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**Abstract**

Plants are the rich source of all the nutrients, minerals and elements essential for human beings. Explorations of less known edible plants should be carried out and their cultivation, using modern agricultural practices, may supplement our requirement of food. Technical studies on their nutritional values are needed before they can be suggested as sources of non conventional foods to boost food supply. *Boucerosia* and *Caralluma* species are xerophytic succulents belonging to the Apocynaceae family with approximately 100 species distributed worldwide. These plants are found in drier regions of India and used as a part of famine food and for antiobesity. *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata*, being succulent, showed high percentage of moisture content, minimizing the amount of total solids to a meager. Ash content was found to be moderate. By the present research we found considerable concentrations of various major and minor mineral elements such as: Sodium, Potassium, Calcium, Magnesium, Phosphorous, Zinc, Manganese, Iron, but low levels of Chromium and Lead respectively. The above two plants contained low levels of Fat, moderate amounts of Protein and Fibre, rich source of Carbohydrate. Finally the Nutritive value is very high in both the plants.

**Key words:** *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata*, nutritional value, mineral elements

**Introduction**

Plants have been used as the source of food from the time when human existence started on earth. Since time immemorial, traditional knowledge and indigenous evidences suggest that a variety of wild edible plant species in India have played a prominent role in providing food and medicine for human beings as well as animals. Edible plants may have different uses in different areas of the same country. Cultivated plants are widely used today although wild edible plants have the significant medical and the other economical properties. During the recent past, wild edibles have featured outstanding in the discussions and framework of rural development and biodiversity conservation. Poor rural and tribal people depend on a wide variety of plants, animals and fungi for their own consumption and for income generation. The South Indian region is well known for these plants which are being utilized by local inhabitants for various purposes, i.e., medicine, fuel, food, timber etc. The nutritive value of plant plays great role in plant and human being, so material extracted from the natural plant through chemical or biotechnology method was elucidated by Chapman (1).

All human beings require a number of complex organic compounds as added calorific requirements to meet the need for their all muscular activities. Humans require a suite of mineral elements in varying amounts for proper growth, health maintenance and general well-being. Human body comprises chemical
compounds such as water, proteins, fatty acids, nucleic acids and carbohydrates; these in turn consist of elements such as carbon, hydrogen, oxygen, nitrogen and phosphorus etc. and minerals. Majority of the wild edible plants having carbohydrates, fats, fibre and proteins form the major portion of the diet, while minerals and vitamins form comparatively a smaller part (2). Plants are capable of absorbing a wide range of mineral ions with relevance to human nutrition and health. Well balanced diet that includes mixed sources of grains, fruits and vegetables, plant foods can make a significant contribution to daily nutritional and mineral needs at all stages of the life cycle. Unfortunately, consumption patterns are not always ideal, and many individuals both in developed and developing countries are failing to attain recommended nutritional and mineral intakes.

There are some important reports regarding mineral and nutritional analysis of plants. Jain et al. (3) have studied the analysis for mineral elements of some medicinal plants. Duhan et al. (4) extensively reported the value of some non conventional plant foods of India. Gopalan et al. (5) worked out on nutritive value of Indian foods. Indrayan et al. (6) worked on determination of nutritive value and analysis of mineral elements for some medicinally valued plants like, Artocarpus heterophyllus, Nelumbo nucifera etc. Nile and Khobragade (7) studied nutritive value and mineral elements of important medicinal plants like, Tinospora cordifolia, Gymnema sylvestre etc. Umar et al. (8) studied nutritional composition of water spinach (Ipomoea aquatica) leaves. Sridhar and Bhat (9) have revealed about Lotus a potential nutraceutical source. Aberoumand and Deokule (10) have also focused on nutritional values of some wild edible plants like Asparagus officinalis, Alocacia indica etc.

Boucerosia and Caralluma species are growing in India, Africa, Middle East, Spain and Pakistan (11). Several species of these genera are found in India. Plants of these species are edible and the medicinal properties include; anti-inflammatory, anti-nociceptive, anti-ulcer, anti-diabetic, anti-pyretic and anti-oxidant effects. Boucerosia and Caralluma extracts have also been found to be appetite suppressant, a property which is well known to Indian tribes and some Caralluma species are used in the treatment of obesity. The extracts of Caralluma species in the form of capsules have been released under different trade names like GENASLIM, SLIMALUMA etc. for body weight control or obesity (11).

