CHAPTER - VI
CHAPTER-6

SUMMARY AND CONCLUSION

6.1: SUMMARY

Plants have been an important source of medicine for thousands of years. In the plant kingdom there are thousands of plants, known and unknown, that yield medicine or drugs of great use to man. They have a great biodiversity and representatives of plant evolution level. Medicinal plants include annual and perennial plants. They include wild or cultivated plants species. In terms of life forms, medicinal plants are equally distributed across habits viz., trees, shrubs and herbs. The majority of medicinal plants are higher flowering plants (Shankar et al, 2000). Medicinal plants are rich source of metabolites that are potential source of drugs and essential oils. Some of them are semi domesticated and mostly grow as weeds. The nutritive values of these plants are important as they act as component for human consumption. Nearly all cultures from ancient times until today have used plants as source of medicine (Unni et al, 2009). Among the entire flora, 35,000 to 70,000 species have been used as medicinal purposes (Ponnue et al, 2003).

Medicinal plants can not only cure our ailments but can also be a potential source of economic development. The demand for medicinal plants is ever increasing, as people are more and more fascinated towards herbal products. Assam state of India is one of the few places on earth with such a unique biodiversity, comprising different climatic zones with a wide range of plant species. The wide geographical and climatic diversity of Assam provides a repository of valuable
indigenous system of medicine, as their extracts in various forms are being used in traditional system of medicine for the treatment of various human ailments. Diverse utilization of medicinal plants has been reported by many researchers from Northeast India. Assam is one of the richest floristic regions of India and has been a source of various valuable medicinal plants. In nature these plants are found growing luxuriantly in diverse habitat conditions having diverse climatic conditions as well.

Medicinal plants contain a variety of different nutritious and therapeutic constituents like vitamins, minerals, trace elements as well as some active ingredients which are responsible for curative action of the herbs. These include alkaloids, tannins, flavonoids, glucosides, mucilage, gums, resins, essential and fatty oils. For thousands of years, the men have prepared cosmetics and perfumes from the natural resources available for them, to care for their skin, hair, eyes and lips and to enhance their natural beauty. Therefore, medicinal plants find application in pharmaceutical, cosmetic, agricultural and food industry.

Four most important medicinal plants namely Alternanthera sessilis, Eclipta prostrata, Sida cordifolia and Centella asiatica were selected for present investigation, which are found luxuriantly growing in diverse habitat conditions in Assam. The growth and development of these plants species are greatly influenced by its climate, soil, and other factors. Depending on their habitat condition some plant populations of the same species growing in diverse habitat may show variation in morphology, anatomy and in their active chemical constituents.

Alternanthera sessilis (L) R. Brown ex de Candolle. is commonly known as sessile joyweed belonging to the family Amaranthaceae. This plant is widely
Alternanthera sessilis is used as a topical treatment for the common skin problem cane vulgaris. Gayathri et al (2006) state that A. sessilis is "used for the treatment of biliousness, dyspepsia associated with sluggish liver, chronic congestion of liver, acute and chronic pyelitis, cystitis, gonorrhea. Leaves of this plant are used as a vegetable in Assam and North-Eastern regions. Young shoots and leaves are eaten as vegetable throughout Assam. Occasionally it is cultivated for food and for use in herbal medicine. Young shoot are nutritious and contain protein 5% and iron 16.7 mg/100 g (The Wealth of India, 1948).

**Eclipta prostrata** (L.) Hassk, belonging to the family Compositae. In Assamese it is commonly known as Kehraj or Keharaja (The Wealth of India, 1952). The herb is used as tonic in hepatic and spleen enlargement and in skin diseases. The plant juice is administered in combination with aromatics for catarrhal jaundice. Leaf juice along with honey is a popular remedy for catarrh in infant (Dymack, Warden and Hooper, 1952). The fresh plant is rubbed on the gums in toothache and applied with a little oil for relieving headache. It is also applied in elephantiasis. The plant is used as a dying herb in tattooing.

