Introduction

Since time immemorial plant based medicines are in use against different disorders as herbal medicines are safer compared to synthetic drugs. The use of herbal medicines has been an ancient practice, and is an important component of traditional system of medicine. Herbal formulations are prepared by practitioners themselves and hence there is a need for documentation and research. Ancient documents and original plant medicines provide proof for the search of plant based drugs by mankind.

Herbal drugs are used nearly by 60 percent of population for the treatment of various disorders. As the modern synthetic drugs are expensive and show increased side effects, the interest in traditional systems of medicine is growing fast.

The recent report of World Health Organization estimates that nearly three fourth of the world population is using plant based medicine for their health care. Presently, modern pharmacology is using many drugs of herbal origin because of their quality and efficacy. Herbal medicine is a major component in all indigenous people's traditional medicine and a common element in ayurvedic, homeopathic, naturopathic, traditional, oriental, and Native American and Indian medicine. About 25% of the synthetic drugs contain at least one active ingredient of plant origin. Therefore, present focus of research to date is in the areas of phytochemistry and pharmacognosy of medicinal plants (Briskin, 2000; Sasidharan et al., 2011).

India is one of the twelve mega-biodiversity countries of the world and one of the richest repositories of traditional information on the medicinal uses of plants with wealthy vegetation and with plants of medicinal importance concentrated in the region of Eastern Himalayas, Western Ghats and Andaman and Nicobar Islands.

Based on various traditional systems of medicine such as Ayurveda, Siddha, Homeopathy and Unani, documentation of medicinal plants information has been done in the course of time. Although there are records of 20,000 medicinal plants being used in traditional medicine, only 9,000–9,500 plants are used in the treatment of various diseases (Ayurveda 2000, Siddha 1300, Unani 1000, Homeopathy 800 and folk 4500) by traditional practitioners. Nearly 70 per cent of the rural population in India depends on the traditional system of medicines. With many forms of alternative
medicines available, the traditional systems have gained importance in the field of medicine during the past decade (Vaidya et al., 2007; Alagesabolopathi, 2012; Pandey et al., 2013).

The medicinal properties of plants are unique to plant species and probably it is due to the effect of the combination of secondary metabolic products present in the plant. The secondary products can have a variety of functions in plants, but their ecological function definitely has some bearing on human health like having anticancerous, antioxidant, antimicrobial, antidepressant, muscle relaxants, anti-inflammatory activities and many more (Briskin, 2000).

The herbal market in India is growing at the rate of 20 and 25 per cent and with an estimated global market of export of herbal products reaching 70 billion dollars; India’s share is about 358 million dollars in 2015-16. Ayurvedic medicine is slowly gaining acceptance as an alternative system of medicine and health care in the world with a market of $3 billion and the World Health Organization (WHO) has projected that the global herbal market will grow to $5 trillion by 2050 (www.thehindu.com/business/markets/Indian-herbal-market). Herbal medicine market in India has been growing fast over the last few years as there is increase in the number of product innovations by ayurvedic product manufacturers and people are exposed to awareness about harmful effects of allopathic medicines. It is estimated that ayurvedic products market may reach a cumulative revenue share of more than 70% in future (www.techresearch.com).

Phytochemical research based on ethnopharmacology is considered as an effective approach in drug discovery and all the extraction, purification and separation processes are performed to ascertain the pharmacological activity of the phytochemical (Fig.1). The ethnopharmacological research relies on the traditional uses of the plant parts in the treatment of various diseases and this knowledge can be retrieved from ancient texts like Chinese Materia Medica and Indian Ayurvedic Charaka Samhita. Even ethnobotanical survey is the best method of collecting information about medicinal plants (Joy et al., 2001; Brusotti et al., 2013).

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The family Lauraceae

The family Lauraceae commonly called Laurel family is included in the order Laurales. The family includes about 55 genera with 3000 species distributed worldwide, mostly from warm temperate or tropical regions, especially Southeast Asia and South America and Brazil (Mabberley, 1997 and 2008; Bhuniya et al., 2010a).

