Medicinal plants play a major role in meeting the medical and health needs of the people, especially in developing countries as they produce a diverse assortment of secondary metabolites of therapeutic importance (Croteau et al., 2000; Terryn et al., 2006). Secondary metabolites are widely used in human therapy, veterinary, agriculture, scientific research and other countless areas (Vasu et al., 2009). Knowledge of chemical constituents of plant is desirable not only for the discovery of therapeutic agents, but also may be of great value in disclosing new sources of such economic materials for the synthesis of complex chemical substances. Even today, compounds from plants continue to play a major role in primary healthcare as therapeutic remedies in many ways (Bobbarala et al., 2011). Therefore, the use and search for drugs and dietary supplement derived from plants have increased (Uma et al., 2009). The present study provides valuable information about phytochemical and pharmacological properties of *Gmelina asiatica* Linn.

### 2.1. Common Names

*Gmelina asiatica* is commonly known as Asian Bushbeech, Asiatic bushbeech-berry, Son-champ, Over leafed Gmelina (English); Ya zhou shi zi (China); Guangdong, Guangxi, Bulang, bulangan (Malaysia); Badhara (Hindi, Urdu and Punjabi); Bhadra (Bengali); Kalishivan, Shivan, Lahanshivan (Marathi); Kavagummudu, Peddanelli, Gumadi, Nelagummudu, Chirugumudu (Telugu); Guludumara, Guludu, Kumatha, Kalshivani, (Kannada); Gombhari, Gopogombhari, Nomdano, (Oriya); Vikarini, Gopabhadra, Gopachadra (Sanskrit); Kumil,
Kumilamaram, Mulkumizhu, Cherkumizhi, Cherukumizhu, Chulungu (Malayalam) and Nilakkumizh, Nilakkumalaa, Mulkumizh, Sirukumalaan, Pedanalli, Kadambal (Tamil). It is also called ‘Ladies nose flower’ (Dassanayake, 1983).

2.2. Ethnomedicinal Uses

Ethnomedicine refers to the study of traditional medical practice which is concerned with the cultural interpretation of health, diseases and illness and also addresses the healthcare seeking process and healing practices (Williams, 2006). The whole plant of *G. asiatica* is medicinally important and many reports claim to cure several diseases according to the Indian traditional system of medicines. The survey reveals that the plant is used as an herbal remedy for gonorrhea, catarrh of the bladder and as a blood purifier (Kiritikar and Basu, 1975; 1984). The leaves, aerial parts and roots are used for the treatment of jaundice, rheumatism, syphilis, gonorrhea, burning sensation of eyes, fever, dysuria, wounds, dandruff, diabetes, hepatic diseases and also to reduce body heat (Apparanantham *et al*., 1982; Parekh *et al*., 2005; Parekh and Chanda, 2007; Vikneshwaran *et al*., 2008; Kusuma and Joshi, 2010; Bakkiyaraj and Pandiyaraj, 2011). The roots of *G. asiatica* have been utilized as a demulcent, antiseptic, astringent and mucilaginous which are considered to be medicinal and useful in traditional medicine as well as in production of official drugs (Ayier and Kolammal, 1953; The Wealth of India, 1991; Yoganarasinghan, 2000). In Srilanka, almost all parts of this plant are used in the preparation of traditional medicines (Jayaweera, 1982). Topical application of the fruit rind of this plant is used to remove dandruff and treatment of wounds by Savaras in Andrapradesh (Rao and Henry, 1996).
2.3. Pharmacognostic Studies

Now-a-days there is a renewed interest in drugs of natural origin simply because they are considered as green medicine and green medicine is always supposed to be safe. Another factor which emphasizes this attention is the incidence of harmful nature of synthetic drugs which are regarded as harmful to human beings and environment. The advantage of natural drugs is their easy availability, economic and less or no side effects but the disadvantage is that they are the victims of adulteration. The more effective the natural drug more is its demand and the chances of non-availability increases. To meet the growing demand, the natural drug is easily adulterated with low grade material (Desai and Chanda, 2014). Owing to the shortage of genuine drug and ever-increasing demands in market, it becomes necessary to search an alternative with equal efficacy without compromising the therapeutic value (Kannan et al., 2012). The pharmacognostic standardization of *G. asiatica* stem was studied by Kannan *et al.* (2012) and Rajesh *et al.* (2013) who observed the anatomical features including epidermal cells, secondary xylem, vascular cylinder, their size, shape, structure, distribution and orientation and also mentioned the internal specific features of fibres, rays, tracheids and calcium oxalate crystals. They also reported the macroscopical, organoleptical characters, their differentiation in young and mature condition of stem, heartwood and sap wood.