*Sida cordifolia* L. is commonly known as country mellow belonging to the family Malvaceae. In Assamese it is known as Boriyal. Roots, leaves and seeds are slightly bitter in taste and used in medicines. The juice of the plant is used in elephantiasis. The mucilaginous leaves are used as a demulcent and their infusion is given in fever as refrigerant. They are reported to be used against dysentery and for ulcer. A decoction of leaves is said to possess emollient and diuretic properties (Nayer and Chopra, 1958). An infusion of root is given in urinary diseases, bilious disorder and gonorrhea. It is also used in nervous disorders such hemiplegia, sciatica and in facial paralysis (Chopra et al, 1956).
Centella asiatica L. belonging to the family Umbelliferae is commonly known as Indian penny wort. In Assamese it is known as Bor manimuni. It is used in the treatment of syphilis, leprosy, all types of fever, abdominal disorders, elephantiasis, hydrocele and used as an antidote against cholera and also cure madness. Leaves are taken as a tonic for improving memory (Chopra et al, 1956). It is also used in the treatment of tuberculosis and as insecticidal (Lond, 1945). Centella asiatica consist some active principal such as vallarine, asiaticoside, sitosterol, tannin and oxy-asiaticoside (Kausik and Dhiman, 1976). The plant is a biosynthetic laboratory, not only for chemical compounds, but also a multitude of compounds like glycosides, alkaloids etc. The compounds that are responsible for medicinal property of the drug are usually secondary metabolites.

The plant species selected for the study have been collected from seven different localities of Assam i.e. four sites in and around Guwahati viz. Gauhati University(G.U.) campus, Boragaon, Santipur, Deepor beel and three others namely Mongaldoi, Sivasagar and Barpeta which are away from Guwahati and distantly placed from one another having the influence of diverse climatic and soil conditions.

A. sessilis and E. prostrata were collected from four different sites like – Santipur, Boragaon, G.U.campus and Deepor beel. C. asiatica was collected from five localities – Santipur, G.U.campus, Mongaldoi, Barpeta and Sivasagar. S. cordifolia was collected from four localities – Santipur, G.U. campus, Mongaldoi and Barpeta.

G.U. campus, Santipur, Boragaon and deepor beel (locality within Guwahati city) are situated between 25.46°N-26.49° N latitude and 90.48° E-91.50°
Mangaldoi is located at a 20.9°N - 26.95°N latitude and 91.45°E - 92.22°E longitude. It has elevation of 150 - 250 meters above sea level. Climate is per humid and is characterized by mild summers and winters. Relative humidity varies from 70% to 78% during February to April and 79% to 89% during May to January. The monsoon of the district commences from the end of March and intensity gradually increases till August and then declines to the minimum during November and December.

Sivasagar is situated between 94.25°- 95.25°E Longitude and 21.45°N- 27.15°N Latitude. It has elevation of 86.6 meters above the sea level. Sivasagar carries a pleasant weather throughout the year. The temperature ranges from 8°C in winter to 35°C during summer. The average relative humidity of this area is about 75%. The district is characterized by highly humid atmosphere with abounded rains. The regular rains of the summer generally prevent the prevalence of the hot weather. After the rainy season the cooler autumn start from October and real cold weather prevails from the end of November and continues till the middle of February. The winter season is followed by the reason of occasional thunder storms from March to May. The temperature begins to rise from the beginning of March and in July and in August it reaches the maximum.

Barpeta lies between latitude 26.5° N -26.49° N and longitude 90.39° E- 91.17° E. The climate of Barpeta remains mild and pleasant round the year. It has
elevation of 35 meters above the sea level. Tropical monsoon climate of the District provides two distinct seasons—summer and winter. The summer season of March to May is followed by the monsoons from June to September. This is followed by cool winter season from October to February. The annual temperature is above 22°C. The average relative humidity is about 80%. Mean annual rainfall ranges from 1500-2600mm for all the sites.

Morphological observations for *A. sessilis* showed a considerable structural diversity of growth. Plants collected from Santipur and Boragaon showed maximum growth than the other sites. It could be concluded that soil conditions of those sites are favourable for the growth of *A. sessilis*. Results of correlation coefficients among different soils and morphological parameters indicate that pH level increased the length of plants and internodes, nitrogen levels were also positively correlated with leaf breadth and number of flowers per inflorescence. Plants collected from Santipur and G.U. campus showed longer plants and long internodes which may be attributed to high pH levels. Plants grown in Santipur showed wider leaves and higher number of flower per inflorescence than the other sites which may be due to high concentration of nitrogen. All the species collected from different habitat showed some variations in morphological characters which may be due to soil and climatic conditions.