Lauraceae comprises of aromatic trees and shrubs or leafless twining parasites usually evergreen and form important components of tropical forests called laurel forests. The leaves are alternate, rarely opposite or subopposite, entire without stipules. The flowers are regular, small, hermaphrodite or dioecious produced in axillary or lateral cymose clusters, racemes or panicles, sometimes in umbellules. The

Fig. 1 Summary of the general approaches in extraction, isolation and characterization of bioactive compounds from plant extracts (Sasidharan et al., 2011)
bracts are deciduous, often involucrate or sometimes absent. The perianth is usually inferior with short tube but enlarged in fruit. Perianth lobes are usually 6, rarely 2 or 4 and sometimes more with equal or unequal, deciduous or persistent in fruit. Stamens occur usually in multiple of the perianth-lobes, in 2-4 series on the tube with filaments having a pair of glands attached or alongside with 2-4 celled erect anthers and 4th row of stamens reduced to glands. Stamens are reduced to staminodes in female flowers which are usually linear or clavate. Ovary is one celled, anatropous, pendulous and sessile at the base of the perianth tube. Fruit is a dry or fleshy berry or drupe, naked or enclosed in the perianth-tube or supported by the more or less enlarged perianth –tube and lobes, with frequently thickened pedicel. Seeds are exalbuminous, pendulous with membranous testa, with plano-convex, fleshy cotyledons and minute radical (Gamble, 1957).

**Botanical description of Litsea species**

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**Habit:** *Litsea floribunda* (Synonym = *Cylcodaphne floribunda*) Bl. Gamble is a tree species endemic to India commonly known as Sutnaga in Kannada. It is a large or medium sized evergreen tree (12-20 m tall) with alternate, elliptic or obovate-oblong, acute or acuminate, tomentose leaves. Inflorescence is umbel, arranged in racemes each group with 5-6 flowers. Fruit is a berry which is oblong, seated on the turbinate perianth - tube with thick pedicel.

**Distribution:** The genus *Litsea* is distributed in Western Ghats, in all districts, at 2000-6000 ft., in evergreen forests; Bababudan Hills and hills of Western Mysore and Coimbatore on Nilgiris chiefly on the eastern slopes up to Coonoor and Kotagiri (Bhuniya *et al.*, 2010a; Gamble and Fisher, 2011).
*Litsea* genus includes evergreen, deciduous trees or shrubs with smooth bark. The leaves are simple, alternate or opposite and penni-nerved. The flowers are unisexual on dioecious trees in umbellules of many flowers usually 4-6 sometimes up to 15, supported by 4-6 or more concave involucral bracts. The umbellules are sessile or peduncled in axillary or lateral clusters or in racemes and rarely solitary. Perianth-tube in male flowers is small or even absent but in female flowers it is funnel-shaped. Perianth lobes are equal or unequal, usually six, sometimes more and caducous. Stamens in male flowers range from 9 or 12, arranged in 3-4 whorls, usually inner whors glandular and four celled introrse anthers. Stamens are reduced to staminodes in female flowers. Ovary is absent or rudimentary enclosed in the perianth-tube or free with thick and curved style, dilated and irregularly lobed stigma. Fruit is a globose ovoid ellipsoid or oblong one seeded berry, seated on the enlarged perianth-tube with more or less thickened pedicel and succulent pericarp. Seed is with thin testa and fleshy cotyledons.

**Phytochemistry**

Plants are rich in various phytochemical molecules such as vitamins, terpenoids, phenolic acids, tannins, flavonoids, quinones, alkaloids, betalains, and many other secondary metabolites, which exhibit different biological activities (Zheng and Wang, 2001; Cai et al., 2004). Studies have shown that many of the phytochemicals are antioxidant compounds and possess anti-inflammatory, antiatherosclerotic, antitumor, antimutagenic, anticarcinogenic, antibacterial, and antiviral activities (Rice-Evans et al., 1995).

