Chapter 2

Nutritive Value
Introduction

Plants have played important roles in sustaining the health and promoting the quality of human life. Medicinal plants are natural resources, yielding valuable herbal products, which are often used in the treatment of various diseases. The uses of medicinal plants covered under investigation are widely reported in Ayurveda and are used since ancient times, which have therapeutic, preventive and curative properties. These herbs were selected from indigenous folk medicines, Ayurvedic, Unani and Siddha systems of medicines. In traditional methods, the medicinal plants being used, very often are in powder or paste, which contain both the organic and inorganic constituents. Any attempt to incorporate these specific parts of plants as intakes of food components will be requiring a thorough analysis of energy and nutrient values, along with the specific knowledge of their metabolic actions and active biological components (Prasad et al., 2010).

Since time immemorial traditional knowledge and indigenous evidence suggest that a variety of wild edible plant species have been played prominent role in providing food and medicine for human being and animals (Maikhuri and Gangwor, 1993). The most important nutrients present in plants are carbohydrates, such as oils, proteins, minerals, ascorbic acids and the antioxidants phenols, such as, chlorogenic acid and its polymers. These molecules are involved in pathogen resistance in plants and the chlorogenic acid concentration represents about the 90% of the total phenolic compounds
in the plants (Ekanayake and Nair, 1998). Protein is an essential primary metabolites and it is very much required in the diet for growth and development of an individual. Proteins are made up of a particular sequence of amino acid that must be provided through the diet (Roy et al., 2002).

Green leafy vegetable supply high quality protein and should be used more freely, and also they are excellent source of minerals, vitamins and energy. Calcium and other minerals are used in the process of eliminating sulphates, phosphates and nitrogen end products from excess proteins and also these minerals used to neutralize the effect of excess protein. If there is adequate supply of minerals in the blood, they are leached from the bones, which contribute to osteoporosis (Torvati et al., 2007).

Dietary fibers play an important role in decreasing the risks of many disorders such as constipation, diabetes, cardiovascular disease, diverticulosis and obesity. Plant based foods are the only sources of dietary fibers. All the fraction cellulose, lignin, hemicellulose, pectin, gums and mucilage of dietary fibers are the major constitution of plant cell wall.

Every nutrient plays an important role in the growth and development of man, on the other hand, deficiency of any one of the nutrient may lead to abnormal developments of the body (Newall et al., 1996).

Qualitative or quantitative determination of mineral elements present in plants are important, because, the concentration and type of minerals present must often be stipulated on the label of a food. The quality of many foods depends on the concentration and type of minerals, what they contains, also play a very significant role against a
variety of degenerative diseases and processes, they may also prevent and reduce injury from environmental pollutants and enhance the ability to work and learn. Some minerals are essential to a healthy diet (e.g. Calcium, Phosphorus, Potassium and Sodium), whereas, some can be toxic (e.g. Lead, Mercury, Cadmium and Aluminium). It is clear that, mineral nutrition is important to maintain good health (Anonymous 1, 1999).

Trace elements play both curative and preventive role in combating diseases. Deficiency of trace elements in human can occur under the most practical dietary conditions and in many diseased statuses. In recent years, scientists have started believing in the therapeutic role of metals in human health (Udayakumar and Begum, 2004).

Most of the nations are facing malnutrition problems in the world. Nutritional deficiency is well recognized in human food and animal feeds. The need of the good quality food and feeds has been increasing due to rapid growth of population. It is most important to overcome the malnutrition problems, further, major share in the total food source of the world is provided by the plants. Therefore, screening the nutritive ability of the available and unexplored plant wealth is most important in the present day. With all the above reasons, the test plant E. mallotformis was subjected to analysis of nutritive value and elemental composition.