Anatomical study for *A. sessilis* revealed that breadth of epidermal layers were thicker in the plants grown in Deepor beel (19.5 μm) than the other sites which may be due to low magnesium concentration plants grown in G.U. campus showed smaller vascular bundles which may be due to high sulphur concentration. Hewitt (1963) observed that high concentration of sulphur decreased the size of vascular bundles.
Morphological observation of *E. prostrata* showed that plants collected from Santipur showed taller plants (32.2 cm) and thicker stem (1.48 cm) than the other sites which may be due to high magnesium concentration (Mohamed and Wahab, 2007). Plants collected from G.U. campus showed very long internodes (4.87 cm) than the sites which may be due to high concentration of sulphur (Bidwell, 1974). From the results of morphological observation of *E. prostrata* showed that plants grown in G.U. campus showed comparatively maximum growth than the other sites. It indicates that habitat conditions of G.U. campus are favourable for the growth of *E. prostrata*.

The anatomical characters of *E. prostrata* showed that plants grown in Boragaon and Deepor beel showed thicker epidermal layers (20.8 μm, 20.8 μm respectively) which may be due to low magnesium concentration (Lyon and García, 1944). Plants collected from Santipur showed very thicker hypodermal layers (75.4 μm) than the other sites which may be due to high concentration of calcium (Hewitt, 1963). Plants collected from Boragaon showed thinner parenchymatous tissue layers (114.4 μm) which may be due to high potassium concentration (Toren, 1954). Calcium concentration was negatively correlated with breadth of epidermal layers. It indicate that plants grown in Santipur showed thinner epidermal layer which may be due to high calcium concentrations and can be the probable factor as reported earlier by Devlin (1966). Plants collected from Santipur showed longer vascular bundles which may be due to high concentration of calcium (Hewitt, 1963).

Morphological observations of *C. asiatica* showed that plants collected from Santipur have very long leaf stalks (13.6 cm), whereas those from G.U. campus and Sivasagar showed short leaf stalks (5.92 cm, 5.46 cm respectively). Likewise plants collected from Barpeta showed long stolons (8.24 cm) and
those from G.U. campus showed short stolons (6.38 cm). Plants collected from Santipur possessed large leaf stalks (1.81 cm), whereas those from Sivasagar have small leaf stalks (.78 cm). Plants collected from Mongaldoi and Santipur showed large leaves (4.68 cm and 4.22 cm respectively) whereas those from G.U. campus showed very small leaves (2.21 cm). Plants collected from Mongaldoi and Barpeta showed very long inflorescence (1.6 cm, 1.6 cm respectively). Morphological observation of *Centella asiatica* showed that plants grown in Santipur showed comparatively maximum growth than the other sites. It indicates that habitat conditions of Santipur are favourable for the growth of *Centella asiatica*.

Anatomical studies of *Centella asiatica* reveal that breadth of epidermal layers were thicker in the plants grown in G.U. campus (18.2 μm) and Mongaldoi (18.2 μm) than the other sites. Plants collected from Sivasagar showed very thick hypodermal layers (46.8 μm) than the other sites.

The morphological measurements of *Sida cordifolia* revealed that plants collected from Barpeta showed taller plants (42.2cm) than the other sites. Plants collected from G.U. campus showed thicker stem than the other sites, which may be due to high concentration of sulphur (Hewitt, 1963). Plants collected from Mongaldoi showed longer inflorescence (1.71cm) than the other sites, which may be due to low calcium concentration (Hewitt, 1963). Results of correlation showed that phosphorous concentrations were positively correlated with number of inflorescence. Results indicate that plants collected from Barpeta showed higher number of inflorescence per plant which may be due to phosphorous (Cheal and Winsor, 2006). Plants grown in Santipur showed thicker stem which may be attributed to medium concentration of calcium as reported earlier by Bidwell (1974).
Anatomical investigation of *S. cor difolia* showed that plants collected from Mongaldoi and Santipur showed thicker epidermal layers (20.8 µm, 20.8 µm) than the other sites. Plants grown in Mongaldoi showed thicker cork layers (68.2 µm). Breadth of cortex layer was thicker in the plants grown in Santipur (65 µm). Likewise, plants grown in Santipur showed thicker phloem layers (83.2 µm), which may be due to high calcium level (Lyon and Garcia, 1944). Barpeta showed thick annual ring layer (314.6 µm) than the other sites.