Biochemical reactions necessary to maintain life in organisms together constitute primary metabolism and the products formed by primary metabolism are called primary metabolites. The metabolic reactions that are not essential to growth and to maintain life of the organism is known as secondary metabolism and the products formed by secondary metabolism are called secondary metabolites, which include organic compounds like alkaloids, cyanogenic glycosides, glucosinolates, flavonoids, saponins, steroids and terpenoids and are derived by unique biosynthetic pathways from primary metabolites and intermediates and have a wide range of chemical structures and biological activities. The physiological action on human body...
can be determined by these phytochemicals with proven pharmacological action (Maobe et al., 2012).

The term alkaloid is derived from the word ‘alkaline’, which means a water soluble base. Alkaloids are nitrogen containing large group of naturally occurring compounds with nitrogen being a part of heterocyclic system. Alkaloids are produced by plants for defence, herbivory and to protect from pathogens and pests. Nearly 10,000 alkaloids are produced by plants and many of them are toxic to human beings. As they play an important role in the physiology of man, they are widely used in the treatment of several human disorders. They are reported to be having antimicrobial, antidiarrhoecal and antihelminthic activities (Mute, 2009; Sharma et al., 2010).

Cardiac glycosides are a group of naturally derived sugars with non-carbohydrate moiety that bind to and inhibit Na\(^+\)K\(^+\)-ATPase used for the treatment of diarrhea, heart failure, atrial arrhythmia and in cancer (Prassas and Diamandis, 2008; Maniyar et al., 2010). Cardiac glycosides are proved to be cytotoxic against cell lines like HT29, HCT116 and CC2 colon cancer cells. It also reported to act against melanoma, breast, lung, prostate, pancreatic, leukemia and renal adenocarcinoma (Khawlhring et al., 2015).

The largest group of plant secondary metabolites, with marked antioxidant properties are flavonoids. More than 8000 polyphenolic compounds (flavonoids) have been isolated from various vascular plants having the core structure: 2-phenylbenzopyranone, in which the three-carbon bridge between the phenyl groups is commonly cyclised with oxygen synthesized by phenylpropanoid pathway. Flavonoids are grouped into three classes such as flavones, flavonols and flavanones. It is reported that flavonoids have hydroxyl functional group conferring antioxidant property and other activities like antimicrobial, hepatoprotective, antibacterial, anti-inflammatory, anticancer, vasodilating and antiviral activities, and anti-feeding activities. However, much of the work is done on the antioxidant activity of flavonoids, which is due to their ability to reduce free radical formation and to scavenge free radicals (Pietta, 2000; Corradini et al., 2011; Kumar et al., 2013).

Phenolics are secondary metabolites that help in mineral uptake, protein synthesis, enzyme activity, photosynthesis and allelopathy. Amino acids
phenylalanine or tyrosine get deaminated to cinnamic acid, and synthesize phenolic compounds by phenylpropanoid pathway. Biosynthesis, in this pathway, produces the large variety of Variuos phenolic compounds such as cinnamic acids, benzoic acids, flavonoids, proanthocyanidins, coumarins, lignans and lignins are formed during the biosynthesis of phenols by this pathway. It is reported that phenolics function as antioxidants by donating hydrogen because of their functional hydroxyl group and have biological activities like antimicrobial, anthelmintic, anticancer, antiallergic, anti-inflammatory and antidiarrhoeal (Cowan, 1999; Pereira et al., 2009; Saeed et al., 2012).

Saponins are steroid or triterpenoid glycosides having high molecular weight compounds that are soluble in water and alcohol. Saponins are reported to be present in 500 genera of plants as secondary metabolites with hypocholesterolaemic, anticarcinogenic, antifungal, antiviral, antioxidant, immunostimulant, antihepatotoxic, antibacterial, antidiarrheal, anthelmintic, antiulcerogenic, antioxytocic, antihypoglycemic, and antimolluscicidal activities. They derive their name from their ability to form stable, soap-like foams in aqueous solutions. They are biologically synthesized through cytosolic mevalonate pathway or through isoprenoid pathway (Francis et al., 2002; Wang et al., 2010b; Negi et al., 2013).

