetarians are less susceptible to diseases, live longer, healthier and more productive lives with stronger immunity[7]. However, there has been a reduction in the consumption of vegetables with each passing decade[8]. *Andrographis paniculata* and *Boerhaavia diffusa* are wide species of vegetables that are relatively underutilized and in most cases neglected[9]. The leaves are cooked and eaten as vegetable. Domestic livestock also grazes the plant especially during famine. *B. diffusa*, commonly called hog weed, is known as *erimmirii* (which literally means water-food) by the Ibos of southeastern Nigeria. The leaves are cooked and eaten as vegetable. The plant is used in folkloric medicine to treat convulsions and as a mild laxative and febrifuge[10]. The roots and leaves are considered to have an expectorant action, to be emetic and diuretic in large doses and are used in the treatment of asthma. The thick roots, softened by boiling are applied as a poultice to draw abscesses and to encourage the extraction of guinea worm[9]. The *Andrographis paniculata* (Kalmegha) is herb and known for its hepatoprotective, antihepatitis B and anticancer activity. The active compounds in leaves are andrographolides, kalmeghin, and andrographin. The leaves contain the highest amount of andrographolide, the most medicinally active phytochemical in the plant, while the seeds contain the lowest. The primary medicinal component of *Andrographis* is andrographolide. It has a very bitter taste, is a colorless crystalline in appearance, and is called a "diterpene lactone" - a chemical name that describes its ring like structure [11]. The neglection of these vegetables coupled to the growing reduction in consumption of vegetables and evaluating the levels of some macro and micronutrients of *B. diffusa and A.paniculata* prompted this study so that this study will increase interest in them. Various techniques of elemental analysis of different medicinal plants have been used[12-18]. However in this present study, elemental concentration with the help of AAS and Vitamin C by HPLC were analysed.

MATERIALS AND METHODS

(i) Collection and preparation of plant materials

Fresh leaves of two herbs, *A. paniculata* and *B. diffusa* were collected from a Roxberg herbal garden of Botany Department, University of Allahabad from the plant stalk and were cleaned by water and immediately analysed for proximate, vitamin & mineral content and phytochemicals content.

(ii) Proximate analysis

Proximate observations for normalized samples of *A. paniculata* and *B. diffusa* were

estimated in triplicate for moisture, fat, protein, ash crude fibre contents and carbohydrates. These were determined by methods as described by AOAC[19] and total ash and mineral content as given by Rangana[20]. Carbohydrate content was determined by difference method.

(iii) Analysis of vitamin C and minerals

For mineral analysis 5 g of respective dried samples were digested in concentrated HNO_3 [19]. The digest was quantitatively transferred to a 50 ml volumetric flask and made up to volume with distilled water. A blank digest was carried out in the same way. All minerals were determined using atomic absorption spectrometry (Perkin Elmer Atomic Absorption Spectrometer A Analyst 700) against aqueous standards. The mineral concentration was expressed as mg mineral/100gm dry weight. The vitamin C content was determined by HPLC (Metrohm 820 IC).

(iv) Phytochemical screening and quantitative estimation

The quantitative estimation of phytochemicals like tanins, saponin, flavonoids, alkaloids and total phenols was estimated according to Trease and Evans [21].

(v) Statistical Analysis:

The obtained data of the proximate, mineral composition and phytochemicals of the *A. paniculata* and *B. diffusa* leaves were analyzed using one-way analysis of variance (ANOVA) and the significant differences between means were determined by post hoc Duncan's multiple range test. Differences were considered to be significant when $p<0.05$. Data were analysed using SPSS package.

RESULTS AND DISCUSSION

The quantitative estimation of the % proximate compositions of *B. diffusa* and *A. paniculata* are shown in Figure 1. It was revealed that the *B. diffusa* and *A. paniculata* contained moisture (76.04% and 73.02% respectively), fat (1.16% and 0.98%), protein (1.719% and 2.85%) and carbohydrate (17.14% and 12.16%) as shown in Figure 1. Keary [9]described the high-quality distribution of nutrients in the vegetables. Therefore the data obtained from this study were significantly different from the previous observations obtained from another leafy vegetable *Amaranthus hybridus*[22]. *A. paniculata* was found to contain 45.01mg/100mg vitamin C while *B. diffusa* contain 40.00mg/100g vitamin C as illustrated in Figure 2 & 3. The deficiency of vitamin C causes scurvy in humans. Vitamin C facilitates wound healing, production of collagen, formation of red blood cells and boosts immune system. The recommended daily allowance of vitamin C is 75mg/day for women and 90mg/day for men[23]. The results of the present study showed that the both *A. paniculata* and *B. diffusa* contain sufficient quantity of vitamin C which may help to control the physiological oxidative stress[24]. Some of the mineral constituents of the defatted leaves are given in Table 1. The sodium, calcium and magnesium contents of *B. diffusa* and *A. paniculata* were as follows 160.21, 218.24 and 8.93 mg/100g and 152.50, 318.62 and 7.68mg/100g dry weight, respectively. The observed data of mineral content of both the plant species were found to be significant ($P \geq 0.05$). The *A. paniculata* have fairly adequate concentrations of sodium and calcium, equivalent concentrations of magnesium, but with low contents of potassium and iron in comparison with those reported for *A. hybridus* leaf extract[23].

