CHAPTER 2

REVIEW OF LITERATURE

*Cassia* is a genus belonging to the family Leguminosae and Sub family Caesalpiniaceae. There are approximately 800 *Cassia* species. The genus was considered a waste basket genus for long time, used to classify plants that did not fit anywhere. Many species of *Senna* were previously included in *Cassia*. *Cassia* is also the English common name for the genus *Cinnamomum* of family Lauraceae. *Cassia* and *Senna* are both traditionally used in traditional medicine. *Cassia* genus is made from *Senna obtusifolia*, a species formerly included in genus *Cassia*. Genus *Cassia* shows species range from under shrubs to trees. They are marked as ornamental and grown as hedge plants or in garden for their bright yellow shower of flowers. The leaves and pulp of fruits are used as a laxative and purgative. The bark of *Cassia auriculata* is employed for tanning. The flowers of *Cassia siamea* are used as vegetable in Thai cuisine.

Among the *Cassia* species around 45 are found in India have been introduced for medicinal purposes and to provide tanning material. They are also a part of traditional system of medicine and have been included in Indian, British and many other pharmacopoeias of the world.
Many reports have shown that some Cassia species contain antimicrobial substances, particularly Cassia alata [Fuzellier et al., 1982; Caceres et al., 1991; Crockett et al., 1992; Caceres et al., 1993; Ibrahim and Osman, 1995; Agarkar and Jadge, 1999; Khan et al., 2001; Villasenor et al., 2002; Somchit et al., 2003]. Many Cassia species are grown as ornamental plants throughout Thailand [Gritsanapan and Nualkaew, 2001]. C. alata, C. fistula, and C. tora are recommended for primary health care in Thailand to treat ringworm and skin diseases [Farnsworth and Wagner, 1992].

The genus Cassia comprises of 750-800 tropical and sub-tropical species. They are mostly trees with typical leaf form bipinnate with numerous leaflets and small scaly strip. The plant Cassia alata is an ornamental shrub, which grows all year round, and flowers during November to January. It grows well in the forest areas of West Africa. In Tanzania, Mustafa et al., [1990] conducted an investigation on the gel made from root bark of Cassia alata which is used in local herbal medicine against convulsions, gonorrhea, bilhazia, heart-burn, stomachache, constipation, wounds and snake bites. In the light of all these, the bark extracts of “Ganna Ganna” tree (Senna sp.) so called in the kpelle language in Liberia folk medicine was investigated and the effect of some bark extracts in vivo and in vitro on microfilaria were examined and found effective [Kiiani, 2006]. Moreover, the leaves have also been reported to be efficacious in the treatment of ringworm and eczema. The bark was found to be useful for various skin diseases.
**Cassia occidentalis:**

*Cassia occidentalis* Linn. is a common weed scattered from foothills of Himalayas to West Bengal, South India, Burma and Sri Lanka. The plant is a diffuse (usually annual) under shrub with loosely spreading branches 60-150 cm long, found throughout India up to an altitude of 1500 m. [The wealth of India 1998]. Different parts of this plant have been reported to possess anti-inflammatory, hepatoprotective tonic, [Saraf, 1994] antibacterial, [Samy and Ignacimuthu, 2000] and antiplasmodial activities [Tona *et al.*, 2004].

The whole plant of *C. occidentalis* has shown the presence of anthraquinones, polyphenolic compounds like flavanoids, tannin etc. Tannins and their related compounds are well known to have antioxidant activity and also inhibit histamine release induced by superoxides in rat mast cells [Sreejith *et al.*, 2010].

The qualitative analyses of leaf extracts with organic solvents confirmed the presence of alkaloid, tannin, glycoside and saponin as reported by Muyibi *et al.* [2000] that the aqueous extract of *Cassia occidentalis* contained tannins, anthraquinone, sterol, cardiac glycoside, saponin and alkaloid. The flower extract of *Cassia occidentalis* showed antimicrobial activity [Damiyan, 2011]. The leaf extract of *Cassia occidentalis* showed good antibacterial activity [Sadiq *et al.*, 2012].
The antimicrobial activity exhibited by hexane, chloroform, methanol and aqueous leaf extracts of *Cassia occidentalis* on *E. coli* [Gasquet, 1993; Percez, 1994; Saraf, 1994] exhibited *in-vitro* antibacterial, antimalarial and antihepatotoxic properties. The plant may be used for the treatment of *coli bacillosis* caused by *E. coli* which occurs in all species of newborn farm animals as major cause of death and economic loss in this age group [Radostits *et al.*, 2000]. Leeflang [1993] had earlier observed that indigenous knowledge and practices will be useful in the promotion of animal health and meat production in Nigeria. Furthermore, Tamboura *et al.* [2000] reported that ethno veterinary medical health care will be the only alternative to western veterinary therapy.

