Chapter 2 Review of literature

Research and scientific literature is the collection of research information and as such, serves as the reservoir of knowledge about a subject. The literature codifies the subject material, maintains a historical record on experimental trials, and aids in problem solving through education and communication about facts and ideas. A close examination of the literature indicates the amount of research on most herbs, spices and medicinal plants remains quite limited. This relatively low average number of published research papers must be viewed with caution, of course as great variation in economic value and commercial use exists. As the scientific literature on the herbs, spices and medicinal plants develops, more exchange of information should occur, helping to advance the science of these plants. Modern research on herbs, spices and medicinal plants has expanded to study a wide variety of tropical areas connected to botany, horticulture and pharmacology of these plants. With this increased interest in herbs, spices and medicinal plants, professional and field specialists associated with trade, horticulture and chemistry have made an ever increasing demand for recent and accurate information on plants, its pharmacognosy and pharmacology.

2.1 Literature survey of *Eclipta alba* (L.) Hassk.

The review of literature encompasses information of folklore claims, pharmacognosy, phytochemistry, pharmacological and cosmeceutical activities of *Eclipta alba* Hassk.

2.1.1 Folklore claims

The literature survey on the ethnomedical uses of *E. alba* reveals that in many parts of the world it is grown commercially as a medicinal crop (Anonymous, 1952). Aerial parts of the plant are used in medicine (Chopra *et al.*, 1956).

**India:** According to Ayurvedic philosophy *E. alba* is bitter; alterative and anthelmintic. It is useful in inflammations, hernia, eye diseases, bronchitis, asthma, leucoderma, anemia, heart and skin diseases, night blindness and syphilis. It is reported as beneficial for complexion, hair, eyes, and teeth. Expressed juice of *E. alba* mixed with goat’s milk is
used in frontal sinusitis and nasal catarrh in children. Bhringraj taila and Bhringrajadi churana are official preparations (Anonymous, 1952; Chopra et al., 1956). In Unani system, the juice of *E. alba* is used in 'Hab Miskeen Nawaz' along with aconite, *Croton tiglium*, “triphala”, *Piper nigrum, Piper longum, Zingiber officinale*, and minerals like mercury, sulphur, arsenic and borax. for various types of pains in the body. It is also a constituent of 'Roghan Amla Khas' for applying on hair and of Ma'jun Murrawah-ul-arwah (Anonymous, 1952).

**Korea:** The plant is used as an antidote for snake bites in Korea (Anonymous, 1987).

**Philippines:** A decoction of the dried plant is used for heamoptysis and heamtemesis. For dysentery and heamturia urine, a decoction of the dried herb or tincture is used. Medicated tea or tinctures are used as household remedies for sprains, furuncle and dermatitis; the tea or tincture is excellent (Dan and Nhu, 1989).

**Nepal:** The plant juice, mixed with an aromatic (essential oil), is used in the treatment of catarrhal problems and jaundice. The leaves are used in the treatment of scorpion stings (Anonymous, 1993).

### Table 2.1: Biological activites of various parts of *Eclipta alba*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant parts</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whole plant</td>
<td>Rejuvenating, Age – sustaining tonic, Detoxifying, Deobstrucent, Antiseptic herb in vitiated blood, Anaemia, Splenic and liver enlargements, Catarrhal jaundice, Hyperacidity, Gastritis, Dysentery, Anti - catarrhal, Spasmogenic, Hypotensive properties</td>
</tr>
<tr>
<td>2</td>
<td>Juice of leaves</td>
<td>Skin diseases, Allergic Urticaria, Asthma, Inflatulence, Colic and liver affections, Bronchitis, Enlarged glands, Dizziness, Vertigo, Blurred vision</td>
</tr>
<tr>
<td>3</td>
<td>Paste of leaves</td>
<td>Applied over swelling</td>
</tr>
<tr>
<td>4</td>
<td>Powder</td>
<td>Bronchitis, Cough, Rheumatism and Skin diseases</td>
</tr>
<tr>
<td>5</td>
<td>Decoction</td>
<td>Invigorate the liver, Graying of hair, Bleedings, Spermatorrhoea, Menorrhagia</td>
</tr>
<tr>
<td>6</td>
<td>Paste of herb</td>
<td>Healing effect, Headache, Toothache</td>
</tr>
</tbody>
</table>
2.1.2 Phytochemistry

Preliminary Phytochemical screening showed the presence of proteins, aminoacids, essential oils, volatile oils, tannins, steroids, carbohydrates, glycosides, alkaloids, flavones glycosides in plant of *E. alba* (Pulak *et al.*, 2002). *E. alba* contains wide range of active principles which includes coumarins, alkaloids, flavanoids, glycosides, polyacetylenes, triterpenoids. The leaves contain stigmasterol, a -terthienylmethanol, wedelolactone, demethyl wedelolactone and demethyl wedelolactone - 7 - glucoside (Wagner *et al.*, 1986). The roots give hentriacontanol and heptacosanol. The roots contain polyacetylene substituted thiophenes. The aerial part is reported to contain a phytosterol, P-amyrin in the n - hexane extract and luteolin – 7 - glucoside, P -glucoside of phytosterol, a glucoside of a triterpenic acid and wedelolactone in polar solvent extract. The polypeptides isolated from the plant yield cystine, glutamic acid, phenyl alanine, tyrosine and methionine on hydrolysis. Nicotine and nicotinic acid are reported to occur in this plant (Jadhav *et al.*, 2009).

**Coumarins**

The dried leaves of *E. alba* have been reported to contain wedelolactone, a complex coumarin and its derivatives dimethylewedelolactone – 7 - glucoside and nor -wedelolactone (Bhargava *et al.*, 1970; Wagner *et al.*, 1986; Yahara *et al.*, 2006; Mitesh *et al.*, 2010). Demethyl wedelolactone, isodemethyl wedelolactone, and strychnolactone have been reported from by percolation and hot extraction of *E. alba* whole plant (Zhang and Guo, 2001).

**Alkaloids**

Alkaloids including ecliptine and nicotine (Pal and Narasimham, 1943; Khargava and Seshadri, 1974; Sikroria *et al.*, 1982) were identified. Bio - active steroidal alkaloids, verazine, 20 – epi – 3 – dehydroxy – 3 – oxo - 5, 6 – dihydro - 4, 5 - dehydroverazine ecliptalbine, (20 R) - 4s - hydroxyverazine, 4s - hydroxyverazine, (20 R) - 25s -
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Hydroxyverazine and 25s -hydroxyverazine have been identified from the methanolic extract (Abdel Kader et al., 1998).