The present study carried out on the plant samples revealed the presence of medicinally active constituents. The phytochemical characters of the two medicinal plants investigated are summarized in Table 2. The phytochemical screening and quantitative estimation of the chemical constituents of the plants showed that the leaves were rich in saponins (2.74-3.23 %),

flavonoids (0.89-1.03 %) and tannins (2.61-9.84 %). The saponins and tannins content obtained from the leaves of *B. diffusa* and *A. paniculata* were found to be significant (P ≥0.05) while, flavonoids content were found to be non significant. These phytochemical were known to show medicinal activity as well as exhibiting physiological activity [25]. *B. diffusa* leaves were found to contain higher concentration of saponin, flavonoids & total phenols (0.53- 0.98 %) while lower concentration of alkaloids (0.56- 0.93 %)) and tanins than *A. paniculata* leaves (Figure 1). Both the total phenols and alkaloids were showed the significant appearance in both the species. Saponin is a known anti-nutritional factor, which reduces the uptake of certain nutrients including glucose and cholesterol at the gut through intra-luminal physicochemical interaction. Hence, it has been reported to have hypercholesterolemia effects[26] and thus may aid in lessening the metabolic burden that would have been placed on the liver. Phenols are said to offer resistance to diseases and pest in plants[27]. Saponin protects the plant against microbes and fungi. Alkaloids are beneficial chemicals to plants with predator and parasite repelling effects. However, they inhibit certain mammalian enzymic activities such as those of phosphodiesterase, prolonging the action of cyclic AMP. They also affect glucagons and thyroid stimulating hormones, while some forms have been reported to be carcinogenic[28]. It is noteworthy that at the concentration of these chemicals in edible vegetables, they are usually non-toxic. Furthermore, steaming or boiling reduces their levels in plant extracts[29]. These vegetables also contain flavonoids, which are phenolic compounds that serve as flavoring ingredients of spices and vegetables[30]. They have been found to have anti-oxidation effects in animals. Therefore, it was reasonable to determine the total primary and secondary metabolite content in the plant extract. The plants studied here can be seen as a potential source of useful drugs also. Further studies are going on these plants in order to isolate the bioactive compounds to have its application in drugs and nutraceuticals. In conclusion, the study has revealed that leaves of *B. diffusa* and *A. paniculata* are potential sources of nutrients and some essential macro, micronutrients and phytochemical needed by man. The importance of these nutrients cannot be over emphasized, to be used as vegetables. These can be incorporated in other foods as nutraceuticals for effective and proper metabolism as well as for the maintenance of good physiological state in man and animals.

Table 1
Mineral composition of Andrographis paniculata and Boerhaavia diffusa

Particulars	*Andrographis paniculata*	*Boerhaavia diffusa*
	Leaves	
P (mg/100g)	250.13±1.23[a]	151.45±1.3[b]
Na (mg/100g)	152.50±3.54[b]	160.21±2.32[a]
K (mg/100g)	0.93±0.08[a]	0.86±0.05[a]
Ca (mg/100g)	318.62±3.02[a]	218.24±2.44[b]
Fe (mg/100g)	0.012±0.001[a]	0.034±0.002[a]
Mg (mg/100g)	7.68±0.06[b]	8.93±0.07[a]
Mn (mg/100g)	0.44±0.02[a]	0.38±0.02[a]
Al (mg/100g)	0.45±0.02[a]	0.36±0.01[b]

Values are mean±standard deviation of triplicate determinations. Different letters within rows show significant differences at ≥0.05 according to the Duncan's multiple range test

Table 2
Phytochemical composition of Andrographis paniculata and Boerhaavia diffusa leaves

Particulars	*Andrographis paniculata*	*Boerhaavia diffusa*
	Leaves	Leaves
Saponin (%)	3.23±0.11[a]	2.74±0.10[b]
Tanin (%)	2.61±0.10[b]	9.84±0.15[a]
Alkaloid (%)	0.56±0.20[b]	0.93±0.16[a]
Total Phenols (%)	0.98±0.11[a]	0.53±0.20[b]
Flavonoids (%)	1.03±0.22[a]	0.89±0.20[a]

Values are mean±standard deviation of triplicate determinations. Different letters within rows show significant differences at ≥0.05 according to the Duncan's multiple range test.