Review of Literature

All living organisms need a number of complex organic compounds as added caloric requirements to meet the need of their muscular activity. Carbohydrates, fats and proteins form the major portion of the diet, while, minerals and vitamins form comparatively a similar part (Indrayan et al., 2005).
Nonprescription drugs are products, comprising minerals and vitamins used to prevent diseases. Meanwhile, most of the medicinal plants are taken as such and in most cases in low doses for prevention of debility. Vitamin E, Se, Zn and other antioxidants of plant origin are proved to be promising weapons in the struggle against premature ageing and the postponement of degenerative diseases (Obiajunwa et al., 2002).

The detailed reports of available information about nutritive value and elemental composition of medicinal plants are summarized as below:

Ravindran et al. (1996) worked on nutritive value of raw and processed colocasia (Colocasia esculenta) corm meal for poultry. Raw, unpeeled colocasia corm meal contained (dry matter basis) 90.7 g/kg crude protein, 796 g/kg nitrogen-free extracts, 1234 mg/kg total oxalates and 8.66 MJ/kg nitrogen-corrected apparent metabolizable energy.

Abdulrazak et al. (2000) evaluated the nutritive potential of some Acacia tree leaves (Acacia brevispica, A. nubica, A. tortilis, A. seyal, A. nilotica and A. mellifera) from Kenya. Results showed that crude protein (CP) content ranged from 134 to 213 g/kg DM, neutral detergent fiber (NDF) and acid detergent fiber (ADF) ranged from 154 to 308 from 114 to 251 g/kg DM, respectively, poor in phosphorus, moderate in calcium, magnesium and sulphur and rich in most microelements. Iron and selenium ranged from 132 to 459 and 13 to >100 mg/g respectively.

Bhandari et al. (2003) conducted work on nutritional evaluation of wild yam (Dioscorea spp.) tubers of Nepal. In this study four wild yam species: Dioscorea bulbifera, D. versicolor, D. deltoidea and D. triphylla were studied. The dry matter ranged from 19.8 to 30.5% on a fresh weight basis. The ranges of crude protein, ash,
Crude fat and crude fibre contents were 1.6–3.1, 0.5–1.2, 0.2–0.3 and 0.6–1.5% of fresh weight, respectively. The ranges of minerals in mg per 100 g fresh weight were K (250–560), Na (4.15–17.8), P (33.1–61.6), Ca (14.3–46.9), Mg (18.3–27.3), Cu (0.10–0.21), Fe (0.39–2.92), Mn (0.14–0.35) and Zn (0.22–0.53).

McSweeney et al. (2005) assessed that comparative nutritive value of *Acacia angustissima* with the tanniferous legumes (*Calliandra calothyrsus* and *Leucaena leucocephala*) and lucerne (*Medicago sativa*). Average NDF and ADF content did not differ markedly between *A. angustissima* accessions (417 and 189 g/kg), *L. leucocephala* (447 and 178 g/kg), *C. calothyrsus* (416 and 205 g/kg) and lucerne (399 and 168 g/kg). Average N content of *A. angustissima* (38 g/kg) and *C. calothyrsus* (36 g/kg) were similar but tended to be lower than *L. leucocephala* (43 g/kg) and lucerne (50 g/kg).

Indrayan et al. (2005) studied on nutritive value and analysis of mineral elements for some medicinally valued plants from Uttaranchal. 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. 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.

In 2006, Hassan et al. revealed the nutritional value of Balsam apple (*Momordica balsamina*) leaves. The plant leaves had high moisture content (71.00±0.95% fresh weights). The concentration of estimated crude protein and available carbohydrates on
dry weight (DW) basis were 11.29±0.07% and 39.05±2.01% respectively. The leaves also have high ash (18.00±0.56% DW) and crude fibre (29.00±1.23% DW) contents; while crude lipid (2.66±0.13% DW) and energy value (191.16 kcal/100g DW) were low. The study detected seventeen amino acids with glutamic acid, leucine and aspartic acid being the predominance amino acids. Isoleucine, leucine, valine and mineral composition per 100g (DW) were as follows: K (1,320.00 mg), Na (122.49 mg), Ca (941.00 mg), Mg (220.00 mg), P (130.46 mg), Fe (60.30 mg), Cu (5.44 mg), Mn (11.60 mg) and Zn (3.18 mg).

