Chapter One

Introduction
Plants have been used since time immemorial as part of human life in different forms. As described in folklore, besides fulfilling the day to day needs of life, plants have been part of medicine treating different ailments. Plant parts are used directly or in form of extracts to treat different disorders. The medicines based on plants are not only easily available but are also considered safe with least side effects. In recent times, the increased use of antibiotics and subsequent generation of resistance in microorganisms, there has been a renewed interest in developing plant based medicines. Different plants are being explored to study their antimicrobial potential as well as application as functional foods so that besides providing nutrition, therapeutic properties can also be imparted in foods. As part of these studies different plants explored include *Curcuma longa* (turmeric), *Datura metel* (datura), *Azadirachta indica* (neem) etc. Pillai and Santhakumari (1981). Ficus is another large family of plants, having mention in folklore medicine but still to be explored for functional food properties and antimicrobial potential.

Ficus is a huge tree growing to 60 feet tall and 60 to 70 feet wide. The dense, rounded canopy and gracefully drooping branches of weeping fig made it quite popular as a landscape tree until recently. The thick, shiny, two to five inches long, evergreen leaves generously clothe the long branches, and the tiny figs eventually turn a deep red. Branches will weep
Fig: 1.1- Fruits and mature tree of *F. glomerata*
Fig: 1.2 Mature Trees of *F. benghalensis* and *F. religiosa*
toward the ground forming a canopy so dense that nothing grows beneath it.

Classification of Ficus down to Genus level.

Kingdom  

Plantae – Plants

Subkingdom  

Tracheobionta -- Vascular plants

Superdivision  

Spermatophyta -- Seed plants

Division  

Magnoliophyta -- Flowering plants

Class  

Magnoliopsida – Dicotyledons

Subclass  

Hamamelidae

Order  

Urticales

Family  

Moraceae -- Mulberry family

Genus  

Ficus L. - fig. P

The genus Ficus is an exceptionally large pantropical genus with over 700 species (Berg, 1989) and belongs to the family Moraceae (Wagner et. al. 1999). Most of them tropical and evergreen, although some, most notably *Ficus carica*, the common fig, are deciduous. It is retained as a single, large genus because it is well defined by its unique reproductive system (Novotny et. al. 2002). Each Ficus species needs a specific pollinating wasp in order to reproduce and spread (Ramirez 1970). Ficus produces a unique "fruit" which is actually an inverted flower. Not all Ficus produce edible fruit. Ficus is a moderately important world crop, with an estimated annual production of one million tons of fruits (Sadhu 1990).
Approximately 40% of this crop is sold as dried fruit (CIHEAM 1994). About 30% of the crop is produced by Turkey (300,000 t) while Italy and Spain has decreased their production in last decade (IBPGR 1986). This is remarkable that of California’s production, 85% is marked as dried fruits, 12% as fruit juice and 3% as fresh fruit (Storey 1975).

Ficus is one of the most loved bonsai for many reasons. Most species are fast growers, tolerant of most any soil and light conditions, make fine indoor bonsai, and perhaps most importantly, are remarkably forgiving of those just learning bonsai watering techniques. Most Ficus grow "Banyan" roots naturally; *Ficus* Linn. (Moraceae) a large genus of trees or shrubs, often climbers with milky juice widely distributed throughout the tropics of both hemispheres, but particularly abundant in South East Asia and Polynesia. About 65 species of Ficus occur in India the more important *Ficus benghalensis* (Banyan) (Armstrong, 1988) *Ficus Carica* (Fig), *Ficus religiosa*, *Ficus glomerata* and *Ficus elastica* (Indian rubber tree). This genus is remarkable for the large variation in the habits of its species. It contains some of the giants of the vegetable kingdom, e.g. Banyan, Peepal and Indian rubber, and also small wiry climbers like *Ficus pumila* and *Ficus scandens* Roxb. Many of the species start their life as epiphytes, often destroying their hosts by their vigorous growth, establish themselves by their aerial roots and assume large dimensions by their spreading habit. All species of *Ficus* yield latex containing caoutchouc, but none of them has attained any importance, except perhaps *Ficus elastica*, as a source of
rubber. Several species produce edible figs of varying palatability ranging from such well known fruits as those of *Ficus carica* to those which are hardly touched by birds. Many arborescent species are cultivated for shade and ornament in garden, parks and roadsides. The leaves of many of them are looped for cattle and elephant fodder. As sources of commercial timber almost all the species are unimportant; some like Banyan and Peepal though available in plenty, are not felled for timber as they are considered sacred. Many species are reported as hosts of the Indian lac insects (Gamble et. al. 1945). *Ficus* species are an important resource for a diverse array of organisms in most tropical forests (Janzen 1979, Gautierhion & Michaloud 1989).