Hydrocarbons

Dithienylacetylene ester (Jain and Singh, 1988), ecliptal or α - terthienyl aldehyde (Das and Chakravarty, 1991), α – terthienyl - methanol (Han et al., 1998) and α - formylterthienyl (Zhang et al., 1997).

Triterpenes

Ecliptasaponin C and D (Zhang et al., 1997), new triterpenoid glucosides, have been isolated from the whole plant of E. alba. A new triterpene saponin, eclalbatin, together with α-amyrin, β - amyrin, ursolic acid, oleanolic acid and wedelic acid has been isolated (Upadhyay et al., 2001). From the whole parts of six new oleanane triterpene glycosides, eclalbasaponins I - VI have been isolated (Yahara et al., 2006).

Volatile oils

The volatile components were isolated from the aerial parts of this plant by hydrodistillation and analysed by GC - MS. A total of 55 compounds, which were the major part (91.7 %) of the volatiles, were identified by matching mass spectra with a mass spectrum library (NIST 05.L). The main components were as follows: heptadecane (14.78 %), 6, 10, 14 – trimethyl – 2 - pentadecanone (12.80 %), w - hexadecanoic acid (8.98 %), pentadecane (8.68 %), eudesma - 4 (14), 11 - diene (5.86 %), phytol (3.77 %), octadec – 9 - enoic acid (3.35 %), 1, 2 -benzenedicarboxylic acid diisooctyl ester (2.74 %), (Z, Z)- 9, 12 - octadecadienoic acid (2.36 %), (Z) - 7, 11 – dimethyl – 3 – methylene - 1, 6, 10 - dodecatriene (2.08 %) and (Z, Z, Z) -1, 5, 9, 9 – tetramethyl - 1, 4, 7 - cycloundecatriene (2.07 %) (Xiong – Hao Lin, 2010).

Saponins

From the whole plant of E. alba, a new triterpene saponin, named eclalbatin, together with α - amyrin, ursolic acid and oleanolic acid were isolated. The structure of eclalbatin has been established as 3 – O – beta – D – glucopyranosyl – 3 – beta – hydroxyl – olean – 12 – en – 28 – oic acid, 28 – O – beta – D – arabinopyranoside (1) on
the basis of chemical and spectral data (Upadhyay et al., 2001). Dasyscyphin C was isolated from *Eclipta prostrata* which were studied on the HeLa cells for the anticancer activity (Khanna and Kannabiran, 2008).

Fig. 2.5. Chemical structure of major constituents of *Eclipta alba*
Table 2.2: Chemical Constituents of *Eclipta alba*

<table>
<thead>
<tr>
<th>Triterpenes</th>
<th>Coumarins</th>
<th>Alkaloids</th>
<th>Sterols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eclalbatin</td>
<td>Wedelolactone</td>
<td>Ecliptine</td>
<td>β glucoside</td>
</tr>
<tr>
<td>Ecliptasaponin A,B,C(1) &amp; D</td>
<td>Dimethylewedelolactone-7-glucose</td>
<td>Nicotine</td>
<td>Daucosterol</td>
</tr>
<tr>
<td>Eclalbasaponins I-XII Oleanolic acid</td>
<td>Nor-wedelolactone</td>
<td>Steroidal</td>
<td>Stigmasterol-3-O-glucose</td>
</tr>
<tr>
<td>α-amyrin, β- amyrin, Ursolic acid</td>
<td>Isodemethyl wedelolactone</td>
<td>Alkaloids</td>
<td>Stigmasterol β-sitosterol</td>
</tr>
<tr>
<td>Wedelic acid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hydrocarbons</strong></td>
<td><strong>Flavonoids</strong></td>
<td><strong>Steroids</strong></td>
<td><strong>Miscellaneous</strong></td>
</tr>
<tr>
<td>Dithienylacetylene ester</td>
<td>Apigenin</td>
<td>Diosgenin</td>
<td>Nonacosanol</td>
</tr>
<tr>
<td>Ecliptal</td>
<td>Luteolin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>α-terthienyl-methanol</td>
<td>Luteolin-7-glucoside</td>
<td>Tigogenin</td>
<td>Stearic acid</td>
</tr>
<tr>
<td>Heptacosanol</td>
<td></td>
<td>Lanosterol</td>
<td>Lacceroic acid</td>
</tr>
<tr>
<td>Hentriacontanol</td>
<td></td>
<td></td>
<td>alpha-terthienyl</td>
</tr>
<tr>
<td><strong>Thiopenes</strong></td>
<td><strong>Polyacetylenic thiopenes</strong></td>
<td></td>
<td>3,4-dihydroxy benzoic acid</td>
</tr>
</tbody>
</table>

Table 2.3. Chemical constituents of parts of *Eclipta alba*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parts</th>
<th>Chemical constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leaves</td>
<td>Wedelolactone [1.6 %], Desmethylewedelolactone, Desmethyl-wedelolactone – 7 – glucoside, Stigmasterol</td>
</tr>
<tr>
<td>2</td>
<td>Roots</td>
<td>Hentriacontanol, Heptacosanol &amp; Stigmasterol, Ecliptal, Eclalbatin.</td>
</tr>
<tr>
<td>3</td>
<td>Aerial parts</td>
<td>α - amyrin &amp; Luteolin – 7 – O – glucoside, Apigenin, Cinnaroside, Sulphur compounds, Eclalbasaponins I - VI</td>
</tr>
<tr>
<td>4</td>
<td>Stems</td>
<td>Wedelolactone</td>
</tr>
<tr>
<td>5</td>
<td>Seeds</td>
<td>Sterols, Ecliptalbine (alkaloid)</td>
</tr>
<tr>
<td>6</td>
<td>Whole plant</td>
<td>Resin, Ecliptine, Reducing sugar, Nicotine, Stigmasterol, Triterpene saponin, Eclalbatin, Ursolic acid, Oleanolic acid</td>
</tr>
</tbody>
</table>
2.1.3 Pharmacology

Crude extract

The crude extract has been found to have wound healing properties. It has been reported to counteract CCl₄ - induced inhibition of the hepatic microsomal drug metabolizing enzymes. The loss of hepatic lysosomal acid phosphatase and alkaline phosphatase by CCl₄ was significantly restored by *E. alba*. The study shows that hepatoprotective activity of *E. alba* is by regulating the levels of hepatic microsomal drug metabolizing enzymes (Saxena *et al.*, 1993). The fresh plant is used as self medication by AIDS patients in southern Thailand and showed potential as a therapeutic agent against Giardia intestinal infections (Sawangjaroen *et al.*, 2005; Supinya *et al.*, 2006). The leaf extract showed hypolipidemic activity in atherogenic diet induced hyperlipidemic rats (Dhandapani, 2007). It has antimicrobial and antioxidant properties (Karthikumar *et al.*, 2007) and also 3 % extract of *E. alba* is used in pilex formulation with other ingredients. It has been reported to decrease bleeding time (Mukherjee and Poddar, 1976). Leaf extract has been used in edema. It is used in the treatment of paronychia (Khan and Khan, 2008).