Term ‘tannin’ is derived from a French word ‘tanin’ (which means tanning substance). Tannins are high molecular weight polymeric phenols produced as secondary metabolites of higher plants. Tannins exhibit antiviral, antibacterial properties, anthelmintic, antidiarrheal, antitumour activities and are also reported to be effective antioxidants (Hagerman et al., 1998; Khanbabaee and Ree, 2001).

The name ‘terpene’, is derived from the word turpentine, a volatile product isolated from pine trees. Terpenoids are natural hydrocarbon secondary metabolites built up from C5 isoprene units found in higher plants having the general formula, \((\text{C}_5\text{H}_8)_n\). Terpenoids are synthesized for defence or as signals against herbivory and other enemies and exhibit biological activities like antimicrobial, anti-hypertensive activity, antimicrobial, antidiarrheal and insecticidal properties (Martin-Smith and Khatoon, 1963; Yadav et al., 2014).
Anthraquinones are cyclic compounds derived from anthracene or phthalic anhydride. Anthraquinones (9,10-dioxyanthracenes) are a class of naturally occurring aromatic organic compounds found in fungi, lichens, flowering plants and some insects which form basic skeleton for their pigments used as colorants (Malik and Muller, 2017). It is reported that they have laxative, antimicrobial, antifeedant properties and also in treating arthritis properties. Anthraquinones are used to relieve constipation as they stimulate laxative effect of large intestine (www.thenaturopathicherbalist.com/plant-constituents/anthraquinones).

Phlobatannins (The term ‘phlobaphen’ comes from the Greek word ‘phloios’ meaning bark and ‘baphe’ meaning dye) are coloured phenolic compounds soluble both in alcohol and water. Phlobaphene is formed under the action of acids or heating of condensed tannins. They are reported to possess wound healing, anti-inflammatory, antioxidant and analgesic activities (Kagbo and Ejebe, 2009; Khawlhring et al., 2015).

Reducing sugar may be a monosaccharide or disaccharide that can donate electrons to other molecules and can therefore act as reducing agent. Free ketone (-CO-) or aldehyde (-CHO) group makes sugars reducing. Sugars act as signal molecules interacting with the hormonal signalling network regulating the plant immune system. In fungal pathogen-plant systems, high concentration of sugars in plant tissues increases plant resistance. Sugars increase oxidation stress at early stage of infection, stimulate synthesis of flavonoids and induce certain pathogen related proteins (Morkunas and Ratajezak, 2014). Sugars function both as nutrients and as signalling molecules in plant life. The interaction of sugars and phenolic compounds form an integrated redox system and help in quenching free radicals in tissues with high soluble sugar concentration. Reducing sugars act as regulatory metabolite modulating gene expression in yeast, animals and plants (Bolouri-Moghaddan et al., 2010).

**Biological Activities**

**Antioxidant activity**

The interest in medicinal plants is increasing in developing countries because of their use in folk medicine as well as their prophylactic properties because of the
opinion that plant derived drugs are safer than synthetic drugs. Antioxidants help in maintaining human health as they are not only capable of preventing the diseases but also used in the treatment of diseases. Antioxidants fight against free radicals and protect us either by scavenging or by protecting antioxidant defense mechanism. The Indian medicinal plants provide a rich source of antioxidants that are known to prevent/delay diseased state (Vaidya et al., 2007, Saeed et al., 2012).