Pharmacological review of Caralluma with special reference to appetite suppression and antiobesity was studied by Dutt et al. (12). Kunert et al. (13) researched on pregnane glycosides of Caralluma adscendens var. fimbriata. Quantitative determination of pregnanes from aerial parts of Caralluma species using HPLC-UV and identification by LC-ESI-TOF was carried by Avula et al. (14).

Obesity is a major global health problem and a risk factor for several chronic disorders such as diabetes, hyperlipidemia, hypertension and cardiovascular diseases. Kuriyan et al. (15) extensively researched on effect of Caralluma fimbriata extract on appetite, food intake and anthropometry in adults. The huge benefits of the plant Caralluma well catered in Caralluma (16). Antiobesogenic and antiatherosclerotic properties of Caralluma fimbriata extract found by Soundararajan et al. (17). Plants belonging to this genus are rich in esterified polyhydroxy pregnane glycosides. The genus is also characterized by the presence of flavone glycosides (18). Caralluma umbellata has in vitro antibacterial activity and is used in traditional medicine by Indian tribes (19). Some selected species of Caralluma and Boucerosia showed antiadipogenesis activity, cellular antioxidant activity and pregnane steroid on cell lines (20, 21). Evaluation of antiproliferative properties of selected species of Caralluma and Boucerosia on skin cancer cell lines was carried out by Vajha et al. (22).
Recent research has highlighted the need for screening of nutritional and mineral properties of plants as they contain all the necessary mineral and nutrients which play a vital role in daily human diet and activities. The present study is therefore attempted to investigate the mineral and nutrient composition of two threatened medicinal plant species *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata* (Fig. 1 and 2). Many researchers have tried to determine the nutritive values and mineral composition of many medicinal plants, but to the best of our knowledge no reports are available on the mineral and nutritional studies of *Boucerosia* and *Caralluma*. Fortunately, research in plant mineral nutrition is ongoing globally and will continue to receive much attention, because efforts to improve plant mineral status are important not only for the nutritional value of our food supply, but also for the healthy and reproductive output of our agronomic crops. However, more advanced, effective pharmacological and clinical studies would be required to investigate *in vivo* mechanism of nutraceutical effects of these very important wild plant species.

**Materials and Methods**

*Mineral and Trace Elements Analysis:* Plant materials (Fig. 1 and 2) were collected, washed with lukewarm water and dried in shade. To prepare the sample for mineral analysis, the washed and dried materials were ground to fine powder and used for dried ashing. In each case the powdered plant material was taken in a pre cleaned and constantly weighed silica crucible and heated in a muffle furnace at 400°C till there was no evolution of smoke. The crucible was cooled at room temperature in a desiccator and carbon-free ash was moistened with concentrated sulphuric acid and heated on a heating mantle till fumes of sulphuric acid ceased to evolve. The crucible with sulphated ash was then heated in a muffle furnace at 600°C till the weight of the content was constant (~2–3 h). 1 g of sulphated ash obtained above was dissolved in 100 ml of 5% HCl to obtain the solution ready for determination of mineral elements through atomic absorption spectroscopy (AAS) and flame photometry (FPM). Standard solution of each element was prepared and calibration curves were drawn for each element using AAS/FPM.

*Proximate/ Nutritive Value Analysis:* For determination of nutritive value, various parameters were studied using the crushed plant material through (AOAC) Association of the Official Analytical Chemists methods 23. Moisture content, ash, crude fat, crude fiber, crude protein and carbohydrate contents and overall nutritive value contents was analyzed by standardized protocols (24).

**Determination of Moisture Content:** For determination of moisture content, the sample...
materials were taken in a flat-bottom dish and kept overnight in an air oven at 100–110°C and weighed. The loss in weight was regarded as a measure of moisture content.

**Determination of Ash Content:** For determination of ash content, 10 g of each sample was weighed in a silica crucible. The crucible was heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 3–5 h at 600°C. It was cooled in a desiccator and weighed to ensure completion of ashing. To ensure completion of ashing, it was heated again in the furnace for half an hour, cooled and weighed. This was repeated till the weight became constant (ash became white or greyish white). Weight of ash gave the ash content.