Antihepatotoxic properties

The hepatoprotective effect of the ethanol / water (1 : 1) extract of *E. alba* has been studied at subcellular levels in rats against CCl₄ - induced hepatotoxicity. *E. alba* significantly counteracted CCl₄ - induced inhibition of the hepatic microsomal drug metabolizing enzymes. The loss of hepatic lysosomal acid phosphatase and alkaline phosphatase by CCl₄ was significantly restored by *E. alba*. The study shows that hepatoprotective activity of *E. alba* is by regulating the levels of hepatic microsomal drug metabolizing enzymes (Saxena *et al.*, 1993). Bi - herbal ethanolic extract (BHEE) from the leaves of *E. alba* and seeds of *Piper longum* at a dose level of 50 mg / kg body weight was administered orally once for 14 days which restored elevated serum marker enzymes such as SGOT, SGPT, ALP, LDH, ACP, GGT and 5' Nucleotidase, due to CCl₄ treatment. All the biochemical parameters like total protein, total bilirubin, total cholesterol, triglycerides, and urea were also restored towards normal levels (Samudram *et al.*, 2008).
Hepatoprotective activity of methanolic extract and sub fractions of leaves and the chloroform extract and sub fractions of roots of E. alba were carried out using carbon tetrachloride - induced liver damage and lysosomal enzymes level in wistar albino rats. The methanolic extract of leaves and the chloroform extract of roots of E. alba showed significant activities and respectively causing 72.8 % and 47.96 % reduction of lysosomal enzyme. The triterpenoid eclabasaponin fraction from methanolic extract of leaves produced significant (78.78 %) and the alkaloidal fraction (60.65 %) reduction of carbon tetra chloride induced increase in lysosomal enzyme in blood. Coumarin fraction and triterpenoidal saponin fraction from the chloroform extract of roots produced very significant (75.6 %) and (52.41 %) respectively reduction of carbon tetra chloride induced increase in lysosomal enzyme levels in blood (Lal et al., 2010).

**Antihyperlipedemic properties**

It has been reported that in the atherogenic diet induced hyperlipedemic model, the aqueous leaf extract of the E. prostrata was given orally to the rats which significantly reduced total cholesterol, triglycerides, total protein. There was a significant elevation in the high density lipoprotein cholesterol levels and 200 mg / kg of extract showed better results compared to 100 mg / kg (Dhandapani, 2007). Animal model containing Charles River Sprague - Dawley CD rats (specific pathogen – free / viral antibody - free Crj/Bgi male, 180 ± 10 g) were fed experimental diets supplemented with 0 mg (control), 25 mg (E<sub>25</sub>), 50 mg (E<sub>50</sub>), or 100 mg (E<sub>100</sub>) of a freeze-dried butanol fraction of E. prostrata per kilogram of diet for 6 weeks which reported significant reduction of serum triacylglycerol and total cholesterol, low-density lipoprotein-cholesterol levels and elevation in the high-density lipoprotein in the E<sub>50</sub> and E<sub>100</sub> groups respectively when compared with the untreated control group (Dae-Ik Kima et al., 2008).

**Antioxidant properties**

The antioxidant effects of E. prostrata was reported when 50 mg / kg and 100 mg / kg dose were fed orally into Charles River Sprague - Dawley CD rats which reduced serum hydroxyl radical (nmol / mg protein per minute) and serum lipid peroxide (nmol / mg protein) levels compared to untreated group. 100 mg / kg dose significantly reduced carbonyl content of oxidatively modified proteins (Dae-Ik Kima et al., 2008).
Antioxidant activity of *E. prostrata* was determined by FRAP, radical scavenging activity, reducing activity and DPPH assay. The antioxidant capacity was increased by increasing the concentration of the extracts from 25 to 100 mg/ml (Bhaskar Rao *et al.*, 2009).

The antioxidant activity of the hexane, ethyl acetate, ethanol and water extracts of *E. prostrata* was determined by ferric thiocynate (FTC). FTC method was used to determine the amount of peroxide formed and that react with ferrous chloride (FeCl$_2$) to form a reddish ferric chloride (FeCl$_3$) pigment. In this method, the concentration of peroxide decreases as the antioxidant activity increases. Hexane, ethyl acetate, ethanol and water extract at various concentration (50, 100, 250 and 500 in µg/mL), showed antioxidant activities in a concentration dependent manner. Ethanolic extract at the concentration of 500 µg/mL showed (77.62 %), which is close to the reference compound α-tocopherol (80.06 %) (Karthikumar *et al.*, 2007). *E. alba* is reported to have free radical scavenging action (Bhattacharya *et al.*, 1997). Kim *et al.* (2008) found that butanol fraction of *E. alba* improves antioxidant activities in rats. Ethanol extract of the aerial parts of *E. alba* showed significant free radical scavenging for DPPH and for hydroxyl radical (Unnikrishnan *et al.*, 2007; Majumdhar *et al.*, 2008).

**Immunomodulatory activities**

It has been reported that protection of neuronal tissues may be possibly due to the immunomodulatory action of *E. alba*. Therefore, *E. alba* can serve as a potential memory modulator (Otilia Banji *et al.*, 2007). Experimentation made to assess the immunomodulatory activity of methanol extracts of whole plant of *E. alba* (1.6 % wedelolactone) at five dose levels (dose - response relationship) ranging from 100 to 500 mg/kg using carbon clearance, antibody titer and cyclophosphamide immunosuppression parameters significantly increased phagocytic index and antibody titer and the F ratios of the phagocytic index and WBC count were also significant (Jayathirthaa and Mishraa, 2004). The aqueous leaf extract *E. alba* was fed into a fish (tilapia, *Oreochromis mossambicus*) at 0, 0.01, 0.1 or 1 % levels as a diet for 3 weeks. After each week, non-specific humoral (lysozyme, antiprotease and complement) and cellular (myeloperoxidase content, production of reactive oxygen and nitrogen species) responses
and disease resistance against *Aeromonas hydrophila* were noted which resulted in increased activity of non-specific immune parameters. The results indicate that dietary intake of *E. alba* aqueous leaf extract enhances the non-specific immune responses and disease resistance of *O. mossambicus* against *A. hydrophila* (Christybabita et al., 2007).

