

Determination of nutritive value and analysis of mineral elements for some medicinally valued plants from Uttarakhand

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Study of different medicinally valued seeds of *Nelumbo nucifera*, *Embelia ribes*, *Eugenia jambolana* and leaves of *Artocarpus heterophyllus* showed Cr, K, Ca, Cu, Zn and Mn to be sufficient in seeds of *N. nucifera* which also have good nutritive value and are quite rich in carbohydrates accompanied by enough protein, but are low in fat. *E. ribes* seeds have even a higher nutritive value with high carbohydrate, enough mineral elements but low protein. Rich in Mg and moderate in protein, the *E. jambolana* seeds have a moderate nutritive value. *A. heterophyllus* leaves are not rich in desired mineral elements except Na, and have a low nutrition value. However, on a dry matter basis they too have a high nutritive value and are used as fodder for livestock.

Keywords: *Artocarpus heterophyllus*, *Embelia ribes*, *Eugenia jambolana*, mineral elements, *Nelumbo nucifera* nutritive value.

ALL human beings require a number of complex organic compounds as added¹ caloric requirements to meet the need for their muscular activities. Carbohydrates, fats and proteins form the major portion of the diet, while minerals and vitamins form comparatively a smaller part. Plant materials form a major portion of the diet; their nutritive value is important. In the present study, the medicinally important seeds of *Nelumbo nucifera*, *Eugenia jambolana*, *Embelia ribes* and the leaves of *Artocarpus heterophyllus* were taken for investigation from the Uttarakhand region, famous for its high biodiversity. Jain *et al.*² have studied the presence of mineral elements in some other such health-related plants.

N. nucifera Gaertn. (syn. *Nelumbium speciosum* Willd.), known as 'kamal' in Hindi, belongs to the family Nymphaeaceae. *N. nucifera* is native of China, Japan and India³. It is commonly found growing in ponds, tanks and jheels. The seeds are sweet⁴ and flavoury, astringent, aphrodisiac, sedative to the pregnant uterus, destroy 'kapha' and 'vata', good astringent in diarrhoea and dysentery; strengthen the body; useful in burning sensation of the body; vomiting and leprosy and also considered as antidote to poison. Nefrine, an alkaloid, isolated from the seeds of *N. nucifera*

has antihypertensive activity⁵ and its effect on platelet aggregation⁶ has been reported. Starch phosphorylase activity has also been reported⁷ in the seeds. An Egyptian sample of seeds is reported⁸ to possess 14.8% crude protein that causes a significant decrease in the blood glucose level of diabetic albino rats. Crude alcoholic and aqueous extracts of the seeds are effective in controlling centrally induced emesis by apomorphine in experimental animals⁹.

E. ribes (family Myrsinaceae) is a large scandent shrub, found throughout India up to an altitude of 5000 ft. It is also found in Sri Lanka, Malaysia and South China¹⁰. Pericarp is brittle, enclosing a single seed covered with a membrane; taste slightly astringent and aromatic¹¹. It has been employed in India since ancient times as anthelmintic¹⁰, but work at the Calcutta School of Tropical Medicine has shown that while it has no effect on hookworm and tapeworm, it is effective in the treatment of ascariasis, where it is better than Santonin¹¹. However, Gupta *et al.*¹² determined a remarkable anthelmintic activity of disalts of embelin, the main ingredient of the seeds. Antibacterial study¹³ has also been made. The antifertility effect of embelin in female rats has been reported¹⁴⁻¹⁷. Bhaduri *et al.*¹⁸ reported the protective action of seed extract against the pulse beetle *Callosobruchus maculatus* infesting cowpea seed. Gupta *et al.*¹⁹ have studied biodistribution of embelin for male antifertility potential. Protective action of embelin against lipid peroxidation on tumour-bearing rats was reported by Chitra *et al.*²⁰. Recently, Wanjari *et al.*²¹ have reported the efficacy of seed extract against *Ascaridia galli* in white leghorn chicks. Chaudhary *et al.*²² have studied embryotoxicity and teratogenicity of the seed powder as a component of the ayurvedic drug, pippaliyadi. Results of the study of a herbal preparation in the treatment of periodontal disorders have also been reported²³.