2.4. Phytochemical Evaluation

Plants are valuable sources of chemical compounds synthesized and accumulated in various parts of plant body (Girija and Ravindran, 2011; Jeeva *et al.*, 2011; Joselin *et al.*, 2012; Florence *et al.*, 2014; Jose *et al.*, 2014). The knowledge of the chemical constituents of plants is desirable to understand herbal drugs and their
preparations (Farnsworth, 1966). Qualitative phytochemical analysis of aqueous and methanolic extracts of *G. asiatica* leaf were carried out by Parekh and Chanda (2007) and Savithramma *et al.* (2012) confirms the presence of secondary metabolites such as alkaloids, anthraquinones, emodins, fatty acids, flavonoids, lignins, phenols, cardiac glycosides, reducing sugar, saponins, steroids and tannins. Similarly, Rajesh *et al.* (2013) and Silvia and Satyanarayana (2014) observed the phytoconstituents such as carbohydrates, aminoacids, proteins, fats and oils, alkaloids, proteins, phytosterols, triterpenoids, furan, flavonoids, cardiac glycosides, tannins, steroids, saponins and phenolic compounds in different solvent extracts of *G. asiatica* stem and root.

GC-MS analysis, nine bioactive phytochemical compounds were identified in the methanolic leaf extract of *G. asiatica* by Azhagumurugan and Rajan (2014). Methanol extract of heart wood powder fraction contains crystalline components such as methyl *p*-methoxy-cinnamate, sitosterol, paulownin, gmelinol, methyl-*p*-hydroxy-cinnamate and cycloolivil lignans (Anjaneyulu *et al.*, 1975). The phytoconstituents isolated from the *G. asiatica* roots contain (+) sesamin, (-) pinoresinol, (-) piperitol, sakuranetin, ovalifolin (Satyanarayana *et al.*, 2007; Balijepali *et al.*, 2010) and nitidine (Gakunju *et al.*, 1995). Triglycerides (10.1%) and 2 monoglycerides (1.6%) were recovered by thin layer chromatographic method from *G. asiatica* seeds (Gunstone and Quresh, 1965).

**2.5. Pharmacological Studies**

*Gmelina asiatica* is used in various healthcare systems for the treatment of various disorders including life-threatening diseases. *In vitro* assays and various
animal models are used to validate the traditional claims associated with this plant. Literature review showed that *G. asiatica* possesses potent pharmacological activities (Ikram *et al*., 1987; Ismail *et al*., 1997; Kasivishwanath *et al*., 2005; Merlin *et al*., 2010; Silvia and Satyanaraya, 2014).

2.5.1. Anti-inflammatory activity

Inflammation is a physiologic response to a variety of stimuli such as infections and tissue injury, which is characterized by redness, heat, swelling, and pain. It involves various immune-system cells and numerous mediators. Three distinct phases are observed during inflammations. Release of histamine and serotonin in the first phase, kinin and prostaglandin in the second and third phase’s respectively (Di Rosa, 1974). The ethanolic root extract of *G. asiatica* were effectively suppress the inflammation and specific activity against the inflammatory mediators like histamine and serotonin in albino rats (Merlin *et al*., 2009b).

2.5.2. Antioxidant activity

Antioxidant compounds are responsible for scavenging free radicals, which are produced during normal metabolism or during adverse conditions that can be harmful to biological systems and leading to death of an organism. Merlin and Parthasarathy (2011) studied the *in vivo* antioxidant activity in chloroform and ethanol extracts of aerial parts of *G. asiatica*. Ethanol extract had better antioxidant radical scavenging effect that was enhanced with increasing concentration when compared to ascorbic acid. Silvia and Satyanaraya (2014) studied the methanolic extract of *G. asiatica* stem for *in vitro* antioxidant activity against 1,1-diphenyl-2-picrylhydrazyl
(DPPH), nitric oxide or nitrogen oxide (NO) and the ferric reducing assays using ascorbic acid.

2.5.3. Antihyperglycemic and hypoglycemic activity

Diabetes is characterized by a loss of glucose homeostasis resulting in high blood glucose level, accompanied by an alteration of lipid parameters. Kasivishwanath et al. (2005) investigated the anti-hyperglycemic and hypoglycemic activity of alcoholic extract of *G. asiatica* bark in Tolbutamide induced normal and alloxan-induced diabetic rats.

2.5.4. Hepatoprotective activity and Antipyretic activity

Hepatic damage is always associated with the cellular necrosis, the increase in tissue lipid peroxidation and the depletion in the tissue glutathione (GSH) levels (Oak and Choi, 1998). Hepatic disorder is increasing in number but there is only limited number of drugs available for the treatment. Currently the researchers across the world are focusing their attention to develop an ideal hepatoprotective agent to treat diseases such as liver cirrhosis, hepatitis B and C infections. Merlin and Parthasarathy (2011) reported the hepatoprotective activity in the chloroform and ethanol extracts of *G. asiatica* aerial parts against carbon tetrachloride (CCl₄) which induces the hepatic damage in rats. Hexane and chloroform soluble extracts of *G. asiatica* roots exhibited prominent oral antipyretic activity in rabbits receiving subcutaneous yeast injections (Ikram et al., 1987).