Total phenol contents of *A. sessilis* showed variations from 18.5±.291 mg/g to 21.45±.287 mg/g in the plant materials collected from diverse habitats. Plants materials collected from Boragaon showed high concentration of total phenol (21.45±.287 mg/g), those from Santipur showed low concentration of total phenol contents (18.5 ±.291 mg/g). Results of correlation coefficients showed that total phenol content was negatively correlated with calcium concentrations at 0.05 level of significance. Plant materials collected from Boragaon showed high total phenol concentrations which may be attributed to lower concentration of calcium.

The results of Rf value of total alkaloid contents of *A. sessilis* showed variations from 57.71±.68 to 68.71±.42. Plants collected from Deepor beel showed high concentration of total alkaloid (68.71±.42), whereas those from Boragaon showed low alkaloid contents (57.71±.68). Results revealed that plants grown in Deepor beel showed high total alkaloid concentration which may be due to medium concentration of potassium in soil. Plants collected from Boragaon possess high phenol contents and those from Deepor beel showed high concentration of alkaloid. Results clearly indicate that climatic and soil conditions of Boragaon and Deepor beel increased the production of phenol and alkaloids in *A. sessilis* respectively.
Total phenol concentration of *E. prostrata* showed variation from 11.50±.155 mg/g to 19.05±.102 mg/g in the plant materials collected from different habitats. Plant materials collected from Deepor beel showed high concentration of total phenol (19.05±.102 mg/g), whereas those from Boragaon showed low concentration of total phenol (11.50±.155 mg/g). Total alkaloid contents of *E. prostrata* varied from 82.28±.714 to 91±.755. Plants grown in Deepor beel showed high concentration of total alkaloid (91±.755) than the other sites.

Maximum concentrations of alkaloids and phenols were observed in the plants grown in Deepor beel. Therefore experimental findings indicate that habitat conditions of Deepor beel favour the production of phenol and alkaloid contents in *E. prostrata*.

Results revealed that concentration of total phenol of *C. asiatica* showed variations from 20.3±.23 to 28.3±.273 mg/g in the plant materials collected from diverse habitats. Results of correlation coefficients among different physicochemical parameters of soil and total phenol concentration of *Centella asiatica* showed that total phenol concentration was negatively correlated with nitrogen concentration at 0.05 level of significance i.e. high nitrogen concentration decreased the concentration of total phenol. Plants collected from Santipur and Sivasagar showed low concentration of total phenol contents which may be due to high nitrogen concentration (Babalar *et al*, 2010, Ushio *et al*, 2009). Plant materials collected from different habitats showed variation in Rf value of total alkaloid contents from 82.71±.42 to 90.57±.685. Plants collected from Santipur showed high total alkaloid concentration (90.57±.685).
Results revealed that maximum accumulation of alkaloids occurred in the plants collected from Santipur and maximum concentration of phenols were observed in the plants collected from G.U.campus. It indicates that soil and climatic conditions of Santipur and G.U.campus favour the accumulation of alkaloids and phenols in plants.

Total phenol contents of *S. cordifolia* showed that plant materials collected from G.U. campus showed very high concentration of phenol (12±.285 mg/g), whereas plants collected from Barpeta showed low concentration of total phenol contents (8.7±.201 mg/g). Likewise plants grown in Barpeta showed high total alkaloid concentrations (98.71±.359) than the other sites.

Highest concentration of total phenol were observed in the plants collected from G.U. campus and those collected from Barpeta showed high accumulation of alkaloids. Experimental finding indicate that the prevailing conditions of soil of G.U. campus and Barpeta favour maximum accumulation of phenols and alkaloids in *S. cordifolia* respectively.

Soil is the product of environment (Lutz and chandler 1959, Jemy 1960, Kollogg 1932), characterized and developed under the influence of innumerable factors, the most important of which are climate, living organisms, time and parent material. The physicochemical properties of soil mainly texture, pH, N, P, K, S, Ca and Mg, which were studied show variations which is reflected in the species composition of different study sites.