The aqueous extract of *C. occidentalis* was tested for antidiabetic activity and the study [Laxmi Verma *et al.*, 2010] proved that there was a significant reduction in fasting blood glucose levels in the normal and alloxan-induced diabetic rats. They also tested for other extracts that include petroleum ether and chloroform extracts and concluded that they are effective. Specific variations were seen in serum lipid profiles (cholesterol and triglyceride), serum protein, and changes in body weight by aqueous extract treated-diabetic animals, when compared with the diabetic control and normal animals. Histopathological studies also revealed that pancreas of the animals showed regeneration by the treatment with leaf extract which were necrosed earlier.
C. occidentalis exhibited significant antihyperglycemic activities in normal and alloxan-induced diabetic rats. The aqueous extract of C. occidentalis showed improvement in lipid profile as well as regeneration of β-cells of pancreas [Laxmi verma et al., 2011].

**Cassia auriculata:**

*Cassia auriculata* Linn. is a common plant of wasteland in Asia that flower throughout the year and also survives under adverse ecological conditions. In Indian ethnomedicine, this plant is commonly known as ‘Avartaki’, ‘Avaram’, ‘Taravada’, ‘Aval’, ‘Avariike’ and ‘Hemapushpam’ [Surana et al., 2007]. The plant has been widely used in traditional system of medicine as a cure for rheumatism [Kirtikar and Basi, 2006] and conjunctivitis [Pari and Latha, 2002b]. In addition, the plant has been reported to possess a number of therapeutic activities to manage diseases like leprosy, gout, cough and asthma [Asolkar et al., 1965]. It is also reported to have antipyretic activity and used in the treatment of ulcer and skin diseases [Vedavathy and Rao, 1991]. Although these plants possess so many medicinal aspects, it is mainly used as a source for dyes in South India [Siva and Krishnamurthy, 2005]. The various parts of the plant were reported to exert a beneficial effect to alleviate the symptoms of diabetes [Pari and Latha, 2002b; Surana et al., 2007, 2008] and serves as a important component of several
antidiabetic polyherbal formulations [Uma Devi and Udupa, 2005; Babu et al., 2004].

*Cassia auriculata* L. has been widely used in traditional medicine as a cure for rheumatism, conjunctivitis and diabetes [Joshi, 2000]. In addition, *Cassia auriculata* has been widely used in Ayurvedic medicine as ‘Avarai Panchaga Choornam’ and the main constituent of Kalpa herbal tea, has come under extensive study in the light of its antidiabetic effects. Pari and Latha [2002b] reported the antiperoxidative effect of *C. auriculata* flowers in streptozotocin diabetic rats.

The *C. auriculata* leaves constituted polysaccharides, flavanoids, anthracene derivatives and dimeric procyanidins [Nageswara Rao et al., 2000]. The plant was reported with spectral elucidation of di-(2-ethyl) hexyl phthalate. The flowers were reported to have anti-oxidant activity. The plant *C. auriculata* constitutes pyrrolozidine alkaloids, roots constitutes flavones glycoside, bark includes tannins and flowers β- sitosterol and seed with fatty oils consisting of palmitic, oleic and linoleic acids. The plant is traditionally used to treat fever, leprosy, eye injuries, whooping cough, chest disease, diabetes, conjuctivities, skin diseases and jaundice [Nageswara Rao et al., 2000]. Thereby, the all specific pharmacological active plant was intended to evaluate a detailed study on anti-oxidant and antimicrobial activity. The methanolic extract of *C.auriculata* leaves
showed significant quantity of total antioxidant, total phenol and total flavanoids [Jeeva Jothi, et al., 2011].

Girish and Sathish, [2008] concluded that, *Salmonella typhi* and *Pseudomonas aeruginosa* is less sensitive for all tested plant extracts, where as other Gram-negative bacteria showed some degree of susceptible for extract of all selected plants. However, *Cassia auriculata* and *Cassia lantana* showed lesser zone of inhibition in all tested pathogenic bacteria, when compared to the zones of inhibition of other plant extracts.

Chitravadivu, et al., [2009] reported the antimicrobial compounds found was anthroquinone, alkaloids, catachols, flavonoids, phenolic compounds, saponins, steroids, tannins and triterpenoids, whose presence may be attributed to the medicinal properties of plants. In their study, *Escherichia coli* was found to be sensitive to *Cassia auriculata* and *Eclipta alba* leaf extract. Ethanolic leaf extracts exhibit more inhibition than *Acalypha indica* and *Phyllanthus niruri*. Aqueous leaf extract of *Acalypha indica* did not respond for its antibacterial activity against *Bacillus subtilis*. Aqueous root extract of *Eclipta alba* exhibit more relative magnitude of inhibition value compared to the other three plants studied.
**Cassia alata:**

*Cassia alata* Linn is locally used in Nigeria in the treatment of several infections which include ringworm, parasitic skin disease [Dalziel, 1965; Palanichamy and Nagarajan, 1990]. *Cassia alata* is also credited for treatment of haemorrhoids, constipation, inguinal hernia, intestinal parasite, bleennorrhagia, syphilis and diabetes [Abo et al., 1998; Adjanhourn et al., 1991]. The leaf of this plant was reported to be useful in treating convulsion, heart failure, abnormal pain, oedema and as purgative but it was especially useful in treating dermatophytosis [Ogunti and Elujobi, 1993].