Genus *Ficus* belongs to the order Utricals of the family moraceae and has about 1000 species. Most of them are trees achieving great heights in tropical regions. In original environment, the crowns of some species attain considerable extension. Some species develop aerial roots from the branches that grow downwards to the soil and serve as a support for the branches and thus cover great dimensions.

In Bundelkhand region, the most common *Ficus* species are *Ficus benghalensis* (syn- *Ficus indica*) in English called Banyan and in Hindi called Bargad, *Ficus glomerata* (syn-*Ficus goolereae* or *Ficus racemosa*) in English called Cluster fig and in Hindi called Gular and *Ficus religiosa* (syn-*Urostigma religiosum*) in English called Bo tree and in Hindi called Peepal.
*Ficus benghalensis* is a common Banyan tree found in monsoon and rain forest. It is hardy, drought resistant and mild frost with standing tree. This large fast growing evergreen tree reaching a height of 3 - 4 meters with spreading branches and many aerial prop roots, leaves stacked, ovate, three nerved entire petioles with a gland at the apex. Leaves are cariaceous with scaly stipules due to shiny wax coating on the surface. Fruits are globose with male, female and gall flowers adjusted in a hypanthodium inflorescence forming a syconus fruit.

*Ficus benghalensis* (Bailey and Bailey, 1976) a very large tree, with spreading branches, attaining at times a height of 100 ft. many aerial roots, developing into accessory trunks and helping the lateral spread of the tree indefinitely; leaves 4 to 8 inches long, cariaceous, ovate to elliptic, with rounded or subcordate base, fruits sessile in pairs ½ - ¾ inch in diam., subglobose, puberulous, scarlet when ripe. The tree occurs through out the forest tracts of India, both in the sub Himalayan region and in the deciduous forests of Deccan and South India. It is grown in gardens and road sides for shade. It attains large dimensions, the leafy crown sometimes attaining a circumference of 1,000 – 2,000 ft. It is evergreen except in dry localities where it is leaf less for a short time. It is hardy and drought resistant, withstands mild frost. It is epiphytic when young. It develops from seeds dropped by birds on old walls or on other trees and is therefore considered destructive to forests trees, walls and buildings. It can also be propagated from cuttings. The tree is attacked by a white spongy rot caused
by *Trametes personii* (Troup 1950). There are several variants of this species differing in leaf shape, presence or absence of aerial roots etc. One form cultivated in gardens, with leaf bases doubled into cup or cone-shaped structures has been considered by some as a distinct species, *Ficus krishnae* (Biswa, 1934-35). Ripe fruits of the banyan are eaten in times of scarcity. They are readily eaten by birds and monkeys. Analysis of partially dried fruits gave the following value: water, 12.9; albuminoids, 8.1; fat, 6.1; carbohydrates, 35.5; fiber, 31.0; ash, 6.4; silica (SiO2), 0.35; phosphorous (P2O5), 0.53; and coloring matter, 7.7%. Alcoholic extracts contain a glycoside (Agric. Ledger, 1904). The leaves are looped for fodder. Analysis of leaves gave the following values (dry basis): crude protein, 9.63; ether extract, 2.64; crude fiber, 26.84; N free extract, 51.59; calcium (CaO), 2.53; and phosphorous (P2O5) 0.40%. Feeding trials on goats showed that banyan leaves constitute a suitable maintenance fodder (digestibility coefficients: crude protein, 42.5; ether ext., 31.8; crude fiber, 41.8 and N-free ext., 65.7; nutritive value: digestible crude protein, 4.09 lb; total digestible nutrients, 51.05 lb. and starch equivalent, 35.0 lb/100 lb of dry matter). The leaves may be used as part roughage up to 40% in composite balanced rations for cattle (Parker; Laurie; Hussin et al., 1952). The latex of *Ficus benghalensis* contains 0.3-7.7% caoutchouc. An understand sterol like compound provisionally named ficosterol (C20H30; m.p.135°C) and glutathione (34 mg/100g) are reported to be present. The coagulum of the latex may be employed in making bird lime. A stable