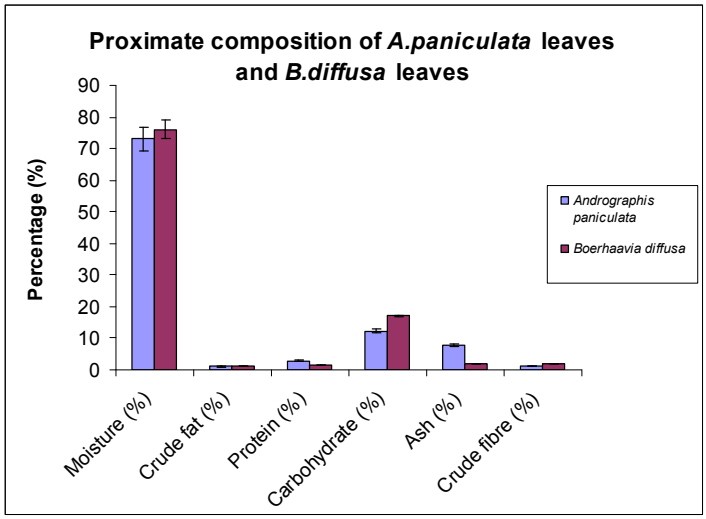

Figure 1
Proximate composition of Andrographis paniculata and Boerhaavia diffusa

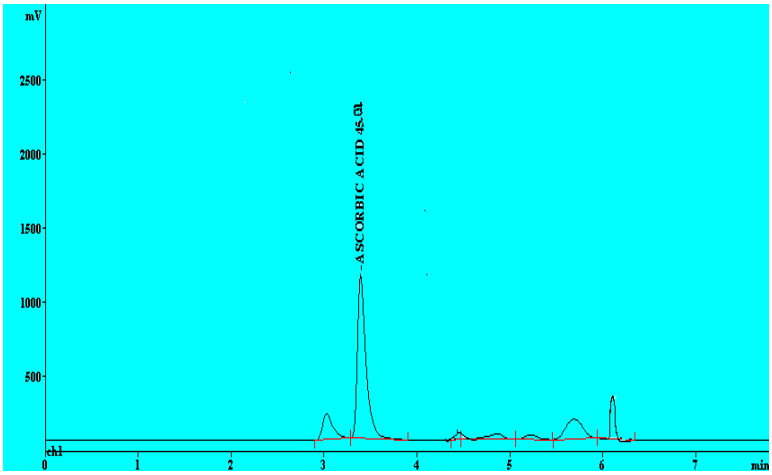

Figure 2
Graph showing Vitamin C content in A. paniculata analysed by HPLC

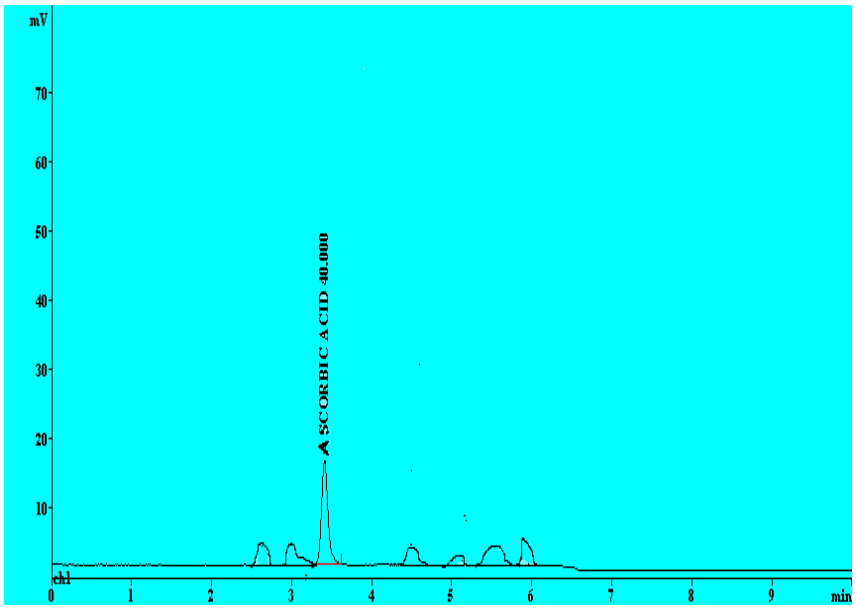

Figure 3
Graph showing Vitamin C content in B.diffusa analysed by HPLC.

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