Ibrahim and Osman [1995] reported that ethanolic extracts of *C. alata* plant showed high antifungal activity against dermatophytic fungal strains such as *Trichophyton mentagrophyte var. interaligitale* and *var. Mentagrophytes*, *Trichophyton rubrum* and *Microsporum gypseum*. Several studies have documented the basis of the leaf of *C.alata* in herbal medicine. Adebayo et al. [1999] documented that Minimum Inhibitory Concentration (MIC) of the plant extract was low on all fungal agents except *Aspergillus niger*.

Makinde et al., [2007] observed that the antimicrobial activity of *C.alata* is associated with the presence of component such as phenols, tannins, saponins, alkaloids, steroids, flavonoids and carbohydrates. The ethanolic and methanolic extract of *C.alata* exhibited very long antimicrobial activity against fungi like
**Candida albicans, Aspergillus flavus, Tricophyton mentagrophytes, Microsporum canis** and **Blastomyces dermatitidis** and some bacteria with maximum activity in the fractions containing alkaloids.

Stem bark of *C. alata* is used to treat fungal infections such as ringworm. It is a common ingredient in soaps, shampoos and lotions because of its antifungal properties. The ethanolic extract of the stem bark of *C. alata* is fungistatic. The ethanolic extract was fungicidal causing cell death and lysis. The mode of action was against protein synthesizing machinery or against an enzyme involved in nucleic acid synthesis. The leaves are reported to be useful in treating convulsion, venereal diseases (syphilis and gonorrhea), heart failure, abdominal pains, oedema, stomach problems, fever, asthma, snake bite and also used as a purgative [Owoyale *et al.*, 2005]. The effectiveness of *C.alata* against skin diseases was confirmed by modern scientific studies [Makinde *et al.*, 2007]. The phytochemical components such as alkaloids, anthraquinones, saponins, tannins, terpenes, steroids, flavonoids, carbohydrates have been investigated for their therapeutic potency [Owoyale *et al.*, 2005].

Heat treatment of fresh *C. alata* leaf was effective in stabilizing kaempferol 3-O-gentiobioside (K3G), which was found abundantly in *C. alata* leaf, as previously reported. [Moriyama *et al.*, 2001]. Various flavonoids glycosides are known to have anti-inflammatory activities. [Harborne *et al.*, 1994].
**Cassia fistula:**

*Cassia fistula* Linn a semi-wild Indian Laburnum (also known as the Golden Shower) beside being an ornamental plant, different parts of this plant have been demonstrated to possess several medicinal values such as hypoglycemic [Bhakta *et al.*, 1997], hepatoprotective [Bhakta *et al.* 1999], antitumour, hypocholesterolaemic [Gupta *et al.*, 2000], wound healing [Lokhande *et al.*, 2006] antibacterial activity (Duraiapandiyan and Ignacimuthu, 2007), antipyretic and analgesic properties [Kannampalli *et al.*, 2007]. *Cassia fistula* is part of food material of certain tribal in India [Reddy *et al.*, 2007]. Based on the ancient practices and traditional uses of this plant as antioxidant and antidiabetic, the present study was undertaken to support the traditional use and to identify its mechanism of action. *Cassia fistula* tree is one of the most widespread in the forests of India, usually occurring in deciduous forests. The whole plant possess medicinal properties useful in the treatment of skin diseases, inflammatory diseases, rheumatism, anorexia and jaundice [Anonymous, 1992, Kirtikar and Basu 1991].

Traditionally, its roots, leaves, flowers and seeds are used as laxative and purgative [Todd, 1967]. It is a vermifuge, anticonvulsant and used against chicken pox [Mann *et al.*, 2003]. Other uses include febrifuge, extrusion of guinea worms [Iwu, 1993] and black quarter [Ndi *et al.*, 2000]. Previous studies have shown that
its leaves exhibited \textit{in-vitro} antibacterial, antimalarial and antihepatotoxic properties [Gasquet, 1993; Percez, 1994; Saraf, 1994]. Seeds are brewed into a coffee like beverage for asthma and the flower infusion is used for bronchitis in the Peruvian Amazon [Akinloye et al., 2003].