Free radicals are an integral part of physiology in the form of reactive oxygen and nitrogen species. Free radical is a highly reactive molecule that can bind to and destroy components of our cells. Free radical damage or oxidative damage is responsible for many diseases mainly cancers and heart diseases. Oxidation occurring under the influence of atmospheric oxygen or reactive oxygen species (ROS) is either delayed or inhibited by antioxidants. Antioxidants help in protecting cells from free radical damage i.e. they are involved in the defense mechanism of the organism against the pathologies associated to the attack of free radicals (Pisoschi and Negulescu, 2011). Toxic effects of free radicals results in tissue damage including liver and pathogenesis of pathological conditions like ageing, arthritis, anemia, neurodegenerative disorders, ischemia, Parkinson’s disease, Alzheimer’s disease, dementia, inflammation etc (Qureshi et al., 2010).

In the biological system, oxygen gives rise to a large number of free radicals and other reactive species collectively known as ROS. The formation of ROS representing both free radical and non-free radical species, can seriously affect our health with their deleterious effects such as atherosclerosis, neurodegenerative diseases, cancer and many more (Jadhav and Bhutani, 2002; Gulein et al., 2002). The generation of ROS is effectively checked in a healthy man by the various levels of inherent antioxidant defense mechanisms such as intracellular antioxidant enzymes and also the food supplements. The antioxidant defense mechanism of organisms reduces the formation of free radicals and develops a system to produce antioxidants that can scavenge free radicals. If the free radical production rate exceeds the capacity of the antioxidant defense mechanisms, substantial tissue injury results (Rahman and Moon, 2007). Therefore, antioxidants, from plant sources, herbal drugs derived from them, and the role of nutrition in prevention of diseases is gaining tremendous interest in the research field of phytochemistry and pharmacognosy.
**Hepatoprotective activity**

Hepatic disease is a condition that affects the cells, tissues, structure and functions of liver which accounts for more than 20,000 deaths every year in all age groups (Balne *et al.*, 2013).

Liver is the second largest and a complex gland of human body weighing about 1.4 kg in adults that plays important role in regulating homeostasis, detoxification, in the metabolism of endogenous and exogenous compounds and in other metabolic activities of the body. It is reported that prolonged drug therapy, xenobiotics, malnutrition, alcoholism and toxic chemicals can cause liver damage due to exposure to free radicals and liver diseases are still a major global health problem (Alqasoumi, 2014). Heptotoxicity results in serious debilities like metabolic disorder to mortality and it accounts for one in 600 to one in 3500 cases (Ibrahim *et al.*, 2011; Kanchana and Sadiq, 2011).

Hepatotoxicity is associated with impaired liver function caused by exposure to a drug or any other non-infectious agent. Liver is most susceptible to the toxic effects of chemicals like acetaminophen, galactosamine, thioacetamide and carbon tetrachloride. The depletion of glutathione resulting in the accumulation of its toxic metabolic NAPQI causes hepatic dysfunction. N-acetylcysteine and transplantation are the only treatments for hepatotoxicity specifically paracetamol toxicity (Nayak *et al.*, 2011; Eidi *et al.*, 2012). Synthetic or conventional drugs used for the treatment of liver diseases are insufficient and have number of adverse effects. African, Chinese and Indian ethnobotanical study reported that in traditional medicine, number of medicinal plants are used for the treatment of liver diseases like jaundice, hepatitis and gallstones.

Many medicinal plants and herbal formulations are used for the treatment of liver diseases. As many as 170 phytoconstituents are isolated from 110 plants having hepatoprotective property, out of which 93 plants of Indian origin are used in combination with other plants in different formulations and these traditional medicines need pharmacological evaluation. Therefore, there is a necessity of potent hepatoprotective drugs in modern medical practice with no or minimum side effects and hence there is focus on systematic research to validate scientific basis for
traditional hepatoprotective medicines (Girish et al., 2009; Kanaujia et al., 2011; Lohan and Das, 2011).

Reactive free radicals cause liver cell damage through mechanism of covalent bond and lipid peroxidation. The use of medicinal plants rich in antioxidants is an effective approach for hepatic damages. Therefore search for novel natural antioxidant of plant origin has increased as it is reported that foods rich in antioxidants cure liver damage (Ashoush et al., 2012).