**Analgesic and Anti-inflammatory activity**

Albino wistar rats were used to investigate anti-inflammatory activity in which methanolic extract was administered orally. 100 and 200 mg/kg showed significant anti-inflammatory activity in carrageenin and egg white induced hind paw edema in rats which was compared with indomethacin (10 mg/kg) and cyproheptadine (8 mg/kg) (Arunachalam et al., 2009). Analgesic effect was studied on albino mice using ethanolic and alkaloidal extract of *E. alba*. Standard experimental models such as the tail clip method, the tail flick method and the acetic acid induced writhing response were used which showed both the ethanol extract as well as the total alkaloids produced good analgesic activity in all the different models of analgesia used. The total alkaloidal fraction was the most efficacious in all models tested (Singh et al., 2008; Sawant et al., 2004).

**Antidiabetic activity**

Leaf suspension of *E. alba* (2 and 4 g/kg) orally in alloxan induced diabetic rats resulted in reduction in blood glucose level, glycosylated haemoglobin. There was decreased activity of glucose - 6 phosphatase and fructose1, 6 - bisphosphatase, and an increase in the activity of liver hexokinase. Thus oral administration of *E. alba* suspension possess potent antihyperglycemic activity (Ananthi et al., 2003). *E. alba* as an ingredient in polyherbal formulation Pan-five were scientifically and clinically proved to possess antidiabetic and diuretic activity by acting upon pancreas by restoration and regeneration of pancreatic β-cell activity (Hemalatha et al., 2006).

**Antimicrobial activity**

Antimicrobial potentials of *Eclipta* plants have been investigated by a number of workers. The shoot extract of *E. alba* possess antimicrobial activity (Anonymous, 1952; Kosuge et al., 1985). The alcoholic extract of *E. alba* has shown antiviral activity against
Ranikhet disease (Dhar et al., 1968). *E. alba* plants have been screened for antifungal (Nene et al., 1968; Farouk et al., 1983; Singh and Singh, 1997; Thyagarajan and Krishnaswamy, 1999) and antibacterial (Phadke and Kulkarni, 1989) properties. *E. alba* seeds frequently observed growing on cattle dung heaps were screened for their antibacterial properties against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas cichorii* and *Salmonella typhimurium* (Kumar et al., 1997). Direkbusarakom et al. (1998) has evaluated *E. alba* plants for antibacterial activity against the fish and shrimp pathogenic bacteria: *Aeromonas hydrophila*, a *Streptococcus* species and ten strains of *Vibrio*. Abdel-Kader et al. (1998) has reported eight steroidal alkaloids obtained from methanol extracts of *E. alba* leaves as DNA damaging agent or antifungal agent against three strains of *Saccharomyces cerevisiae*. Wiart et al. (2004) have also investigated methanol extract of *E. alba* for antibacterial and antifungal activities. The ethyl acetate and ethanol extracts of *E. alba* were found to be active against *Escherichia coli*, *Klebsiella pneumonia*, *Shigella dysenteriae*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus* (Karthikumar et al., 2007).

Ethanol extracts of fruits of *E. alba* has been found to possess strong inhibitory effects on acne-inducing bacteria *Staphylococcus epidermidis* (Kumar et al., 2007). Girish and Satish (2008) tested the aqueous and methanol extracts of *E. alba* against some human pathogenic bacteria and found that methanol extracts had wider range of activity. Yasmin et al. (2008) studied that the aqueous extracts of *E. alba* leaves showed mild antifungal activity on *Fusarium moniliforme*. Khanna and Kannabiran (2008) evaluated the antimicrobial activity of pure saponins fraction from leaves of *E. alba* for pathogenic bacteria and fungi. The antileptospiral (antibacterial) activity of *E. alba* was well studied by Prabhu et al. (2008) and results showed better inhibitory action against various serogroups of *Leptospira* species inhibited by both water and ethanol extracts.

**Hair growth promoting effects**

*Eclipta alba* (L.) Hassk. is one of the best known ayurvedic herb with purported claims of hair growth promotion. A black dye obtained from *E. alba* is used for dyeing hair and tattooing. Bhringaraja oil is a famous hair tonic for maintaining dark hair and reversing baldness. It may be used along with *Centella asiatica* (Brahmi) and *Phyllanthus*
emblica (Amla). *E. alba* extracts have been used in traditional Chinese medicine as well as by middle-eastern ayurvedic doctors for thousands of years to prevent hair loss. It is reported to improve hair growth and color (Chopra *et al.*, 1956; Kritikar and Basu, 1975). Taken internally, it is believed to blacken the hair and beard (Boulos *et al.*, 1984). Topical application of fresh *Eclipta* juice mixed with neem oil reportedly stimulated hair growth and in some cases changed gray hair to black (Chandra, 1985). The leaf juice of plant is applied as hair tonic on the scalp (Jamir, 1997). Roy *et al.* (2007) developed and evaluated a polyherbal formulation containing *E. alba* for hair growth-promoting activity. Although the chemical component which promotes hair growth has not yet been identified, it is believed that its ability to promote hair growth seems from its bioactive steroidal alkaloids (McCarthy, 2008). Petroleum ether extracts of *E. alba* with other herbs was prepared and evaluated their hair growth promoting activity in albino rats (Nakaguchi *et al.*, 2001; Roy *et al.*, 2008; Datta *et al.*, 2009). The extracted juice of *E. alba* if taken internally and applied to the scalp blackens the hair (Chopra *et al.*, 1955; Kritikar and Basu, 1975). *E. alba* has been reported in various polyherbal formulation (Baishiyou, 1993; Cheol, 2004; Lee, 1995, 2001, 2004; Shin, 2006; Xiulan, 1997) for hair growth promotion.