Four new compounds, 5-(2-hydroxyphenoxy methyl) furfural, (2'S)-7 hydroxy-5-hydroxymethyl 1-2- (2'-hydroxypropyl) chromone, benzyl 2- hydroxy-3, 6-dimethoxybenzoate, and benzyl 2 beta-O-D-glucopyranosyl 1-3,6-dimethoxybenzoate, together with four known compounds, 5-hydroxymethylfurfural, (2'S)-7-hydroxy-2-(2'-hydroxypropyl)-5-methylchromone, and two oxyanthraquinones, chrysophenol and chrysophanein, were also isolated from the seeds of \textit{Cassia fistula} by Kuo et al., [2002].

Microbial infection is a common health problem in Bangladesh. People of rural Bangladesh use different plant parts for the ailment of various bacterial infections. [Kritikar et al., 1987; Ghani, 1998]. The medicinal plants continue to play an important role for the management of different microbial diseases. In recent years there has been a resurgence of scientific interest in the use of medicinal plants for the development of new pharmacotherapeutic agents against different species of microorganisms including the resistance organisms [Hatano et al., 1999 and Palombo and Semple, 2002]. Effective, cheap and safe medicinal
agents may appear as alternative potential source for controlling microbial infections particularly the resistant cases.

*Cassia roxburghii*

Plant gums and mucilages have been widely used in various industries like paper, textile, food, pharmaceuticals, ink, cosmetics and petroleum due to their abundance in nature and low cost. They are frequently used in pharmaceuticals as thickening, binding, emulsifying and suspending, gelling and stabilizing agents and also used as coating materials in microencapsulation. As binders they impart adhesive qualities to the powder material by formulation of granules of the desired size, hardness, strength, friability and compressibility. Various gums, which have been used as binders include, gelatin, acacia gum, tragacanth, alginic acid and its salts and guar gums. In view of importance of binders in pharmaceutical industry for the manufacture of tablets and capsules *C. roxburghii* seed gum was evaluated for its binding properties through assessment of various parameters essential for pharmaceutical formulation [Tausif et al., 1992; Cunningham et al., 2001].

*Cassia roxburghii* commonly known as Ceylon senna, red cassia, is a fairly large “shower” tree with feather like pinnately compound leaves and twigs covered with a dense carpet of fine, soft hair. Seeds are medium size and consist of about 50% endosperm which is responsible for yielding water soluble gum.
Liver a major metabolic organ affected by various chemicals and toxins daily and identification of a successful hepatoprotective agent will provide a useful tool for the treatment of hepatic diseases. In absence of reliable liver-protective drugs in modern medicine, a large number of medicinal preparations are recommended for the treatment of liver disorders [Chatterjee 2000] and quite often claimed to offer significant relief. Among those Cassia roxburghii is one of the medicinal plants used in ethno medicine for the treatment of various liver ailments.

They posse’s purgative, tonic, febrifugal, expectorant and diuretic properties. The plant is used to cure sore eyes, typhoid, asthma and disorders of hemoglobin [Bagci and Sahin, 2004]. A decoction of the plant is used in hysteria, in dysentery and other stomach troubles, and also as an application to sores, itch and inflammation of the rectum. The leaves are used in foot and mouth disease of cattle. Their extract exhibits activity against earthworms. The seed is bitter and has tonic, febrifugal and purgative properties. It is considered to be a blood tonic and excellent diuretic. Seeds are useful in cough and whooping cough, convulsions and in heart diseases [Bagci and Sahin, 2004]. Arulkumaran et al., [2009] studied the antibacterial activity of C.roxburghii seeds against 8 Gram positive and 7 Gram negative bacteria.

From the literature survey it is well understood that the leaf and bark extract of C.occidentalis, C.alata, C.auriculata and C.fistula are studied by
various workers from different parts of the world. From south India, the report is very few. In Tamil Nadu, most of the wastelands are spotted with any one of the Cassia species. The flowers of C.auriculata are collected shade dried and the powder is made into a decoction and consumed for diabetes by some of the rural communities. Some species of Cassia flowers are consumed as vegetable. Since the literature survey does not show any report on the activity of flowers, the present investigation was focused on flowers and leaves of cassia species.

Five different Cassia species namely C. occidentalis, C. auriculata, C. alata, C. fistula and C. roxburghii were selected based on literature survey, availability of the plants. C. occidentalis represents under shrub, C. auriculata shrub, C. alata large shrub, C. fistula a small tree and C. roxburghii a large tree. Of the five plants selected in C. roxburghii almost there are no reports.

Therefore in the present study, the five species would be compared for their anatomical differences, antimicrobial activity, antidiabetic activity, antioxidant activity. The activity of leaves and flowers would be compared for all the five species.