**Nootropic activity**

In the Indian system of medicine, there are more than 100 plants that are being used for the therapy of central nervous system (CNS) disorders. Thus India, a country with different systems of medicines, offers an unfettered choice for the new clinical effects of traditionally used medicinal plants.

The process of memory consists of registration, consolidation and retrieval. Registration is the process of perceiving the sensory information and ability to set on the perceived information that involves an electrical or electrochemical change in brain activity and is referred as ‘short term memory’. Consolidation is the process of conversion of registered information to a ‘long term memory’ trace, involving physiochemical changes in neural network. Retrieval is the process of making the stored information accessible. Any drug, supplement, nutraceutical or functional food that is said to improve mental functions such as cognition, memory, intelligence, motivation, attention and concentration is called nootropic. Nootropics can alter the supply of neurotransmitters, enzymes, ensure oxygen supply to brain and also stimulate the nerve growth (Gindi et al., 2011).

The brain possesses considerable potential oxidative capacity but a limited ability to combat oxidative stress. Oxidative stress leads to neuronal cell injury in various pathological states of the brain, including neurodegenerative disorders. The brain accounting for 2% of the body weight consumes nearly 20% of the oxygen supplied to the body and because of its high oxygen demand, becomes most susceptible to oxidative damage. Phytochemicals especially novel antioxidants offer an effective and safe means of improving body's defense against free radicals and and
also in treating cognitive disorders and thus are gaining importance in modern as well as in traditional system of medicine (Biradar and Joshi, 2011). Nerve cells do possess their own defense mechanism to fight against oxidative stress using some limited resources of available antioxidant enzymes in the biological system. As the focus of medicine shifts from treatment of manifest disease to prevention, herbal medicine is considered as a better choice.

Age, stress and emotions are the conditions that lead to loss of memory as in Alzheimer’s disease. Natural ageing is one of the factors which deteriorate memory in humans. However, free radicals, lead to oxidative damage to the brain as the brain is highly-vulnerable to oxidative stress due to high rate of oxygen free radical generation which may lead to development of dementia or Alzheimer’s disease. So reducing oxidative stress by anti-oxidants, protecting brain inflammatory lesions using anti-inflammatory drugs and facilitation of brain cholinergic neurotransmission with anti-cholinesterase are some positive approaches to manage memory loss (Joshi and Parle, 2006c).

**Antidepressant activity**

Depression and anxiety are the two common psychiatric disorders known and many suffer from these at some time during their life and depression is the major mental disease ranked as the fourth leading cause of disability. According to World Health Organization report (2001), depression may become the second leading cause of premature death world wide by 2020 and 21% of world population suffers from this disease (Onasanwa et al., 2010; Mannan et al., 2015). Depression was considered to be an old-age disease but recent reports show that even the younger population is affected from depression. Depression is more common in patients with dementia and poses a risk factor for the development of dementia. About 30 % of the patients suffering from depression do not respond to the modern drug therapy and the remaining fail to recover completely and moreover antidepressant drugs have a plethora of side effects and drug-drug/drug-food interactions (Kulkarni et al., 2009).

Life time risk of depression range from 5% to 12 % in men and 12% to 15% in women and it is estimated that 15% of patients suffering from depression commit
suicide. Out of 8% world population, 15% of adults in developing countries suffer from mental health problems (Sanmukhani et al., 2011; Sutar et al., 2014).

Several antidepressant drugs like tricyclic antidepressants, monoamine oxidase inhibitors and selective serotonin reuptake inhibitors are used in the treatment of depression but they have serious side effects such as insomnia, anxiety, weight gain etc. Therefore, search for new antidepressant drug from natural source i.e. the plants with minimum side effects and a wider safety margin is on and ayurveda has become the drug of choice with investigations on for the search of novel drug with better tolerated molecules from plant sources. Current researchers are seeking alternatives to conventional antidepressants with improved efficacy and phytochemicals provide an extensive research area in antidepressant therapy. It is reported that secondary metabolites like polyphenols, alkaloids, terpenes, terpenoids, saponins, amines and carbohydrate have antidepressant activity (Bahramsoltani et al., 2015).