emulsion of the latex, prepared by adding 4 parts of petrol, turpentine or benzol to 1 part of latex with the addition of the few cc. of formaldehyde may be used for closing small holes in motor car tyres (Ganapathy & Sastri, 1938; Nath and Debnath, 1946-47). The wood (wt. c. 36 lb. /cu. Ft.) is grey or grayish white and moderately hard. It is not considered to be of much value as timber. It is durable under water and may be used for well curbs. When carefully cut and seasoned, it can be used for furniture. The wood of aerial roots is stronger and more elastic; it is used for tent poles, cart yokes, banghy poles and carrying shafts. Recent trials have shown that the wood is suitable for the production of paper pulp both by chemical (soda) and mechanical processes. Analysis of air-dried wood from different sources gave the following values: moisture, 9.6-12.6; cellulose, 42.5-47.4; lignin, 31.3-35.5; ash, 0.9-1.5 and reducing sugars, 1.9-2.6%. The wood in the form of chips can be converted to chemical wood pulp by cooking with 25% caustic soda (8% solution) at a pressure of 30 lbs / sq. inch for 2 hours. The yield of unbleached pulp is 46%. Writing paper of good quality can be produced by sizing the pulp with rosin (3%) and alum (5%). Mechanical wood pulp requires 22-35% bleach to produce a product with a fair degree of whiteness. The fiber is deficient in tensile strength for the production of newsprint; this can be remedied by a partial cooking with 8% caustic soda at atmospheric pressure for 1 hour or by mixing with 20% of long fibred stock, e.g. rag pulp (Dutt, 1941). A coarse rope is prepared from the bark and aerial roots of the tree. The bark contains 11% tannin.
The Banyan tree is one of the recorded hosts of the Indian lac insect (Edwards et. al., 1952).

Stem bark of *Ficus benghalensis* is used as antihelminthic. It is used for diarrhea, dysentery, diabetes, cuts and wounds, joint pain, cracked heel and toe (Sarkar, 1994; Siwakoti & Verma, 1996; Karna, 1997; Shakya et al., 1999; Joshi & Joshi, 2001; Panthi & Chaudhary, 2003). Stem bark of *F. benghalensis*, root of *Asparagus racemosus*, fruits of *Annona squamata*, and shoot of *Colebrookea oppositifolia* are crushed and eaten on empty stomach to cure urinary problems (Paudyal, 2000). Bark decoction is taken as antidote (Thapa, 2001), used in epitaxis (Bhattarai, 1993c) and stomachache. Boiled bark is employed in cold, cough and asthma. Milky sap from bark is used for diarrhea, dysentery, indigestion, joint pain (Shakya, 2000), dermatitis, gum swelling, gonorrhea, and snake bite. It is valued to take out pus of wounds (Manandhar, 1986) and is mixed with sugar to give to children suffering dysentery (Yadav, 1999). The latex is also used for polishing copper, brass and bronze (Vihari, 1995). Leaves latex causes allergy to children (Dangol, 2002). Aerial root juice is used for stopping menstruation and applied externally for body pain, toothache, diabetes, joint pain (Mishra, 1998) and rheumatism (Kharel & Siwakoti, 2002). Root bark powder is mixed with *Desmostachys bipinnata* (Kush) and sugar and considered to control leukorrhoea. Root latex treats boils and wounds (Parajuli, 2001) and obstantiates vomiting (Chopra et al., 1956). The
decoction from aerial roots and water obtained from rice wash is used in diarrhea.