Datta *et al.* (2009) investigated the efficacy of methanol extract of *E. alba* as hair growth promoter. *E. alba* is used in hair oil preparations since it promotes hair growth and maintains hair black. 10 % w/v of *E. alba* was a main ingredient in the preparation of herbal formulation for hair growth (Thorat *et al.*, 2009). Alopecia is a dermatological disorder with psychosocial implications on patients with hair loss. *E. alba* is a well-known ayurvedic herb for hair growth. In the reported work petroleum ether and ethanolic extracts were incorporated into oleaginous cream (water in oil cream base) and applied topically on shaved denuded skin of albino rats. The time (in days) required for hair growth initiation as well as completion of hair growth cycle was recorded. Minoxidil 2 % solution was applied topically and served as positive control for comparison. The result of treatment with 2 and 5 % petroleum ether extracts were better than the positive control minoxidil 2 % treatment (Roy *et al.*, 2008).
Thakur et al. (2008) investigated that β-sitosterol and wedelolactone were responsible for hair growth activity. 5α - reductase inhibition contributes in treatment of androgenic alopecia. Daniel (2006) also reported that E. alba herbs were used for promoting hair growth activity. Iqbal Hussain et al. (2011) reported that the medicated oils of E. alba is widely used as hair tonic and to prevent hair fall and premature graying of the hair. Bhringaraja is the most common ingredient incorporated in numerous market preparations of various hair oils.

According to Agarwal and Gayatri (2011) herbal formulations containing petroleum ether extracts of E. alba, methanolic extracts of E. alba and various fixed oil like mustard oil, coconut oil and sesame oil are used for evaluating the formulations for hair growth promoting potential activity. The results showed that the animals treated with the methanolic extract of E. alba shows highest number of hair follicle and the earliest hair growth seen in methanolic extract gel formulation.

**Anticancer activity**

Methanolic extract of E. alba was evaluated for its anticancer activity against Ehrlich Ascites Carcinoma (EAC) in Swiss albino mice. On day 1, the extract of E. alba at a dose of 250 and 500 mg/kg body weight were administered orally and continued for 9 consecutive days. The anticancer activity was examined by determining the tumor volume, tumor cell count, viable tumor cell count, nonviable tumor cell count, mean survival time and increase in life span in experimental animal models. The extract increased the life span of EAC treated mice and restored the hematological parameters as compared with the EAC bearing mice. Thus, study revealed that the methanolic extract of E. alba showed anticancer activity in the tested animal models (Malaya Gupta et al., 2005). Coumarins are also known to act as phytoestrogens. These compounds are present in soyabeanes and clover. In many countries it is used as diet which acts as chemopreventive agent in breast and prostate cancer (Kaushik Basu et al., 2008).

Dasyscyphin - C (saponins) a newer isolated compound from E. prostrata reported to have anticancer - cytotoxic activity. It was tested under *in vitro* conditions in HeLa (Human cervical carcinoma) and vero cell lines. At the concentration of 50 g / ml it showed a good anticancer - cytotoxic activity on HeLa cells (Khanna and Kannabiran,
A rat hepatic stellate cell line (HSCs) was used as \textit{in vitro} assay system, the methanolic extract of aerial parts of \textit{E. prostrate} showed significant inhibitory activity on HSCs proliferation (Mi Kyeong Lee \textit{et al.}, 2008).

**Anti-venomous activity**

The constituents of \textit{E. alba} have found to neutralize the lethal and myotoxic activities of venom of south american rattle snake (Mors \textit{et al.}, 1989) and rattle snake at Tamil Nadu (Samy \textit{et al.}, 2008). Fresh aerial parts are used to treat snakebites in Brazil (Martz, 1992). Melo \textit{et al.} (1994) found that \textit{E. prostrata} extracts inhibit the myotoxic and hemorrhagic activities of crotalid venom. Pithayanukul \textit{et al.} (2004) isolated demethyl wedelolactone from butanolic extracts of \textit{E. prostrata} and evaluated for its anti-venom potential against the lethal action of the venom of the Jararaca (\textit{Bothrops Jararaca}). Secondary metabolites wedelolactone and demethyl wedelolactone isolated from extracts of natural and genetically modified \textit{E. alba} with \textit{Agrobacterium rhizogenes} LBA 9402, were found to inhibit the myotoxic activities induced by basic phospholipases A2 isolated from venoms of \textit{Crotallus durissus} terrificus and \textit{Bothrops jararacussu} (Diogo \textit{et al.}, 2009).

**Combination therapy**

\textit{E. alba} (whole plant), \textit{Mimosa pudica} (whole plant), \textit{Vitex negundo} (whole plant) and \textit{Solanum nigrum} (aerial parts) possessed styptic and anti-inflammatory properties and help in regeneration of the vascular endothelium (Sahu and Pankaj, 2001). Combination of herbs like \textit{Anethum sowa} (Shatapushpa), \textit{Piper longum} (Pippali mool), \textit{Valeriana wallichii} (Tagar), \textit{Cassia fistula} (Aragvadh), \textit{Withania somnifera} (Ashwagandha) and \textit{Triphala} (A herbal combination of three fruits) with \textit{E. alba} (Bhringaraj) pacify the aggravated vata dosha and combination with \textit{Elaeocarpus ganitrus} (Rudraksha), \textit{Herpestris monniera} (Brahmi) showed a tranquilizer effect (Haveliwala, 1963). Herbal mixture containing \textit{Phyllanthus nigrum}, \textit{Picrorrhiza kurroa}, \textit{Zingiber officinale}, \textit{Boerhaavia diffusa}, \textit{Andrographis paniculata}, \textit{Cichorium intybus}, \textit{Emblica officinalis}, \textit{Embelia ribes}, \textit{Terminalia chebula}, \textit{Terminalia arjuna}, \textit{Piper longum} with \textit{E. alba} is used as a good digestive tonic (Bruce Milliman \textit{et al.}, 2000). Galactin Vet Bolus a polyherbal ingredient containing \textit{E. alba} increased the yield of milk in the Holstein and jersey
crossbred cows (Baig and Bhagwat, 2009). *E. alba* with *Acacia catechu* leaves reduced severe hepatotoxicity (Rolf teschke and Ruediger bahre, 2009).

**Other pharmacological activities**

It has been reported that the importance of free carboxylic acid at C-28 position in echinocystic acid derivatives from the methanolic extract *E. prostrata* showed antifibrotic activity (Mi Kyeong Lee, 2008). Ethanolic and ethyl acetate fractions of *E. prostrata* were tested for its antibacterial activities against *Escherichia coli*, *Klebsiella pneumoniae*, *Shigella dysenteriae*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus* (Karthikumar et al., 2007). *E. prostrata* is combined with a non-plant material which is used to bath children suffering from malnutrition for 9 days and used as self medication by AIDS patients in southern Thailand (Sawangjaroen et al., 2005; Cheryl Lans, 2007). 16 parts of *E. prostrata* (bringaraj), 1 part of *Triphala* formula {*Emblica officinalis* (amalaki), *Terminalia chebula*, (haritaki), *Terminalia belerica* (bibhitaki)}, 1 part of *Caltropis gigantea* (arka) and 1 part of *Smilax officinalis* (sariva) mixed with 80 parts of sesame oil and boiled to make a medicated oil which is reported to be used in skin diseases (Bensky Dan and Andrew Gamble, 1986).