In 2007, Gurbuz determined that the four varieties of *Vitis vinifera* leaves has significant nutritive values, they were evaluated based on their chemical composition, *in vitro* gas production, dry matter (DM) and crude protein (CP) degradation.

In the same year 2007, Abolaji *et al.* exposed the nutritional potentials of three medicinal plant *Parinari polyandra*, *Blighia sapida* and *Xylopia aethiopica* available in the western part of Nigeria. *B. sapida* and *X. aethiopica* were evaluated through their proximate compositions as well as percentage mineral elements composition. *B. sapida* was high in crude fibre compared with *P. polyandra* and *X. aethiopica*. Moisture contents of *X. aethiopica* and *B. sapida* were 16.04±1.25% and 10.17±2.60% respectively while that of *P. polyandra* was 30.65±5.02%. The total ash contents of *P. polyandra*, *B. sapida* and *X. aethiopica* were 2.53±1.20%, 3.66±1.20% and 4.37±0.85% respectively. The total high percentage of fat is found in *X. aethiopica*, it followed by *B. sapida* and *P. polyandra*. While the total protein of *B. sapida*, has high percentage. It is followed by *X. aethiopica* and *P. polyandra*. *X. aethiopica* has highest percentage of carbohydrate;
it is followed by *P. polyandra* and *B. sapida*. *X. aethiopica* can be a good source of magnesium, phosphorus and potassium.

In 2008, Udensi *et al.* investigated that nutrient component of *Discorea alata* showed that the average crude protein of *D. alata* was 6.7%. Carbohydrate (81.6 - 87.6%) was the predominant fraction of the tuber dry matter. The mineral contents of the yam tuber varieties were also evaluated with values ranging from 240-400 mg/100g, K; 190-380 mg/100g, Na; 180-340 mg/100g, P; 20.2-80.2 mg/100g, C and 24.3-97.2 mg/100g, Mg. Vitamin C content of the yam tubers ranged from 16.7-28.4 mg/100g, fresh weight. Significant differences in the crude protein and mineral contents were observed among the varieties. Functional property levels in the yam tubers were found to be in the range of 0.64-0.76 g/cm (BD); 2.90-3.65 g/g (WAC); 27.0-3.5 sec 3 (wettability) and 30-50% w/v (gelation).

Oloyede (2008) studied on chemical constituents of Cowry (*Cyparica samplomoneta*) showed the presence of alkaloid, cardiac glycosides, tannins and quinones. Chemical analysis revealed the presence of calcium (91.35±0.45 mg/100g) and Iron (47.52±0.02 mg/100g) as well as aluminum and sodium in considerable quantities. Proximate analysis showed that it contained moisture content (0.22%), ash content (76.30%), crude fibre (7.27%), crude protein (5.10%), carbohydrate (14.13%) and crude fat (0.42%).

Nile and Khobragade (2009) determined the nutritive value and mineral elements of some important medicinal plants from western part of India. Plants like *Tinospora cordifolia*, *Gymnema sylvesters*, *Tricholepis glaberrima* are subjected for their nutritive value and mineral elements. *T. cordifolia*, *G. Sylvesters* and *T. glaberrima* showed
sufficient mineral elements like P, K, Na, Ca, Fe, Zn, N, Mg and low in Cu, Cr with good nutritive value and rich in carbohydrate enough protein but low in fat content.

Rezaei et al. (2009) assessed on nutritive value of *Amaranthus hypochondriacus*, treated with different levels of molasses. Three levels of molasses (i.e., 0, 50, 100 g/kg of fresh basis) were compared. Both fresh and ensiled amaranth was rich in Ca, K and Mg, moderate in P and low in Na.