*Ficus glomerata* or Gular is a tall tree with a height of up to 8 to 15 meters with spreading branches, bark is reddish gray often cracked vertically, leaves dark green 7-10 cm long, ovate or elliptical with acute apex 3 nerved the upper side dark green and shiny and lower side marked with green dots, petioles strong about ½ inch long, fruits syconus green which turn into orange reddish or dark crimson color on ripening. *Ficus glomerata* trees 6 to 10 mt. high; young branches having leaves alternate, ovat-oblong, 6 - 15 × 3-6 cm, obtuse or acute at apex, rounded or acute at base, entire, subcariaceaus, smooth, glabrous, stipulate, receptacles in clusters on main branches of trunk or on leafless branches, pedunculate, subglobose or pyriform, 2-3 cm across, green to red. Male flowers sessile, in 2-3 rings near the ostiole. Female flower sessile or shortly pedicellate. It is widely spread in wastelands and mixed forests, on the bank of drains and rivers. Root is used to treat dysentery and diabetes while bark to stop bleeding. Latex is used to treat diarrhea and piles, while leaves in bilious affections. Figs are stomachic, carminative and edible. (Flora of Madhya Pradesh, 1997) *Ficus glomerata* are fodder, edible and ceremonial (Manandhar, 1972; HMGN, 1982; Dhakal & Aizz, 1996; Chaudhary et al., 1999; Pathak, 2000; Priya, 2000; Sah et al., 2002; Manandhar & Acharya, 2003). Milky juice of stem is used to cure stomachache as reported by Ghimire et al. (2000), cholera and mumps (Basnet, 1998). It is used in boils, diarrhea,
dysentery and piles (Yadav, 1999). Root sap cures heat stroke, chronic wounds and malaria in cattle (Thapa, 2001). Leaf latex and cow milk are mixed and used for boils and blisters (Siwakoti & Siwakoti, 2000) and measles. Leaf juice is massaged on hair to check splitting. Infusion of leaves is used in menorrhoea. Fruit paste is applied in regulating diarrhoea and constipation (Vihari, 1995). Seed paste is taken in measles and smallpox (Acharya, 1996) and diarrhoea (Singh, 1994). Paste of stem bark is taken in burns, swelling and leucorrhoea (Paudyal, 2000), dysentery, diarrhoea and used as astringent (Tiwari, 2001). The powder from stem bark is used in curing boils and secretion of milk for lactating mother. Latex is used as adhesive (Dangol, 2002).

*Ficus religiosa* called Peepal is another large tree with green cordate leaves, shining the entire margin long accumulate apex. Fruits syconus with a sessile receptacle smooth globose dark purple or red commonly considered as religious plant used for tantra activities. *Ficus religiosa* is cultivated in various tropical areas of the world. It is a sacred tree native to India where it grows up to elevations of 5,000 ft (1,524 mt.) (Neal 1965).

In the United States, it is grown in southern California, the trees are considered sacred and worshipped. Figs are laxative and used to treat asthma; latex as tonic; bark for gonorrhoea and scabies while leaves to antidote snake bite. (Flora of Madhya Pradesh, 1997)