**Table 2.4. Pharmacological activities of the chemical constituents**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Chemical constituents</th>
<th>Pharmacological activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wedelolactone</td>
<td>Antihepatotoxic (Nazim Uddin et al., 2010), Antibacterial (Karthikumar et al., 2007), Trypsin Inhibitor, Antivenom (Vianna-da-silva et al., 2003)</td>
</tr>
<tr>
<td>2</td>
<td>Eclalbosaponins</td>
<td>Hair revitalizing (Thorat et al., 2009), Antiproliferative (Khanna and Kannabiran, 2008; Kaushik-Basu et al., 2008), Antigiardial (Sawangjaroen et al., 2005)</td>
</tr>
<tr>
<td>3</td>
<td>Demethylwedelolactone</td>
<td>Antihepatotoxic (Wagner et al., 1986), Antihaemorrhage (Mukherjee and Poddar, 1976), Antivenom (Vianna-da-silva et al., 2003), Dye (cosmetic) (Meena et al., 2010)</td>
</tr>
<tr>
<td>4</td>
<td>Dasycyphin C</td>
<td>Antiviral, Anticancer (Khanna and Kannabiran, 2008)</td>
</tr>
<tr>
<td>5</td>
<td>Eclalbatin</td>
<td>Antioxidant (Tewtrakul et al., 2007)</td>
</tr>
<tr>
<td>6</td>
<td>Ecliptalbine, verazine</td>
<td>Lipid lowering, Analgesic (Abdel-Kader et al., 1998)</td>
</tr>
</tbody>
</table>
2.2 Literature survey of *Lippia nodiflora* Linn.

2.2.1 Folklore claims

*Phyla nodiflora* (*Lippia nodiflora*) belongs to Verbenaceae family, distributed in India, Ceylon, Baluchistan, South Africa and Central America. *L. nodiflora* L commonly known as Booken, is a traditional medicine in many parts of Pakistan and used for the treatment of various dermatomycoses (Ravikumar and Sudha, 2011) like tinea capitis, tinea pedis, tinea manuum, tinea corporis *etc*. The plant is aromatic, runner plant with scanty roots and cure adenopathy, chronic indolcent ulcers, bronchitis, fevers and cold (Kirtikar and Basu, 1991). The plant is also used for boils, indigestion in children and for the women after the delivery (Chopra *et al.*, 1956). The plant is used as gastro protective effect, anti inflammatory (Balakrishnan *et al.*, 2011), antineoplastic, antioxidant and diuretic (Shukla *et al.*, 2009). The aerial parts of this plant are used as anodyne, antibacterial, diuretic, emmenagogue, parasiticide, refrigerant and febrifuge agents. Leaves and fruits are eaten for the treatment of irritation of the internal piles and for joints and knee pain. It is effective against bronchitis, respiratory diseases, arthritis, stomachic wounds, burning sensation, and asthma, loss of consciousness, neuralgia sores, spasm and vertigo (Manjunath, 1962).

2.2.2 Phytochemistry

The plant is rich in many important medicinal useful compounds. The plant contains a variety of constituents such as triterpenoids, flavonoids, phenols, steroids, and many others. Among these flavonoids, the most commonly found in *L. nodiflora* are Nodifloretin (3), β -sitosterol glycoside and stigmasterol glycoside from the leaves of *L. nodiflora* (Barua *et al.*, 1971). Nodifloridin A (1) and Nodifloridin B (2) along with lactose, maltose, glucose, fructose and xylose were isolated from the plant (Joshi, 1970). Two new flavone glycosides lippiflorin A (16) and lippiflorin B (17), along with the known compound nepetin and batalilfolin from the ethanol extract of *L. nodiflora* were isolated (Nair *et al.*, 1973).

From the flowers of *L. nodiflora*, two flavones glycosides, 6 - hydroxyluteolin - 7 Oapioside and luteolin - 7 - O - glucoside, and three flavones 6 – hydroxyl luteolin,
nepetin and batatifolin were isolated (Barnabas et al., 1980). From the alcoholic extracts of *L. nodiflora*, two phenylpropanoid compounds acteoside (18) and 2’-O-acetylenochinachoside and a flavone demethoxycentaureidin were isolated (Khalil et al., 1995). From *L. nodiflora*, twelve flavones sulfates Hispidulin 7-sulfate (4), Hispidulin 7, 4’-disulfate (5), Jaceosidin 7, 4’-disulfate (6), Nepetin 3’, 4’-disulfate (7), Nodifloretin 6, 7-disulfate (8), 6-Hydroxyluteolin 6, 7-disulfate (9), Nodifloretin 7-sulfate (10), 6-Hydroxyluteolin 6-sulfate (11), 6-Hydroxyluteolin 7-sulfate (12), Jaceosidin 7-sulfate (13), Nepetin 7-sulfate (14), and Hispidulin 4’-sulfate (15), along with the known compounds Nepetin, Hispidulin, and Jaceosidin (Tomas–Barberan et al., 1987). Halleridone and Hallerone as their acetyl derivatives were isolated from the leaves of *L. nodiflora* (Ravikanth et al., 2000). From the methanolic extract of the aerial parts of *L. nodiflora*, a new triterpenoid lippiacin, a new steroid 4’, 5’-dimethoxybenzoloxy stigmasterol along with the known stigmasterol and β-sitosterol [1, 6] were isolated (Siddiqi et al., 2007).