**Determination of Crude Fat:** Crude fat was determined by extracting 2 g moisture free sample with petrol in a Soxhlet extractor, heating the flask on a sand-bath for about 6 h, till a drop taken from the drippings left no greasy stain on the filter paper. After boiling with petrol, the residual petrol was filtered using Whatman No. 40 filter paper and the filtrate was evaporated in a pre weighed beaker. Increase in weight of beaker gave crude fat.

**Determination of Crude Protein:** The crude protein was determined using micro Kjeldahl method. 2 g of oven-dried material was taken in a Kjeldahl flask and 30 ml conc. H₂SO₄ was added followed by the addition of 10 g potassium sulphate and 1 g copper sulphate. The mixture was heated first gently and then strongly once the frothing had ceased. When the solution became colourless or clear, it was heated for another hour, allowed to cool, diluted with distilled water and transferred to an 800 ml Kjeldahl flask, washing the digestion flask. 3 or 4 pieces of granulated Zn and 100 ml of 40% caustic soda were added and the flask was connected with the splash heads of the distillation apparatus. Next 25 ml of 0.1 N sulphuric acid was taken in the receiving flask and distilled. When two-thirds of the liquid had been distilled, it was tested for completion of reaction. The flask was removed and titrated against 0.1 N caustic soda using methyl red indicator for determination of Kjeldahl nitrogen, which in turn gave the protein content.

**Determination of Crude Fibre:** Crude fibre was determined to be reported along with the nutritive value. The estimation was based on treating the moisture and fat-free material with 1.25% dilute acid, then with 1.25% alkali. Then 2 g of moisture and fat-free material was treated with 200 ml of 1.25% H₂SO₄. After filtration and washing, the residue was treated with 1.25% NaOH. It was then filtered, washed with hot water and then 1% HNO₃ and again with hot water. The residue was ignited and the ash weighed. Loss in weight gave the weight of crude fibre.

**Determination of Carbohydrate:** Percentage of carbohydrate was given by: 100 – (percentage of ash + percentage of moisture + percentage of fat + percentage of protein).

**Nutritive Value was Finally Determined by:** Nutritive value = 4 x percentage of protein + 9 X percentage of fat + 4 X percentage of carbohydrate. The percentage of various mineral elements and nutritive values were summarized in tabular form.

**Results and Discussion**

The sample solution for mineral analysis was prepared first, then washed and dried materials were ground to fine powder and used for dried ashing. In each case the powdered plant material was taken in a pre cleaned and constantly weighed silica crucible and the same method was followed through, atomic absorption spectroscopy (AAS) and flame photometry (FPM). Results of the mineral and trace elements in two medicinal plants are given in Table- 1; Fig. 3. The concentrations of these elements for *Boucreosia indica* and *Caralluma adscendens* var. *fimbriata* are as follows; (w/w). Sodium (Na) is higher 65 mg/100 g in *B. indica* compared to *C. fimbriata* 40 mg/100 g. Sodium plays important role in transport of metabolites and takes part in ionic balance of human body.

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Potassium (K) is higher with 260 mg/100 g in *B. indica* than *C. fimbriata* with 120 mg/100 g. Potassium regulates heart rhythms, important as a diuretic, maintain tissue excitability and normal muscle contraction and helps in release of chemicals which acts as nerve impulses. Its deficiency causes nervous irritability mental disorientation, low blood sugar, insomnia and coma. Calcium (Ca) is also high in *B. indica* with 4200 mg/100 g and moderate in *C. fimbriata* 2280 mg/100 g. Calcium plays important role in building and maintaining strong bones, teeth and also large part of human blood and extra cellular fluids. It is also necessary for normal functioning of cardiac muscles, blood coagulation, milk clotting and regulation of cell permeability. Ca deficiency causes rickets, back pain, osteoporosis, indigestion, irritability, premenstrual tension and cramping of the uterus.

The concentration of Magnesium (Mg) is slightly low in *B. indica* with 180 mg/100 g than *C. fimbriata* with 200 mg/100 g. Magnesium is highly required in plasma and extracellular fluid, maintains osmotic equilibrium and plays important role in formation and function of bones, muscles, prevents disorders, high blood pressure and depression, also plays important role in enzyme activity. Mg deficiency interferes with transmission of nerve and muscle impulses, causing irritability and nervousness, prevent heart diseases. Phosphorous (P) is low in *B. indica* with 390 mg/100 g slightly high in *C. fimbriata* with 420 mg/100 g. Phosphorous maintains blood sugar level, normal heart contraction, cell growth and repair mainly needed for bone growth, acid base balance and kidney function.