A large deciduous tree, epiphytic when young with spreading branches and round or broadly ovate, caudate, more or less pendulous leaves; fruits
sessile in axillary’s pairs, depressed globose, c.1/2 inch in diam., black or purple when ripe. The tree is found wild or cultivated nearly throughout India and is held sacred by Hindus and Buddhists. It is planted as an avenue or road side tree. It grows fast and can be raised from seeds. It can also be propagated by cuttings, but these do not strike as well as those of Ficus benghalensis. The fruits and tender leaf, buds are occasionally eaten in times of scarcity. The fruits are eagerly devoured by birds. Analysis of the dried fruits gave: moisture, 9.9; albuminoids, 7.9; fatty matter, 5.3; carbohydrates, 34.9; colouring matter, 7.5; ash, 8.3; silica, 1.85 and phosphorous (P₂O₅) 0.69%. The leaves and twigs are looped for cattle and elephant fodder. The average composition of the leaves is as follows (dry matter basis): crude protein, 13.99; ether ext., 2.71; crude fiber, 22.36; N-free extr., 46.02; total ash, 15.06; lime(CaO), 4.64; and Phosphorous, (P₂O₅), 0.52%. The protein content of the leaves is 2 – 3 times that of grasses and compares favorably with that of leguminous forages. Compared with other green roughages the ether extracts is also high, but the major part of it is composed of chlorophyll and other pigments. The maximum content of the leaves are 2 – 3 times that of leguminous fodders. Ficus religiosa is edible, ceremonial, fodder and fuel wood (Manandhar, 1972; Upadhyay, 1992; Acharya, 1999; Parajuli, 2000; Rajbhandary & Dhakal, 2003; Khatri, 2005). Leaf juice and honey is applied on asthma, cough, sexual disorders (Yadav, 1999; Gurung, 2002), diarrhoea (Bhattarai, 1993b), haematuria (Jain et al. 1991), earache and toothache (Muller
Boker, 1999; Kharel & Siwakoti, 2002), migraine (Mandar & Chaudhary, 1993), eye troubles (Tiwari, 2001), gastric problems (Kattel & Kurmi, 2004) and scabies. Leaf decoction is used as analgesic for toothache. Fruits are eaten to facilitate asthma (Bhattarai, 1993a) and respiratory system. Fruit paste is taken to cure scabies, Stem bark is used in gonorrhoea (Joshi & Joshi 2000), bleeding (Shrestha 1997; Dangol, 2002), cuts, wounds (Manandhar, 1998a), paralysis, diabetes (Thapa, 2001), diarrhea, bone fracture (Karki, 2001) and used as antiseptic, astringent and antidote. Bark infusion is taken in scabies. Bark juice taken with Dolichus biflorus (Ghahata in Nepali and Karthi in Tharu) is used to reduce fever in cattle (Chaudhary, 1994). Paste of bark is taken with honey to treat cough and cold as well as accompanying mild fever. Aerial root juice is used for menstrual problems (Manandhar, 1998b).

*Ficus benghalensis, Ficus glomerata and Ficus religiosa*, are reported to be extensively used in Nepal for various purposes. The use of *Ficus* species as ethno medicine in Nepal is quite noteworthy (Kunwar & Adhikari 2005b). *Ficus benghalensis* (Bar) is most important, used to heal 22 ailments (Joglekar et. al., 1963). Except *Ficus glomerata, Ficus religiosa* and *Ficus benghalensis* some other *Ficus* species show antimicrobial activities, as *Ficus capensis* exhibited antimicrobial activity against *Vibrio cholerae* (Akinsinde and Olukoya. 1995).

Since the above are of historical importance, ancient origin, very popular commonly found in the rural areas and easily distinguished by common
people, therefore the present work has been restricted only to these plants of the genus *Ficus*. The leaves of these plants are commonly used as fodder for goats; the fruits are edible but commonly these plants are planted by the roadside and gardens for shade and religious significance. Generally plant parts in the form of fruits, shoots, leaves, figs, flowers, roots, tubers, etc. are collected which still share a good proportion of tribal dishes. Traditionally edible species meet the protein, carbohydrate, fat, vitamins, and mineral requirements to a great extent but only studies have been conducted to trace the relationship of elemental contents at the time of food consumption. Even in these studies the fiber and the protein content are considered as the main elements of the food and very less is known about the elemental composition of such plants. A large section of the population particularly in remote areas depends upon variety plants for their survival as food and for medicinal purposes together with some miscellaneous use, such as house construction, fuel and other purposes.

Uses of such wild plants still continue whenever they are available. In the present investigation attempts will be made to record the nutritional values of *Ficus* plants, which are easily grown and survive in adverse condition. Information of chemical constituents of these plants will add to the existing knowledge about their nutritional and their medicinal values; so that their functional importance could be considered and utilized as human resources.
Considering the vast importance of plant based medicines and potential of
*Ficus* as source of antimicrobial drugs as well as functional foods, the
present study is proposed with following objectives:

1. Phytochemical analysis of plant parts (Fruits, leaves and Bark) of
   *Ficus*.

2. Screening of various extracts of *Ficus* plants to evaluate their *in
   vitro* antimicrobial activity.

3. Study of micro flora associated with fruits of three species of
   *Ficus*. 