Atasie et al. (2009) analyzed that proximate, physico-chemical and elemental analysis of groundnut (*Arachis hypogaea*). The results showed that the groundnut oil contained 47.00% fat, 38.61% protein, 5.80% moisture, 1.81% carbohydrate, 3.70% crude fibre and 3.08% ash. Minerals (mg/100g) included: Na (42.00±0.71), K (705.11±0.86), Mg (3.98±0.04), Ca (2.28±1.94), Fe (6.97±1.62), Zn (3.20±0.11), P (10.55±0.68). The physico-chemical characteristics showed; saponification value, 193.20 mgKOH/g, iodine value 38.71 (g/100g), acid value 5.99 (mgKOH/g), free fatty acid (mgKOH/g) 3.01 peroxide value 1.50 (meq/kg) and refractive index 1.449. The predominant fatty acid was found to be oleic acid (41.11%). The groundnut can be considered as a good source of protein with high nutritional value.

In 2009, Smith determined on chemical composition of *Senna siamea* (*Cassia* Leaves) revealed that the percentage crude protein, crude fibre, moisture content, ash content, carbohydrate and crude fat of the leaves are 4.01%, 12.36%, 46.01%, 17.93%, 7.67% and 12.02% respectively. The result of the mineral composition in PPM (Part per million) shows that iron, magnesium, manganese, potassium, calcium, sodium, copper, phosphorus and lead are 112.00, 876.00, 35.10, 812.00, 932.00, 612.00, 0.84 and 0.34 respectively while cadmium and vanadium was not detected in the leaves.
Chapter 2

Nutritive Value

The photochemical analysis shows that the leaves contain anthraquinones, alkaloids, phylobatannins and saponin.

Aberoumand (2009) assessed on the nutritional properties of few plants like *Asparagus officinalis*, *Chlorophytum comosum*, *Cordia myxa*, *Portulaca oleracia* and *Solanum indicum* collected in Behbehan, South Iran and also *Alocacia indica*, *Eulophia ochera* and *Momordica dioica* collected from the south of India. It was determined that five vegetables, namely *A. officinalis*, *C. comosum*, *E. ochera*, *P. oleracia* and *S. indicum*, provide mineral concentrations exceeding 2% of the plant dry weight and are much higher than typical mineral concentrations in conventional edible vegetables; they are thus recommended for future commercial cultivation.

Aberoumand and Deokule (2009) studied that the plants like *Alocacia indica*, *Asparagus officinalis*, *Chlorophytum comosum*, *Cordia myxa*, *Eulophia ochreata*, *Momordica dioica*, *Portulaca oleracia* and *Solanum indicum* have very good nutritional value. Especially plants like *P. oleracia* and *A. officinalis* have high amounts of proteins, fats and calorie values. Therefore, these plants are recommended for consumers as vegetables in their diet.

Iniaghe *et al.* (2009) worked on proximate composition and phytochemical constituents of leaves of some *Acalypha* species. *A. marginata* showed that it contained moisture (10.83%), crude fat (5.60%), ash (15.68%), crude protein (18.15%), crude fibre (11.50%) and carbohydrate (38.24%); while *A. racemosa* contained moisture (11.91%), crude fat (6.30%), ash (13.14%), crude protein (16.19%), crude fibre (7.20%) and carbohydrate (45.26%). Steroids and phlobatannins were detected in *A. hispida* and *A. racemosa*, while glycoside was detected only in *A. hispida*. 

62
Ngozi et al., 2009 revealed that *Chromolaena odorata* leaves have a good source of high quality protein 88.24% with methionine as the limiting amino acid, with a high total carbohydrate (20.58% WW and 50.82% DW), crude fibre (10.76% WW and 26.57% DW) and protein (6.56% WW and 16.20% DW). The presence of alkaloids, cyanogenic glycosides, flavonoids, phytates saponins and tannins.