Textural status of different study sites are mainly clay loam, sandy loam and sandy clay loam type. Soils of Santipur and Barpeta showed sandy clay loam type of soil, G.U.campus and Mongaldoi showed sandy loam type of soil, whereas
Boragaon, Deepor beel, and Sivasagar showed clay loam type of soil. The $p^H$ indicated acidic in nature of soil which showed variation between 4.09 to 6.38 concentrations during observation. This may be due to higher concentration of soil organic matter (Miles, 1986). Sivasagar, Santipur, Boragaon, Deepor beel and Barpeta showed high and medium organic matter which may be due to the higher percentage of clay particles. Concentration of organic matter in clayey soils is two to four times higher than that of coarse textured (sandy) soils. Soil of all the sites showed high and medium concentration of nitrogen which may be due to high and medium concentration of organic matter in soil (Gustafson 2005, Tan 1994 and Schnitzer 1986). Mongaldoi showed high potassium concentration which may be contributed to high $p^H$ levels. High $p^H$ levels favour the weathering of minerals into the release of various ions like potassium (Singh, 1996). Soils collected from G.U. campus and Mongaldoi showed high concentration of sulphur which may attributed to high organic matter concentration (Tan, 1994 and Schnitzer, 1986). Soils of Santipur and G.U. campus showed high calcium level (4.6 Meq/100gms), which may be due to slightly acidic soil (Hewitt, 1953), whereas it was very low at Barpeta (.6 Meq/100gms) may be due to highly acid soils (Miller, 2004). Likewise the soils of Santipur showed high magnesium concentration (1.6 Meq/gms) which may be due to high organic matter (Hewitt, 1953).

Results of correlation coefficients among different parameters of soils of *A. sessilis* and *E. prostrata* indicates that soils of G.U. campus showed high phosphorous concentration which may be due to lower concentration of organic matter concentration. Site Santipur showed high concentration of nitrogen which may be attributed to the high concentration of magnesium. Likewise Results of correlation coefficients among different parameters of soil of *C. asiatica* showed
that site G.U. campus and Mongaldoi showed high $p^H$ level which may be due to lower concentration of organic matters in soil. Likewise site Sivasagar showed low $p^H$ level (extremely acidic) which may be due to high organic matter concentration (Miles, 1986).

Correlation coefficients among different parameters of soils of *S. cordifolia* indicate that soils of G.U. campus and Mongaldoi showed high sulphur concentration which may be attributed to lower organic matter concentration. Soils of site Santipur and Barpeta showed medium concentration of sulphur which may be attributed to higher concentration of organic matter in soil.

### 6.2. CONCLUSION:

In the light of the present study carried out with four important medicinal plants (*A. sessilis, E. prostrata, C. asiatica, S. cordifolia*) in different habitat condition of Assam, it can be concluded that all plant species showed significant variations in their morphological and anatomical characters and also in their chemical constituents. The investigation showed significant correlation between morpho-anatomical characters and different habitat condition. Morphological and anatomical findings for *A. sessilis* revealed that soil with high $p^H$ level, nitrogen, sulphur, organic matter concentration and low phosphorous concentration showed maximum growth of *A. sessilis*. Likewise soil with low calcium contents showed high phenol concentration and soil with high potassium concentration increased total alkaloid concentration in *A. sessilis*.

Morpho-anatomical findings showed that soils with high magnesium, organic matter, nitrogen concentration and low calcium concentration are favourable
for the growth of *E. prostrata*. Correlation between phenol and alkaloid with different soil parameters showed that soil with low potassium concentration increased concentration of phenol and soil with low calcium concentration showed maximum accumulation of alkaloid in *E. prostrata*.

Results of present investigation suggest that the soil with high magnesium concentration, pH level and low phosphorous and calcium concentration showed maximum growth of *C. asiatica*. The species showed high accumulation of phenol in soils with low nitrogen concentration. Production of phenolic acid can be modified by application of nitrogen on soil. Likewise plants grown in soil with high magnesium concentration showed high concentration of alkaloid.

Morphological and anatomical investigation of *S. cordifolia* showed that the plants grown in soil with high phosphorous concentration, low calcium and potassium concentration showed maximum growth. Results suggest that soil with low organic matter concentration and high sulphur concentration increased the concentration of phenol. Likewise soil with high organic matter and low sulphur concentration showed maximum accumulation of alkaloid in *S. cordifolia*.

Since these medicinally important plant species showed variations in their growth and also in their secondary metabolites in response to different habitat conditions, their efficacy will vary to cure human ailments.