A. heterophyllus Lamk (family Moraceae), commonly known as Jack tree and 'kathal' in Hindi, is a large evergreen tree cultivated throughout the hotter parts of India²⁴. Leaves are useful in skin disease and are considered as antidote to snake poison²⁵. They make a part of Munda medicine, drunk to stop vomiting. Leaves are estrogenic²⁶ and leaf ash is useful in healing ulcers²⁷. Mature leaves have hypoglycaemic activity and do not have any adverse effect on normal body function. They are frequently used as fodder for livestock.

E. jambolana Lam. syn. *Syzygium cumini* Linn (family Myrtaceae), is a large evergreen tree with pale brown bark, slightly rough on old stems with shallow cracks and depressions. Leaves are elliptic-oblong, acute, smooth and shining. Fruit variable in size up to 2.5 cm long, ellipsoid, black with pink juicy pulp. Seeds are astringent, diuretic, and stop urinary discharges²⁸. They are also used in diabetes. Recently, Rathi *et al.*²⁹ used the plant extract of *E. jambolana* for prevention of experimental diabetic cataract.

Authenticated seeds of *N. nucifera*, *E. ribes* and *E. jambolana* were procured from the local market, whereas leaves of *A. heterophyllus* were collected from the uni-

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versity campus. Specimens have been deposited in the herbarium of Plant Medicine Section of the Chemistry Department at our university under registry nos 10/15, 09/15, 14/15 and 06/15 respectively, and are available for inspection. Plant materials were 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 ashing³⁰. In each case the powdered plant material was taken in a precleaned 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). One gram 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.

For determination of nutritive value, various parameters were studied using the crushed plant material.

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 consequently till the weight became constant (ash became white or greyish white). Weight of ash gave the ash 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 content³¹.

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 petrol³², the residual petrol was filtered using Whatman no. 40 filter paper and the filtrate was evaporated in a preweighed beaker. Increase in weight of beaker gave crude fat.

The crude protein was determined using micro Kjeldahl method. Two grams 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 a 800 ml Kjeldahl flask, washing the diges-

tion flask. Three or four pieces of granulated zinc, 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 solution using methyl red indicator for determination of Kjeldahl nitrogen, which in turn gave the protein content.

Crude fibre was determined to be reported along with the nutritive value. For determination of crude fibre, the estimation was based on treating the moisture and fat-free material with 1.25% dilute acid, then with 1.25% alkali, thus imitating the gastric and intestinal action in the process of digestion. 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 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 fibre³².

Percentage 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 × percentage of protein + 9 × percentage of fat + 4 × percentage of carbohydrate.

Results of the percentage of various mineral elements in four plant materials are given in Table 1, while the results of nutritive and other values are summarized in Table 2.

Though the percentage of chromium was quite low in all the studied materials, it was comparatively higher in *N. nucifera* seeds. Chromium plays a vital role in metabolism of carbohydrates and its deficiency leads to diabetes in human body³³. Deficiency of chromium results in hyperglycaemia, growth failure, neuropathy, cataract and atherosclerosis³⁴.

Sodium was higher in *A. heterophyllum* leaves; but they contained less potassium, whereas in the other three study materials K was significant. Na and K take part in ionic balance of the human body and maintain tissue excitability. Because of the solubility of salts, Na plays an important role in the transport of metabolites. K is of importance as a diuretic. Calcium was high in *N. nucifera* seeds, but negligible in *E. jabolana* seeds. Ca constitutes a large proportion of the bone, human blood and extracellular fluid; it is necessary for the normal functioning of cardiac muscles, blood coagulation and milk clotting, and the regulation of cell permeability. It also plays an important part in nerve-impulse transmission and in the mechanism of neuromuscular system. Magnesium was moderate in all materials, except *A. heterophyllum* leaves in which it was high because of chlorophyll content in leaves. In humans, Mg is required in the plasma and extracellular fluid, where it helps maintain osmotic equilibrium. It is required in many enzyme-catalysed reactions, especially those in

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Table 1. Per cent concentration of various elements

Plant	Cr	Na	K	Ca	Mg	Cu	Zn	Mn	Fe
<i>Nelumbo nucifera</i> (seeds)	0.0042	1.00	28.5	22.10	9.20	0.0463	0.0840	0.356	0.1990
<i>Embelia ribes</i> (seeds)	0.0019	1.25	21.5	16.80	7.55	0.0150	0.0450	0.047	0.2300
<i>Eugenia jambolana</i> (seeds)	0.003	1.82	16.7	0.54	10.2	0.0018	0.0006	0.068	0.2580
<i>Artocarpus heterophyllus</i> (leaves)	Nil	7.88	3.32	4.56	13.9	0.0021	0.0110	0.031	0.0560