Nisar et al. (2009) worked on nutritional levels of *Indigofera gerardiana* and *Crataegus songrica* showed significant results. The percent levels of moisture (4.8), ash (4.79) and fats (3.03) were higher in *C. songrica* compared to the levels of moisture (3.06), ash (4.23) and fats (2.37) in *I. gerardiana*. The % levels of protein (3.7) and fibers (17.8) were same in both plants while the level of carbohydrate (68.84) was higher in *I. gerardiana* as compared to the levels of carbohydrate (65.88) in *C. songrica*.

In 2010, Krishnamurthy and Sarala investigated the nutritive value and the elemental composition of different parts of *Withania somnifera* which are grown in two distinct geographical regions (Sondekola and Karthikere) of Karnataka. Among these macro elements, Karthikere samples recorded maximum values of nitrogen, phosphorous and magnesium and Sondekola samples recorded maximum values of sodium, potassium and calcium. The components of micronutrients, the highest values of iron were recorded both in Sondekola and Karthikere samples.

Ayoola et al. (2010) evaluated that the elemental composition of *Spondias mombin* (Hog plum) Fe, 574.00 mg/kg, Zn, 59.60 mg/kg, Mn, 23.00 mg/kg, Cr, 66.00 mg/kg Cu, 13.00 mg/kg, Cd 50.00 mg/kg. The mineral composition of leaves contained K 1.20%, Ca 1.05% and P, 0.32% Na 1.80%. Trace elements concentration in *Vernonia*
amygdalina leaves were Fe, 277.30 mg/kg, Zn, 74.50 mg/kg, Mn, 227.00 mg/kg, Cr, 89.00 mg/kg Cu, 11.00 mg/kg and Cd, 4.30 mg/kg.

Vinayaka et al. (2011) revealed the nutritive composition of fruit of Zizyphus rugosa. The carbohydrate content of the fruit material was found to be 15%. Reducing sugar content was higher as compared to non-reducing sugar. Among sugars, the fructose content was high. Crude fat and fibre contents were found to be low. Among macroelements, potassium was found to be in higher concentration. Manganese was in high concentration among microelements. Cadmium and lead were not detected. The fruit has a rich source of the sugars which makes it good food for animals, birds and for ants. It can be supplemented as a good source of the different important metal requirement of the body.

Literature survey indicated that, So far no work has been attempted to study the nutritive value and elemental composition of E. mallotiformis. Hence, through the present study, the nutritive value and elemental composition of E. mallotiformis has undertaken.

Materials and Methods

Preparation of plant sample

Leaves of the E. mallotiformis were collected from the study area and they were washed with water and dried in shade. The dried materials were grind to powder. The powder was used for the determination of mineral composition and nutritive values. The analysis was made at the Department of Applied Botany, Kuvempu University, and the Central Coffee Research Institute (CCRI) Balchonnur, Chikamagalur district of Karnataka, India.
Elemental analysis

The microelements sodium and potassium were analyzed by Flame Photometer-Jenway-PFP-7 FPM Compressor Unit- 122. The phosphorus was analyzed by Jenway 6300 Spectrophotometer.

The microelements calcium, magnesium, zinc, copper, manganese, lead and cadmium were analyzed by atomic absorption spectra GBC 932 AA/AAS.

Determination of Macronutrients

Determination of Potassium

The concentration of potassium was determined with the help of flame photometer using separate standards of potassium. The yellow colored solution was aspirated at the wavelength of flame photometer to detect the concentration of potassium. Finally the percentage of potassium was calculated with the help of following formula.

\[
\% \text{ of Na/K} = \frac{\text{Graph ppm}}{10^6} \times \text{Dilution factor} \times \frac{\text{Volume of sample digestion made}}{\text{Weight of the leaf sample}} \times 100
\]

