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Phytochemical Profile, Antimicrobial, Antioxidant Activities of Medicinal Plants in Local Area of Himachal Pradesh

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Abstract: ***The current research was carried out to appraise phytochemical antioxidant and antibacterial activity of various crude extracts viz, methanol, chloroform, ethyl acetate, acetone, and aqueous extracts of Bauhinia variegata, Ficus racemosa, Ficus palmata, Carissa carandas, Bombax ceiba towards microorganisms such as Staphylococcus aureus, Pseudomonas aeruginosaSalmonella typhi, Vibrio cholerae, K. pneumonia, E.coli, S. paratyphi, B. megaterium, B.subtilis, Sarcina lutea, S. epidermidis, B. cereus S. pyogenes, Shigella dysentery, V. cholera, by agar well diffusion method. The highest percentage of extraction yield was noted in aqueous extract followed by methanol and chloroform extracts. The phytochemical test discovered that the presence of proteins, carbohydrates, lipids, alkaloids, phenols, flavonoids, steroids, glycosides, tannins, and terpenoids.The crude extracts of planthave displayed significant to moderate and dose-dependent (25, 50 and 1000µg/ml) antibacterial activity.The antibacterial activity of ethanolic extract of Bauhinia variegata exhibited a greater zone of inhibition for Salmonella typhi, Methanolic extract of Ficus racemosa (leaves) has more effective to gram (+) ve than gram (-) ve bacteria, Ficus palmata exhibited a greater zone of inhibition for Bacillus cereus, Bombax ceiba exhibited a greater zone of inhibition for S. aureus, Carissa carandas exhibited a greater zone of inhibition for V. cholerae.***

Keywords: Medicinal plants, Antimicrobial, Antioxidant, Phytochemical, Extracts

1. Introduction

The forest of Himachal Pradesh said to have been the birthplace of Ayurveda and is known to supply a very large proportion of the medicinal plant requirements in India with one estimates quoting figures as high as 80% of all Ayurveda drugs 46% of all Unani and 33% of all allopathic drugs developed in India. Researchers estimated that over 120 million people in the Himalayas region rely primarily on plant products mostly extracted from the wild with medicinal plants were one of the major groups. Plants are the main source of medicine for a man before the advancement of Science and Technology (Omotayo*et al*., 2012).

India is ranked 6th among 12 megadiverse countries in the world. Himachal Pradesh is one important state in India which is known for its great diversity in terms of flora and fauna and also its rich plan- based ethnomedical traditions (Ramakrishnan, 2006). The present study was started to collect and making a permanent record of the medicinally important floristic diversity of Himachal Pradesh. About 27% of populations depend on forests and use various plants for their health care.

Out of the total 4,22,000 flowering plants that are known all over the world more than 43% are reported from India of possessing medicinal importance. In Himachal Pradesh, about 21.3% of plant species have an important medicinal property.

In history, plants have provided a source of inspiration for novel drug compounds, as medicine derived from the plants has made a large contribution to human health and well beings. Generally, secondary metabolites, contain constitute an important source of microbicides, pesticides, and many pharmaceutical drugs. Medicinal plants have been excellent sources for centuries as a proxy remedy for treating human diseases because they contain numerous active constituents of immerses therapeutic value (Madan*et al*., 2015).

Due to fewer communications means poverty ignorance and unavailability modern health facilities, most of the people especially rural areas were still forced to practice traditional medicines for their common day ailments and these people from the poorest link in the trade of medicinal plants. The use of herbs to treat disease is almost universal among non – industrialized societies. The plant-based medicines have been consumed in all civilizations. Now – a – Days plant-based drugs are widely used and many countries contribute 40 to 50 % of their total health budget in the production of novel drugs. It is believed that herbal medicines have a good effect on the body without causing any side effects. Although they contain many inert compounds they also possess some active compounds that boast their ability (Verma and Singh, 2008). According to the study, 18% of the world's top 150 prescription drugs are derived from plant sources (Kate and Laird, 1999).

In the modern world, multiple drug resistance has developed against many microbial infections due to the indiscrimination use of commercial antimicrobial drugs commonly used in the treatment of infectious disease. This situation-forced scientist to search for new antimicrobial substancestherefore there is a need to develop alternative antimicrobial drugs for the treatment of infectious diseases from medicinal plants. The use of the plant extracts and phytochemicals, both with known antimicrobial properties can be a great significance in therapeutic treatments (Dipanker*et al*., 2011).

To treat human diseases, living organisms and plants have great potential. The tribal knowledge depends on the surrounding plants regarding the use of plant species for

various purposes. It was also realized that 95% of the herbal wealth was unexplored and till now only 5% of herbal wealth was studied (Arya*et al*., 2008).