2.5.5. Nematicidal activity

Azhagumurugan and Rajan (2014) reported that the nematicidal activity of *G. asiatica* leaves in acetone extracts were more effective against the root-knot
nematode, *Meloidogyne incognita* egg and larvae. The extract of leaves at different concentrations (5, 10, 15, 20 and 25 ppm), were tested and resulted a reduction in egg hatchability and an increase in nematode larval mortality.

### 2.5.6. Anticancer activity and Antiproliferative activity

Cancer diseases are characterized by a rapid and uncontrolled cellular growth, local tissue invasion and distant metastases (Chabner and Collins, 1990) and the free radicals have been implicated in carcinogenesis (Player, 1982). Breast cancer is the second most prevalent cancer and leading death in women (Parkin *et al.*, 2001). Experiments conducted by Merlin *et al.* (2010) in the petroleum ether, chloroform, ethyl acetate and ethanol extracts of *G. asiatica* showed potent cytotoxicity activity. Among the different extracts evaluated for cytotoxicity, chloroform extract significantly increased the percentage of cells with condensed nuclei when compared to other extracts. The chloroform extract of *G. asiatica* has potential anticancer activity in caspase 3 deficient breast cancer cell line MCF-7. Similar studies carried out by Balijepalli (2010) on the roots of *G. asiatica* showed antiproliferative activity against MCF-7 and MDA-MB-231 human breast cancer cell lines. Ethyl acetate extract of *G. asiatica* roots exhibited antiproliferative activity in a clear dose-dependent manner.

The chloroform extract of aerial parts of *G. asiatica* is effective against Dalton’s Ascitic Lymphoma in Swiss Albino Mice was studied by Merlin and Parthasarathy (2010). In this study Dalton’s Ascitic Lymphoma cells were injected to the mice and treated with *G. asiatica* extract for 2 weeks and five-fluorouracil was used as a reference drug. A significant increase in the life span and a decrease in the
cancer cell number and tumor weight were noted in the tumor-induced mice after treatment with chloroform extract of *G. asiatica* against Dalton’s Ascitic Lymphoma cells.

### 2.5.7. Antimicrobial activity

Microorganisms have developed resistance to many antibiotics and as a result, immense clinical problems in the treatment of infectious disease have been developed. In particular, the antimicrobial activities of extracts and plant essential oil have formed the basis of many alternative medicines and natural therapies (Seth *et al.*, 2012). Shibu and Dhanam (2013) studied the antibacterial efficacy of *G. asiatica* and its antimicrobial action against certain bacteria and fungi. Parekh and Chanda (2007) examined antibacterial activity of aqueous and methanol extract of *G. asiatica* leaf against Gram-positive bacteria *Bacillus cereus* and Gram-negative bacteria *Klebsiella pneumonia* using agar disc diffusion and agar well diffusion assay. Bakkiyaraj and Pandiyaraj (2011) reported the antimicrobial activity of aqueous and methanol extract of *G. asiatica* leaf against bacterial strains such as *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Staphylococcus aureus* using cup-plate agar diffusion method. Merlin *et al.* (2009b) investigated the petroleum ether, chloroform, ethyl acetate and ethanol extract of aerial parts of *G. asiatica* which showed antibacterial activity by disc diffusion method and found that the chloroform extract was found to be more effective and showed antibacterial and antifungal activity against all organisms tested at the concentration of 500 µg/disc.

Experiments conducted by Sudhakar *et al.* (2006) in the ethanol extracts of roots of *G. asiatica* exhibited a broad spectrum of antibacterial activity against the
bacterial strains such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus faecalis*, *Bacillus subtilis*, *Bacillus pumilus* and *Proteus vulgaris* when compared to Amphicillin and did not show any activity against the tested fungal strains *Aspergillus niger*, *Candida albicans* and *Rhizopus oligosporus* using agar well diffusion method. The minimum inhibitory concentrations (MICs) of extracts determined by broth dilution method was ranged from 0.075 to 0.450. The root extract of *G. asiatica* showed highest activity against *Streptococcus faecalis*.

The survey of literatures revealed that *Gmelina asiatica* Linn, is an important medicinal plant reported in the ancient literature of traditional Indian medicine. The review summarizes the important pharmacological studies on *G. asiatica* and emphasizes its phytochemical investigations and isolated principles.