**Anxiolytic activity**

Anxiety is defined as “a state of intense apprehension, uncertainty, and fear resulting from the anticipation of a threatening event or situation, often to a degree that normal physical and psychological functioning is disrupted”. Excessive anxiousness is not only a disorder but also decreases the quality of life inducing psychosomatic diseases like Agarophobia, Specific phobia, Social Phobia and Separation anxiety disorder. Anxiety not only affects physical health and longevity but it is also accompanied by nervous behavior and somatic complaints. A report by The American Psychiatric Association (APA) has reported that anxiety disorders share features of fear and anxiety. Anxiolytic drugs belong to the benzodiazepines groups. The clinical uses of benzodiazepines have side effects like psychomotor impairment, sedation, myorelaxation, ataxia and amnesia. Numerous traditionally used plants exhibit pharmacological properties with great potential for therapeutic applications in the treatment of central nervous system disorders, such as anxiety disorders. Hence there is a search for new herbal drug from plant source with greater efficacy, lesser undesirable effects with minimum or no tolerance and dependence (Doukkali et al., 2015). Plant secondary metabolites are employed in the treatment of psychotic disorders especially for anxiety in traditional medicine practice, most of which directly affect the central nervous system, serotonin, gamma-Aminobutyric
acid (GABA) and Benzodiazepine neurotransmitters activities (Wolfman et al., 1994; Ayoka et al., 2005).

Anxiety-related disorders such as generalized anxiety, panic, obsessive-compulsive disorder, phobias or post-traumatic stress are the most common mental illness and a major cause of disability in the world. Mental disorders have been found to be common, with over a third of people in most countries reporting them with sufficient criteria to be diagnosed at some point in their life (Barua et al., 2012).

Although benzodiazepines are among the first line of anxiolytic drugs with well-known benefits, their side effects are prominent, including sedation, muscle relaxation, amnesia and physical dependence. As 43% of patients with anxiety disorders are already using alternative treatment, it is essential to look for anxiolytic drugs of plant origin with no or minimum side effects.

**Characterization of compounds**

Plant extracts with pure compounds or as standardized extracts provides ample opportunities for drug discovery. Since the plant extracts occur as a combination of different types of phytochemicals with different polarities, their separation, characterization and isolation is a big challenge. Number of separation techniques are used in the isolation of pure bioactive compounds such as Thin layer chromatography (TLC), Column chromatography, Flash chromatography, Sephadex chromatography and High performance liquid chromatography (HPLC). Later, the isolated compounds are used for the determination of structure and finding their biological activities. In addition to the above mentioned chromatography techniques, non-chromatographic techniques such as immunoassay, phytochemical screening assay, Fourier transformed infrared spectroscopy (FTIR) are also used for the identification of bioactive compounds (Sasidharan et al., 2011).

**Research on the genus Litsea**

*Litsea* is a genus of family Lauraceae comprising about 300 species in the world of which 45 are found in India and 18 of them are endemic to India (Bhuniya et al., 2010c). Genus *Litsea* is mainly found distributed in north-eastern states (Arunachal Pradesh, Meghalaya, Sikkim) and Western Ghats. Out of 18, 12 are found in Karnataka with highest species diversity of *L. floribunda* in Western Ghats and
Madikeri having the most abundant distribution of the selected species (Saldanha 1996; Srinivas and Krishnamurty, 2016a).