Determination of Phosphorous

Orthophosphate (phosphorous) present in the leaves was determined by Vanado molybdate yellow colour method. The 5 ml of aliquot of leaves digested was taken in 50 ml volumetric flask and mixed with 10 ml vanado molybdate reagent. Having thoroughly mixed the final volume was adjusted to 50 ml by distilled water. After 30 min the developed yellow colour was measured on a spectrophotometer at 470 nm. The
concentration of phosphorous was calculated with the help of standard graph. The percentage of phosphorous is calculated with the help of following formula.

\[
\% \text{ of } P = \frac{\text{Graph ppm}}{10^6} \times \frac{\text{Vol. of digestion made}}{\text{Aliquot}} \times \frac{\text{Volume of sample digestion made}}{\text{Weight of the leaf sample}} \times 100
\]

**Determination of Calcium and Magnesium**

One ml of aliquot leaves digested material was taken in 50 ml by volumetric flask, final volume was adjusted to 50 ml by adding distill water. The presence of calcium and magnesium were determined at the wavelength 422.7 and 228.2 nm of AAS respectively. The percentage of calcium and magnesium were calculated with the help of following formula.

\[
\% \text{ of } \text{Ca/Mg} = \frac{\text{Graph ppm}}{10^6} \times \text{Dilution factor} \times \frac{\text{Volume of sample digestion made}}{\text{Weight of the leaf sample}} \times 100
\]

**Determination of Micronutrients**

The 2 ml of digested samples were taken and diluted to 50 ml and the sample was aspirated of at the wavelength of 213.9, 324.75, and 279.5 of AAS to detect concentration of Zn, Cu and Mn respectively. Finally, the values of micronutrients are expressed in ppm by the help of following formula.

\[
\text{ppm of } Zn/Cu/Mn = \frac{\text{ppm}}{1000} \times \text{Dilution factor} \times \frac{\text{Volume of sample digestion made}}{\text{Weight of the leaf sample}} \times 100
\]
Analysis of Lead and Cadmium

The 2 ml of digested samples were taken and diluted to 100 ml. The presence of lead and cadmium were detected with the help of AAS by aspirating the sample at the wavelength of 217 nm and 228 nm with appropriate lamps. The ppm of lead and cadmium were calculated by the help of following formula (Gali et al., 1999).

\[
\text{ppm of Pb/Cd} = \frac{\text{ppm}}{1000} \times \text{Dilution factor} \times \frac{\text{Volume of sample digestion made}}{\text{Weight of the leaf sample}} \times 100
\]

Determination of nutritive value

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

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 grayish white). Weight of ash gave the ash content.

Determination of moisture content

The samples materials were taken in a flat bottom dish and kept overnight in a hot air oven at 100-110°C and weighed. The loss in weight was regarded as a measure of moisture content.
Determination of crude fat

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

Determination of crude protein

Crude protein was determined by using Kjeldhal method. One gram of powdered dried plant material was taken in Kjeldhal flask; 25 ml of diacid mixture was added. The digestion was carried out on low flame initial for 10 to 15 minutes until frothing stops. Then digestion at 1 to 1½ h or till the content in Kjeldal flask become clear the flask was cooled and the contents was transferred quantitatively to the 100 ml volumetric flask and final volume was adjusted to 100 ml by adding distilled water, 10 ml of diluted acid digested samples was taken in a micro Kjeldhal distillation assembly. The boric acid mixed indicator solution was kept ready at the receiving end to trap ammonia, 30ml of 40% NaOH was added and distillation was carried out till the colour of the mixture changes and was further continued for some time to trap the all ammonia released. No changes in colour of the red litmus paper indicate the completion of distillation. The quantity of ammonia distilled was estimated by titrating against 0.01N H₂SO₄ or HCl till the colour changes to purple.