Table 2. Nutritive value of selected medicinal plants

Plant	Ash (%)	Moisture content (%)	Crude fat (%)	Protein (%)	Carbohydrate (%)	Crude fibre (%)	Nutritive value (Cal/100 g)
<i>N. nucifera</i> (seeds)	4.50	10.50	1.93	10.60	72.17	2.70	348.45
<i>E. ribes</i> (seeds)	6.70	5.23	3.61	2.42	82.04	5.32	370.33
<i>E. jambolana</i> (seeds)	22.32	12.45	1.26	8.20	55.77	15.14	267.22
<i>A. heterophyllus</i> (leaves)	8.20	57.90	2.50	5.70	19.70	7.20	124.10

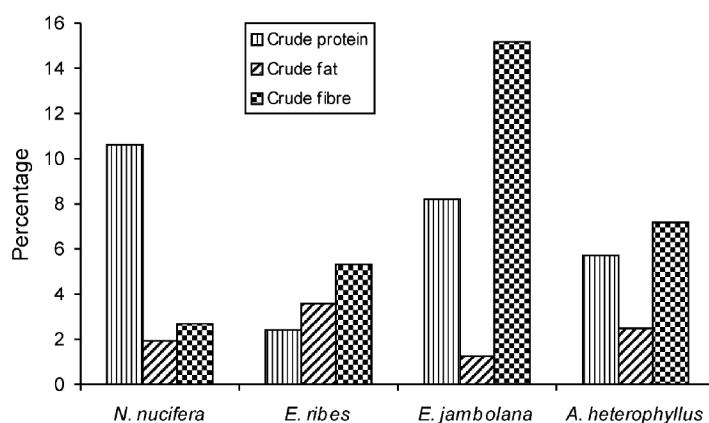


Figure 1. Percentage of crude protein, crude fat and crude fibre on DM basis.

which nucleotides participate where the reactive species is the magnesium salt, e.g., $MgATP^{2-}$. Lack of Mg is associated with abnormal irritability of muscle and convulsions and excess Mg with depression of the central nervous system.

Copper and zinc were sufficient in seeds of *N. nucifera*, moderate in seeds of *E. ribes* but low in the other two materials. Cu is also a component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin, an iron-oxidizing enzyme in blood³⁵. The observation of anaemia in Cu deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin³⁶. Zn is a component of many metalloenzymes, including some enzymes which play a central role in nucleic acid metabolism³⁷. In addition, Zn is a membrane stabilizer and a stimulator of the immune response³⁸. Its deficiency leads to impaired growth and malnutrition³⁹. Manganese was also comparatively higher in *N. nucifera*. It is essential for haemoglobin formation⁴⁰, but excess is harmful.

Iron was comparatively high in *E. jambolana* seeds but low in *A. heterophyllus* leaves. Importance of iron is well known.

Nutritive value of seeds of *E. ribes* was maximum followed by seeds of *N. nucifera* and *E. jambolana*. Leaves of *A. heterophyllus* were found to be of less nutritive value, but on a dry matter (DM) basis (moisture 57.9%) they too have good nutritive value, which supports their use as fodder for livestock. Verma *et al.*⁴¹ have reported higher crude protein and crude fibre but less crude fat in the leaves from northeastern hill region. The crude protein, fat, and fibre on DM basis in the four samples are shown in Figure 1. Advantage of *E. jambolana* seeds lies in their comparatively high crude fibre and protein content and not very high carbohydrate content and very low fat. *N. nucifera* seeds have good protein (10.6%) and high carbohydrate (72.17%). In an Egyptian sample, Ibrahim and El-Eraqy⁸ determined 14.81% protein. A sample from Japan⁴² gave much different values for mineral elements as well as the nutritive value parameters, though the overall nutritive

value was almost the same as determined in the present work.

N. nucifera seeds seem to have good nutritive and suitable mineral element value, particularly for those who require protein and high carbohydrates. *E. jambolana* seeds seem to be a balanced one. *A. heterophyllus* leaves are good for those who require high sodium and also good as a fodder, while *E. ribes* seeds with high carbohydrate and high nutritive values seem to be good for younger people.

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