The plant was fractionated several constituents from the *L. nodiflora* using multi component solvent systems; Hexane : Toluene : Ethyl acetate (2 : 1.5 : 0.5) for methanol extract and Hexane : Ethyl acetate (3 : 1) for chloroform and petroleum ether extract. Five different phenolic components were isolated and were compared using a HPTLC, among these extracts, the highest number of constituents were isolated from the butanol extract (Kaur and Shukla, 2010). The molecular basis of a compound, cyclo pentane phenanthrenol, which exhibit anti inflammatory property was also given (Balakrishnan et al., 2011). Nodifloretin - A, a new flavone was also discovered (Basu et al., 1969). Chemical and biological investigations of medicinal herbs *Phyla nodiflora, Ruellia patula* and *Ruellia brittoniana* were done (Akhtar, 1993). Steroidal constituent from the aerial parts of *Lippia nodiflora* Linn was also obtained (Bina et al., 2009).
Table 2.5. Chemical constituents of plant parts of *Lippia nodiflora*

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Phytoconstituents isolated</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>Halleridone and Hallerone&lt;br&gt;β - sitosterol&lt;br&gt;2 – phenethyl alcohol, 1 – octen – 3 - ol, linalool, 2, 6 -dimethyloctane, methyl salicylate, calamene, α – copaene, α – bergamotene, δ – cadinene, β – bisabolene, umbellulone&lt;br&gt;Stigmasterol, Phytol</td>
<td>Ravikanth et al., 2000&lt;br&gt;Forestieri et al., 1996&lt;br&gt;Terblanche and Kornelius, 1996&lt;br&gt;Gabay et al., 2010&lt;br&gt;Ogunlesi et al., 2009</td>
</tr>
<tr>
<td>Leaves and Roots</td>
<td>Flavonoides, β – caryophyllene, β – caryophyllene oxide</td>
<td>Duke and Ayensu, 1985; Pascual et al., 2001</td>
</tr>
<tr>
<td>Whole aerial parts</td>
<td>Lippiacin, Benzofuranone rengyolone (halleridone 2)&lt;br&gt;Cyclo – pentano phenanthrenol&lt;br&gt;n - hexa decanoic acid&lt;br&gt;Dodecanoic acid</td>
<td>Siddiqui et al., 2007&lt;br&gt;Balakrishnan et al., 2010&lt;br&gt;Falodun et al., 2009&lt;br&gt;Bodoprost and Rosemeyer, 2007</td>
</tr>
<tr>
<td>Whole plant</td>
<td>Lippiflorin A and Lippiflorin B&lt;br&gt;Aceteoside and 2’ – O – acetyl echinacoside&lt;br&gt;Nepten, Jaceosidin, hispidulin aglycones, hispidulin, hydroxyluteolin, nodifloretin mono and disulphates, lippiflorin A and B glycosides, nodifloretin A and B, nodiflorin A and B glucosides, Alkaloids, resin&lt;br&gt;Nodifloridin A and B&lt;br&gt;Nodifloretin, β - sitosterol glycoside</td>
<td>Nair et al., 1973&lt;br&gt;Khalil et al., 1995&lt;br&gt;Tomas – Barberan et al., 1987&lt;br&gt;Forestieri et al., 1996&lt;br&gt;Joshi, 1970&lt;br&gt;Barua et al., 1971</td>
</tr>
</tbody>
</table>
2.2.3 Pharmacological activities

Hepatoprotective and Antioxidant potential of *Lippia nodiflora*

The methanolic extract of *Lippia nodiflora* (MELN) has been evaluated for antioxidant activity and hepatoprotective effects in paracetamol induced liver injury (750 mg / kg, b.w). MELN was administered orally for 7 days at doses 200 and 400 mg / kg. The higher dose (400 mg / kg) of MELN was found to be more effective than the lower dose (200 mg / kg) in paracetamol induced liver damage. MELN produced significant (P < 0.001) hepatoprotective effect by decreasing the activity of serum enzymes such as SGOT, SGPT, ALP bilirubin and lipid peroxidation, while it significantly (P < 0.001) increased the level of total protein, glutathione (GSH), catalase (CAT) and superoxide dismutase (SOD) in a dose dependent manner (Durairaj *et al.*, 2008). The MELN was found to be equivalent to that of standard silymarin 25 mg / kg, thus the plant was found to be hepatoprotective probably due to the antioxidantal potential on hepatocytes and the methanol extract of *L. nodiflora* for total phenolic content, indicated by the Folin-Ciocalteu phenol reagent was found to be 114.8 μg / mL total phenolics for 1 mg of the extract.

Anti-diuretic activity

The diuretic potential of methanol and aqueous extracts of the aerial parts was assessed in albino rats using *in-vivo* Lipschitz test model. The volumes of urine, urinary concentration of sodium and potassium ions were the parameters of the study. Furosemide was used as standard. The results indicate that methanol and aqueous extract at 500 mg / kg body weight shows a significant (P < 0.05) increase in the urine volume and electrolyte excretion (P < 0.001) when compared to control. Both the extracts show significant diuretic activity (Sangita Shukla *et al.*, 2009).

Antitumor activity

The methanolic extract of *L. nodiflora* has been evaluated for antitumor activity using Erich’s Ascites Carcinoma (EAC) bearing swiss albino mice. The mice were administrated with the methanol extract at 200 and 400 mg / kg of body weight daily for nine days after 24 hours of tumor inoculation. The methanolic extract indicated
significant (P < 0.001) decrease in tumor volume, viable cell count and packed cell volume, the life span of the mice was also found to be increased. For the mice treated with the methanol extract the hematological profiles reverted to more/less normal levels, while the serum enzymes, total proteins and bilirubin were altered narrowly. The methanol extract increased the levels of reduced glutathione (GSH), catalase (CAT) and superoxide dismutase (SOD) and reduced the levels of lipid per oxidation. The plant was found to bear good antitumor activity, which was supposed to be due to the increase of antioxidant activity (Durairaj et al., 2009).

**Anti-inflammatory activity**

The crude methanol extract and the isolated compound of cyclo-pentano phenanthrenol from *L. nodiflora* were assessed for anti-inflammatory activity. Human peripheral blood mononuclear cells were used as models to examine intracellular protein levels of pro-inflammatory mediators (MAPK and NF-KB) and the mitogen induced lymphocyte proliferation, cytokine mRNA expression (TNF-α, IL-1β and IL-6). The NO release levels, on treatment with the extract and the isolated compound were correlated with the underlying iNOS mRNA expression in the murine macrophage cell line RAW 264.7. In the cell line RT-PCR for COX-2, MMP2 and MMP9 were also conducted. As an *in vitro* model for the rat basophilic leukemia cell line RBL-2H3 was employed for PLA2 activity. The crude extract (20 μg / mL) and the isolated compound (10 μg / mL) were used to assess the activity. Cyclo-pentano phenanthrenol was found to inhibit TNF-α, IL-1β and IL-6 expression, prostaglandin biosynthesis via PLA2, NO release via iNOS suppression and COX-2 inhibition and the activation of intracellular targets, MAPK and NF-KB. Thus the compound was concluded to exhibit anti-inflammatory activity (Durairaj et al., 2009).