The percentage (%) of N was calculated with the help of following formula

\[
\text{Percentage of Nitrogen} = \frac{\text{Titrate value} \times N.\text{H}_2\text{SO}_4 \times 0.014 \times \text{dilution factor} \times 100}{\text{Weight of the plant sample}}
\]
The percent of crude protein was estimated by multiplying the percent of Kjeldhal nitrogen into 6.25 (standard factor) it was calculated by using the following formula.

\[
\text{Crude protein} = \text{Percentage of Kjeldhal nitrogen} \times 6.25.
\]

**Determination of crude fibre**

The estimation crude fiber was based on treating the moisture and fat free material with 1.25% dilute HCl, then with 1.25% alkali, then 2gm 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 was weighed. Loss in weight gave the weight of crude fibre. Percentage of carbohydrate was calculated by using the formula,

\[
100 - (\% \text{ash} + \% \text{moisture} + \% \text{fat} + \% \text{of protein})
\]

**Nutritive value**

Nutritive value was finally determined by using the following formula

\[
\text{Nutritive value} = 4 \times \% \text{protein} + 9 \times \% \text{fat} + 4 \times \% \text{Carbohydrate}
\]

**Statistical analysis**

Proximate and elemental analysis was carried out three times for each parameter of a leaf sample. Hence, we got three replicates (n = 3) from which, the mean and standard deviation (SD) were calculated (Indrayan *et al.*, 2005; Krishnamurthy and Sarala, 2010).
Results and Discussion

Proximate analysis

The result of proximate analysis shows variant concentration/proportions of biochemical and other contents (Table 2.1). The percentage of moisture content was high in mature leaf samples (55.23±1.07), when compare to young leaf sample (52.18±1.67). In case of percent of ash content, highest percentage of ash content was recorded in mature leaf sample (4.85±0.31) when compare to young leaf sample (4.47±0.1). The percentage of crude fiber was more in matured leaf (2.64±0.05) when compare to young leaf sample (1.48±0.03). Whereas, the percentage of crude fat content was high in matured leaf (5.06±0.23) when compare to young leaf sample (4.46±0.66). The percentage of crude protein is maximum in young leaf (1.37±0.1) when compare to mature leaf sample (2.05±0.23). The percentage of carbohydrate is more in young leaf (36.84±2.17) than matured leaf (35.54±1.47). The results revealed that, the young leaf sample has highest nutritive values (195.96 ± 3.95cal/100g) when compared to mature leaf sample (193.18±6.95).

Elemental composition analysis

The data of Table 2.2 shows that, the macro element viz., calcium (Ca) and magnesium (Mg) showed higher percentage in matured leaf sample of about 7362±3.61 and 4117.33±2.08 respectively, when compare to young leaf sample, which is about 5136±129.55 and 2227.67±2.52 respectively. Whereas, macro elements like nitrogen, phosphorus and potassium were recorded at higher percentage in matured and young leaf sample as 2.53±0.01, 0.13±0.002, 1.14±0.02, 2.7±0.10.2±0.001, 1.57±0.01 respectively.
Chapter 2

Nutritive Value

The data of the Table 2.3 shows that, the micro element, manganese (Mn) and iron (Fe) showed higher percentage in matured leaf sample about 687.2 ±0.32, 103.63±0.15 respectively, when compare to young leaf sample of about 397.43±0.6, 87.87±1.05 respectively. Whereas other micro elements like zinc (Zn), copper (Cu) and lead (Pb) were recorded at a considerable percentage in matured and young leaf sample 71.5±0.1, 31.43±0.15, 16.3±0.1, 59.43±0.47, 10.43±0.15, 15±1.0 respectively.

Table 2.1. Percentage of proximates composition of E. mallotiformis

<table>
<thead>
<tr>
<th>Leaf Samples</th>
<th>Moisture</th>
<th>Ash</th>
<th>Fiber</th>
<th>Fat</th>
<th>Protein (%)</th>
<th>Carbohydrates</th>
<th>Nutritive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>52.18±1.67</td>
<td>4.47±0.1</td>
<td>1.48±0.03</td>
<td>4.46±0.66</td>
<td>2.05±0.23</td>
<td>36.84±2.17</td>
<td>195.96±3.95</td>
</tr>
<tr>
<td>Matured</td>
<td>55.23±1.07</td>
<td>4.85±0.31</td>
<td>2.64±0.05</td>
<td>5.06±0.23</td>
<td>1.37±0.1</td>
<td>35.54±1.47</td>
<td>193.18±6.95</td>
</tr>
</tbody>
</table>