Zinc (Zn) is quite low in *B. indica* with 0.31 mg/100 g compared to *C. fimbriata* which contains 0.40 mg/100 g. Zinc is a component of many metallo enzymes, including some enzymes which play a central role in nucleic acid metabolism. In addition, Zn is a membrane
stabilizer and a stimulator of the immune response. Its deficiency leads to impaired growth and malnutrition. Manganese (Mn) is also low in B. indica is 0.40 mg/100 g and high in C. fimbriata with 0.70 mg/100 g. Manganese is essential for hemoglobin formation, but excess is harmful. Iron (Fe) was comparatively low in B. indica with 20 mg/100 g, and in C. fimbriata it was 22 mg/100 g. Iron make body tendons and ligaments, certain chemicals of brain are controlled by presence or absence of Iron, it is essential for formation of hemoglobin, carries oxygen around the body. Fe deficiency causes anemia, weakness, depression, poor resistance to infection.

Chromium (Cr) was very low in comparison with all other mineral elements in both studied plants. B. indica contains 0.02 mg/100 g, whereas C. fimbriata contains 0.01 mg/100 g. Chromium is vital element as it works with insulin to stabilize blood sugar level, help to absorb energy from blood and increase muscle mass, reducing fat mass in human body, it plays a vital role in metabolism of carbohydrates. Deficiency of Cr results in growth failure, cataract, hyperglycemia, neuropathy, atherosclerosis and leads to diabetes in human. Lead (Pb) is also lowest among various biologically important elements. As it is 0.01 mg/100 g in B. indica and BDL (Below detectable level) in C. adscendens var. fimbriata Lead is best known for its toxicological properties. Low levels of Pb in both plants suggested their non toxic nature.

Nutritive values of Boucerosia indica and Caralluma adscendens var. fimbriata were high on a dry matter (DM) basis. The percentages of proximate analysis results (Table- 2; Fig. 4) revealed that dried part of B. indica has Moisture content 94.6 %, Ash content 22.52 %, Crude Fat 3.54 %, Crude Protein 11.58 %, Crude fibre 15.00 %, Carbohydrate 62.36 % and finally Nutritive value 327.62 (cal/100gm). Where as in C. adscendens var. fimbriata, Moisture content was 95.10 %, Ash content 15.81 %, Crude Fat 3.90 %, Crude Protein 10.82 %, Crude fibre...
moisture concentration of these two plants agrees with definitions of vegetables, which were characterized with high water content. The protein contains all of essential amino acids and forms the building blocks of bones, teeth, muscles, skin and blood. In addition, it helps to regulate fluid balance and acts as enzymes transporters. As an antibody, protein also helps as a defense mechanism of the body against different diseases. The body can synthesize many of the amino acids required for protein synthesis, but some amino acids must be obtained from the proteins in the diet. Plant food

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Boucerosia indica</th>
<th>Caralluma adscendens var. fimbriata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>94.61</td>
<td>95.10</td>
</tr>
<tr>
<td>Ash content (%)</td>
<td>22.52</td>
<td>15.81</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>3.54</td>
<td>3.90</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>11.58</td>
<td>10.82</td>
</tr>
<tr>
<td>Crude fibre (%)</td>
<td>15.00</td>
<td>16.82</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>62.36</td>
<td>69.47</td>
</tr>
<tr>
<td>Nutritive value (cal/100gm)</td>
<td>327.62</td>
<td>356.26</td>
</tr>
</tbody>
</table>

These two antiobesity plants contains considerable quantities of good source of essential nutrients, which supports their use as food, fodder and good source of various important nutrients for humans as well as live stock. *Boucerosia indica* and *Caralluma adscendens var. fimbriata* with high vegetable carbohydrate, fibre, sufficient protein and with low fat. And also with suitable mineral elements showing high nutritive value. The elevated moisture concentration of these two plants agrees with definitions of vegetables, which were characterized with high water content. The protein contains all of essential amino acids and forms the building blocks of bones, teeth, muscles, skin and blood. In addition, it helps to regulate fluid balance and acts as enzymes transporters. As an antibody, protein also helps as a defense mechanism of the body against different diseases. The body can synthesize many of the amino acids required for protein synthesis, but some amino acids must be obtained from the proteins in the diet. Plant food