The genus *Litsea* is rich in aporphine alkaloids, butanolides, sesquiterpenes, flavonoids, terpenoids and fatty acids (Gottlieb, 1972; Agarwal *et al.* 2011). Valene-1 was isolated from *L. excelsa* (Lee *et al.*, 1993) and sesquiterpenes namely isocurcumol and diepoxygermacranolida were isolated from *L. cassiaeifolia* (Hakim *et al.*, 1993) and the structure was determined by X-ray crystallographic methods. Fruits, flowers and bark of *L. cubeba* and *L. glutinosa* are rich in essential oils (Choudhary *et al.*, 1996 and 1997; Wang *et al.*, 1999; Amer and Mehlhorn, 2006). Bark of *L. akoensis* is rich in butanolide, coumarin and syringaldehyde (Tsai *et al.*, 2000). One lignin and five butanolides were isolated from the leaves of *L. acutivena* and their structures were elucidated from spectral analysis (Cheng *et al.*, 2001). Sesquiterpenoids were isolated from the leaves of *L. verticillata* (Zhang *et al.*, 2003). Two lactones, litsealactone A and litsealactone B were isolated from the leaves of *L. japonica* which significantly inhibited complement activity in an *in vitro* anti-complement assay (Min *et al.*, 2003). Flavonoids are reported from the leaves of *L. coreana* and *L. japonica* (Lee *et al.*, 2005). A new long chain linear diol, namely oblongifolinol was isolated from the bark of *L. rotundifolia* (Zhao *et al.*, 2006). Four phenolic compounds were isolated from the bark extracts of *L. monopetala*, with strong antioxidant activity (Arfan, 2006). Extracts from *L. akoensis* exhibited significant anti-inflammatory activity, inhibiting the nitric oxide production in the LPS induced microphage assay extracts (Lin *et al.*, 2007). Genus *Litsea* is rich in fatty lauric acid with traces of myristic acid, stearic acid, oleic acide and linoleic acid (Kotoky *et al.*, 2007). A butanolide and a lactone from the leaves of *L. acutivena* (Tsai *et al.*, 2007) and their structures were elucidated by spectral analysis. Tanaka *et al.* (2009) isolated an amide from the leaves and twigs of *L. auriculata* and its structure was elucidated by spectroscopic analysis. Wang *et al.* (2009) isolated a novel compound aryltetralone lignan from the leaves and twigs of *L. pedunculata*. Nine terpenoids were isolated from the essential oils of *Litsea* species from Mexican Bays (Jimenez-Perez *et al.*, 2011). Essential oils of *L. cubeba* were obtained by hydro distillation with citral being the abundant component (Si *et al.*, 2012). Butanolides were isolated from *L. glutinosa* which were characterized and structurally elucidated based on the spectral studies (Agarwal *et al.*, 2013). Aporphine alkaloids were
isolated from the crude extract of *L. cubeba* using high-speed counter-current chromatography and the chemical structures were confirmed using electrospray ionization-mass spectrometry (Sun et al., 2015). *Litsea* exhibits pharmacological activities like anticancer, anti-inflammatory, antimicrobial, antioxidant, antidiabetic, anti-HIV, insecticidal etc (Wang et al., 2016). Recently, polyphenols, essential oils and flavonoids were detected in *L. coreana* that are responsible for biological activities like hepatoprotective, hypoglycaemia, anti-inflammation, antioxidant and antibacterial activities of the plant (Jia et al., 2017).

Till date, no data is currently available on the phytochemical profile, antioxidant and other biological activities of *L. floribunda*. The species selected in the current investigation is the first report on the phytochemicals, antioxidant and hepatoprotective potential, nootropic, antidepressant and anxiolytic activities and characterization of compounds from *L. floribunda*. Therefore, based on the lacunae, the present study outlines the following objectives.

1. Evaluation of phytochemicals and antioxidant activity in the leaf and stem bark extracts of *L. floribunda*
2. *In vivo* antidepressant and anxiolytic potentials of *L. floribunda* extracts
3. Evaluation of nootropic and brain antioxidant activity of *L. floribunda* extracts
4. Characterization of compounds from leaf and stem bark extracts of *L. floribunda* extracts