Table 2.2. Macronutrients (in %) leaves of E. mallotiformis

<table>
<thead>
<tr>
<th>Leaf Samples</th>
<th>Macro elements(ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Young</td>
<td>2.7±0.1</td>
</tr>
<tr>
<td>Matured</td>
<td>2.53±0.01</td>
</tr>
</tbody>
</table>

Table 2.3. Micronutrients (in %) leaves of E. mallotiformis of Agumbe region

<table>
<thead>
<tr>
<th>Places</th>
<th>Leaf Samples</th>
<th>Micro elements(ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fe</td>
<td>Cu</td>
</tr>
<tr>
<td>Agumbe</td>
<td>Young</td>
<td>87.87±1.05</td>
</tr>
<tr>
<td></td>
<td>Matured</td>
<td>103.63±0.15</td>
</tr>
</tbody>
</table>
Discussion

All human beings require a number of complex organic compounds, as added 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. Due to increasing populations of the world, food demands have overwhelmed the available land resources. It has been reported that, protein-calories malnutrition deficiencies is a major factor responsible in nutritional deficiency diseases (Roger et al., 2005). Through the present study it was conformed that the nutritional value and elemental composition of the *E. mallotiformis* is at par to the nutritive value of accepted medicinal plant which are presently under usage.

In the present study, fibre content was more in mature leaves compare to young leaves. The dietary fibre plays an important role in decreasing the risks of many disorders such as constipation, diabetes, cardiovascular diseases, obesity etc. (Spiller, 2001). From the analysis, *E. mallotiformis* showed that, occurrence of increased percentage of carbohydrates. The carbohydrates are main source and store of energy. They are the starting substances for biological synthesis of many compounds. The micronutrients (trace elements), together with other essential nutrients are necessary for growth, normal physiological functioning of the body and maintenance of life. They must be supplied through the food, since the body cannot synthesize them. Some of them are vitally important for health. Manganese and copper play important role in enzymatic catalysis and crucial to virtually all biochemical and physiological process (Sadiqa et al., 2008). Copper is a component of many enzyme systems, such as cytochrome oxidase, lysyl oxidase and cerulo plasmin, iron-oxidizing enzyme in blood (Mills, 1981). The
observation of anaemia in copper deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin (Anonymous 2, 1974). Zinc is a component of many metallo enzymes, including some enzymes, which play a central role in nucleic acid metabolism (Atukorala and Waidyanatha, 1987). In addition, Zinc is a membrane stabilizer and a stimulator of the immune response (Hambidge, 1978). Its deficiency leads to impaired growth and malnutrition (Prasad, 1981). Manganese is essential for haemoglobin formation, but excess is harmful (Critchley, 1986). Nitrogen is an essential element for structural proteins. It is found in purines, pyrimidines, porphyrins and coenzymes (Robert and Francis, 1986). When nitrogen is supplied in excess, the plant shows dark green leaves with abundance of foliage and reduced growth of root system and as a result the plant shows high shoot to root ratio (Salisbury and Ross, 1984). Potassium is of importance as a diuretic (Indrayan et al., 2005). The present study has been carried out in order to determine the proximate and mineral contents of the leaves by various methods. The results revealed that, young leaves are more nutritive than mature leaves. The macro, micro and toxic elemental content also varied not only with respect to the regions of the plants, where they grow, but also with their ages. However, the leaf samples recorded low concentration of elemental components which is confirmed by recording low values of ash content. This study play an important role in justifying the *E. mallotiformis* is one of the important medicinally useful plant.
A - Loading leaf sample to kjeldhal tubes
B - Flame Photometers
C - Kjeldhal unit
D - Atomic absorption spectroscopy
References