**Antimicrobial activity**

The methanolic extract of *Phyla nodiflora* had been evaluated for antibacterial (*S. aureus, M. luteus, P. mirabilis*). The anti microbial screening was performed by agar diffusion method using a paper disc. The sterilized (autoclaved at 120˚C for 30 min) medium was inoculated with the suspension of the micro organisms. The paper impregnated with the extracts (1000 μg / ml) was placed on the solidified medium. The
Petri dishes were pre-incubated for one hour at room temperature and incubated at 37°C for 24 hrs and 48 hrs for antibacterial and antifungal activity respectively. Gentamycin was (1000 μg / ml) used as a standard for anti-bacterial. The ethanol extract showed significant antibacterial activity due to the presence of bio-active compounds when compared with petroleum-ether and aqueous extract (Durairaj and Gupta, 2007).

**Antifungal activity**

The antifungal activity of crude extracts of *L. nodiflora* L. against the human pathogenic fungi was reported. The crude extract of various solvents of *Phyla nodiflora* had been screened for antifungal activity against *Aspergillus niger*, *A. Flavus*, *Paecilomyces varioti*, *Microsporum gypseum*, *Trichophyton rubrum*. All crude extract had significant inhibition activity against most of the fungi. Ethanol extract had maximum inhibition activity (100 %) against tested organism as compared to aqueous (82.6 %), Methanol (61 %), Ethyl acetate (87 %) extracts (Pirzada *et al.*, 2005).

**Antiurolithiatic activity**

The ethanolic extract of *L. nodiflora* (Linn.) had been evaluated against calculi producing diet-induced urolithiasis. Calcium oxalate urolithiasis was induced by administration of gentamycin and calculi producing diet (5 % ammonium oxalate in standard rat pellet feed). The extract was also assessed for effect on *in vivo* antioxidant parameters like lipid peroxidation, reduced glutathione, catalase in hyperoxaluric kidney and *in vitro* scavenging of nitric oxide and 2 – diphenyl – 2 – picryl hydrazyl free radicals. Ethanolic extract of *L. nodiflora* exhibited significant effect in preventing calcium oxalate stone formation and also in dissolving the pre-formed calcium oxalate stones in the kidney along with significant effect on both *in vitro* and *in vivo* antioxidant parameters. The present study clearly demonstrates the antiurolithiatic activity of *L. nodiflora* supporting the traditional claim (Sujatha Dodala *et al.*, 2010).

**Antidiabetic and Hypolipidaemic**

The effect of methanol extract of *L. nodiflora* Linn. in streptozotocin induced diabetic rats was reported by Rangachari and Savarimuthu (2011). The methanolic extract of *L. nodiflora* at three dose levels were administered orally to streptozotocin (STZ) (40
mg / kg bw) induced diabetic rats for 15 days. The extract at three dose levels showed a significant increase in the liver, muscle glycogen and serum insulin level and a significant decrease in fasting blood glucose, glycosylated hemoglobin levels and serum marker enzyme levels. The total cholesterol and serum triglycerides levels were also significantly reduced and the high density lipoprotein level was significantly increased upon treatment with the L. nodiflora methanol extract. Histochemical study of pancreas also confirmed the biochemical findings. Acute toxicity studies revealed the non-toxic nature of the methanol extract of L. nodiflora exerts significant antidiabetic and hypolipidaemic effect in STZ-induced diabetic rats (Rangachari and Savarimuthu, 2011).

Neuropharmacological activity

The neuropharmacological profile of petroleum, chloroform and ethanolic extracts of aerial part of L. nodiflora was reported with experimental models using test such as potentiation of diazepam-induced sleeping time, locomotor activity, motor coordination, exploratory behavior pattern, elevated plus maze and maximal electroshock convulsions. It showed that the ethanolic extract of L. nodiflora at both doses (250 and 500 mg / kg p.o.) and its chloroform extract at a higher dose of 500 mg / kg produced central inhibitory (sedative) effect, anticonvulsant effect and anxiolytic effect in mice. Values were statistically significant (P < 0.05 and P < 0.01) when compared to the control group. The petroleum ether extract of plant at both dose levels (250 and 500 mg / kg p.o.) did not produce any central effects. The ethanolic and chloroform extracts showed the central inhibitory activity due to the presence of flavonoids. The essential oils of the leaves of Lippia alba, Lippia gracilis, Lippia microphylla and L. nodiflora were tested for larvicidal activity against the instar larvae of Aedes aegypti. The higher larvicidal activity (LC50 = 26.3 μg / mL) was observed for the oil of L. gracilis, while appreciable activity was observed for the oil of L. nodiflora (Zheng, 2008).

Antidandruff activity

Zheng (2008) suggested that since L. nodiflora contains nodifloretin, β-sitosterol glucoside, stigmasterol glucoside, nodifloridin A and nodifloridin B, it could be used in proper doses for the treatment of hepatitis. Narayanan et al. (2008) suggested that the
plant extracts of any of the two plants, *Datura metel, Murraya koenigii, L. nodiflora* and *Wrightia tinctoria* possess antidandruff application.

2.3 Justification for inclusion in the study

Cosmeceutical value of the plants is generally determined by the presence of biologically active compounds. Such phytocompounds have been characterized as flavonoids, alkaloids, tannins, terpenoids, saponins and so on. Standardization of herbal cosmetics is an important task. The major problems faced by users are non-availability of rigid quality control profile. Proper identification and standardization is a primary condition. *Eclipta alba* and *Lippia nodiflora* has been used in traditional and folklore medicine for the treatment of hair growth and dandruff control activity. An attempt have been made to isolate new compounds from aerial parts of *Eclipta alba* and *Lippia nodiflora* and systematic screening of the extracts may result in the discovery of novel and effective compounds. The literature survey revealed that *Eclipta alba* and *Lippia nodiflora* are not much scientifically explored for its folklore claims and phytochemical constituents. Hence in this study, we had investigated the phytochemical characterization of the active principle of *Eclipta alba* and *Lippia nodiflora* and the application of its crude extracts in various cosmeceutical activities, selected on the basis of ethnomedical lead and literature survey.
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Akhtar, M. F. Chemical and biological investigations of medicinal herbs *Phyla nodiflora, Ruellia patula* and *Rueilla brittoniana* Ph.D. Thesis. 1993, Pakistan: Univ. of Karachi.


Chapter 2

Review of Literature


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Web Source


http://www.bluvenus.com/SW/herbal/index.html

http://www.kettlecare.com/index.html

http://www.agriinfotech.com

http://www.reviveholisticbeauty.com

http://www.womenfitness.net