**Table 1.** Mineral and trace elements composition of *Boucerosia indica* and *Caralluma adscendens var. fimbriata* by atomic absorption spectroscopy (AAS) and flame photometry (FPM)

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Boucerosia indica</th>
<th>Caralluma adscendens var. fimbriata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (Na)</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>260</td>
<td>120</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>4200</td>
<td>2280</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>390</td>
<td>420</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.31</td>
<td>0.40</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.01</td>
<td>BDL</td>
</tr>
</tbody>
</table>

**Table 2.** Proximate/Nutritive value composition of *Boucerosia indica* and *Caralluma adscendens var. fimbriata* by Association of the Official Analytical Chemists (AOAC) methods

16.82%, Carbohydrate 69.47% and lastly Nutritive value 356.26 (cal/100gm).

Nutritional Evaluation and Mineral Analysis of *Boucerosia indica*
that provides more than 12% of its calorific value from protein is considered as good source of protein. And mineral deficiency causes poor growth, impaired immune function and delayed mental development (25).

Adequate intake of dietary fibre (DF) plays an important role in decreasing the risks of many disorders such as constipation, diabetes, cardiovascular diseases, diverticulosis, obesity, serum cholesterol level, hypertension, colon and breast cancer (26). All the fractions (Cellulose, lignin, hemicellulose, pectin, gums and mucilage) of dietary fibre are the major constituents of plant cell wall. As such, carbohydrate is the most important source of food energy among the macronutrients, accounting between 40–80% of total energy intake (27). Fat is in tune with that a diet contain 1–2% of its calorific of energy as a fat is said to be sufficient to human beings while excess fat consumption is implicated to certain cardiovascular disorders (28). However, the present findings suggest that *B. indica* and *C. adscendens* var. *fimbriata* could have great potential in nutritive value together with its medicinal properties.

**Summary and Conclusions**

Plants are complex organisms whose mineral needs are determined by a number of molecular, cellular and whole-plant events. *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata* species have many medicinal and pharmaceutical uses and grow abundantly in the Southern India, its sustainable harvest from nature and cultivation may improve the local economy. Moreover, the xerophytic nature of the species may have advantages in cultivating in dry slopes to protect the soil erosion. These present findings have important connotations in light of upcoming organic foods, nutraceutical and pharmaceutical industries in the state. Our research data show that both the plants contain appreciable amount of proteins, fat, fibre, carbohydrate and calorific value, mineral, trace elements and generally low levels of toxicants. Thus, it can therefore be concluded that *B. indica* and *C. adscendens* var. *fimbriata* can contribute significantly to the nutrient requirements of man and should be used as a source of nutrients to supplement other major sources. Chemical analysis however should not be the sole criterion for judging the nutritional value of these two plants. It is necessary to consider other aspects such as the biological evaluation of the nutrient contents of these plants in order to determine the bioavailability of the nutrients and also the effects of processing on the chemical and nutritive value of the plants.

**Mineral and Trace Elements Analysis:** The concentrations of these elements for *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata* (Table-1; Fig. 3) are as follows: w/w (mg/100 g) Sodium - 65 and 40, Potassium 260 and 120, Calcium 4200 and 2280, Magnesium 180 and 200, Phosphorous 390 and 420, Zinc 0.31 and 0.4, Manganese 0.4 and 0.7, Iron 20 and 22, Chromium 0.02 and 0.01 and Lead 0.01 and BDL respectively.

**Proximate or Nutritive Value Analysis:** *Boucerosia indica* and *Caralluma adscendens* var. *fimbriata* (Table-2 & Fig. 4) contained 94.61% and 95.81% of Moisture, 3.54% and 3.90% Fat, 11.58% and 10.82% Protein, and 15.00% and 16.82% Fibre, 62.36% and 69.47% Carbohydrate respectively. Finally nutritive value was calculated as 327.62 Cal/100g and 356.26 Cal/100g for dry weight respectively.

**References**