Medicinal plants are believed to be an important source of new chemical compounds with potential therapeutic effect, a wide range of medicinal plants parts is used for extract as raw drug and they possess varied medicinal properties. The number of multi-drug resistant microbial strains and the appearance of strains with reduced susceptibility to antibiotics is continuously increasing. Medicinal plants represent a rich source of antimicrobial agents. Because of the side effects and the resistance that pathogenic microorganisms build against antibiotics, many scientists paid attention to plants species extract and biologically active compounds (Kilani, 2006).

Plants produce many secondary metabolites (phytochemicals) which are alkaloids, glycosides, steroids, and many other bioactive compounds. The secondary metabolites of plants are found to be a source of various phytochemicals that could be directly used as intermediates for the production of new drugs. Phytochemicals are extensively investigated as a source of medicinal agents. It is anticipated that adequate antimicrobial efficiency will be used for the treatment of microbial infections. Ethnobotanical studies have been reported in several parts of India to protect the traditional knowledge from disappearing. Ethnobotanical studies are very significant in revealing locally important plant species especially for the discovery of crude drugs (Jain *et al*., 2014).

An antimicrobial is an agent that kills or inhibits the growth of microorganisms such as bacterial, fungi, and protozoans. The agent that kills bacteria is called bactericidal and those that inhibit their growth are known as bacteriostatic. Plants have been used in traditional medicine for several thousand years all over the world. According to WHO, 80% of the population relies on plants based medicine for primary healthcare. Plants meet human's basic needs food, clothes, cosmetics, and the supply medicines (Handral*et al*., 2012).

In Indian Ayurvedic system, of medicine has flourished and in this system home remedied prepared based on the therapeutic use of plant species by a Layman or traditional healers. Most of the medicinal plant species are used in the preparation of Ayurvedic products. In various Ayurvedic formulations, the parts of the plant are utilized. The plant species such as *B. variegate, F. racemosa, F. palmate, B. ceiba,* and *C. carandas* are used for the treatment of antitumor, antiulcer, anticancer, anti-diabetic, dysentery, wound, mumps, smallpox, cholera, antipyretic activity, etc (Singh *et al.,* 2000).

In the present study, an attempt has been made to evaluate the phytochemicals, antioxidants, and antibacterial pattern of *Bauhinia variegata, Ficus racemosa, Ficus palmata, Bombax ceiba,* and *Carissa carandas.*

2. Review of Literature

The present review aims to document the morphology, distribution, phytochemical, antioxidant, antimicrobial, medicinal properties of *B. variegate, F. racemosa, F. palmata, B. ceiba,* and *C. carandas.* Information regarding the overview of the plants is tabulated in Table 1.

Table 1: Botanical information and Reference of the studied medicinal plants

Scientific Name	Common Name	Family	Origin	Distribution	Fruit/flower Appearance	Blossom season	Picture of flower	Reference
Bauhinia variegata	Mountain ebony, Kachnar	Fabaceae	South-east Asia	India, Burma, china	Purple flowers	January-April		Liaw*et al*.,2012,Singh 2016
Ficus racemosa	Gular fig, cluster fig	Moraceae	South-east Asia	India, Burma, Australia	Orange and reddish dark color fruits	March-July		Arora,2012
Ficus palmata	Wild Himalayan fig or Bedu	Moraceae	North-western India	India, Nepal, Iran	Greenish-white flowers	March-April		Parmar 1982
Bombax ceiba	Red silk cotton tree	Bombaceae	Tropical Asia	India, Thailand, Myanmar, China	Flowers bright red color found in cluster	January-March		Chaudhary and Khadabadi, 2014
Carissa carandas	Karonda	Apocynaceae	Tropical Asia	India, Bangladesh, Srilanka, and Nepal	White flowers	January-February		Singh and Upaal, 2015, Saha *et al*., 2011

2.1. Botanical description of *Bauhinia variegata* (Kachnar)

Classification	
Kingdom	Plantae
Division	Magnoliophyta
Subdivision	Spermatophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Fabales
Family	Fabaceae
Sub-Family	Caesalpiniaceae
Genus	*Bauhinia*
Species	*variegata*

Bauhinia variegata

Vernacular Name

Languages	Vernacular Names
Sanskrit	Kovidara
English	Mountain ebony, Buddhist bauhinia
Hindi	Kachnar, Kaniar
Marathi	Raktakanchan
Gujarati	Kovindara
Punjabi	Kachnar
Tamil	Sigappu mandaraii
Telugu	Devakanchanum

Bauhinia variegata common name is Kachnar in Hindi (Kumar *et al.*, 2016). *Bauhinia variegata* is widely distributed in tropical regions and found throughout India especially in Punjab central and South India. It is widely found in sub-Himalayan and the outer Himalayas up to an altitude of 1300 meters. It is a small to medium-sized tree. It grows to a height of about 10-12m and is a deciduous tree found throughout India, at an altitude of 1800m in the Himalayas. It is native of Asia (Pakistan, China, India, and Nepal). Its foliage is wider, tightly subclasses, severely heart shape per two leaflets that are oviform and 10-15cm long.Flower occurs in various colors, lateral, stalkless, 5 stamens, flat fruit, and hard glabrous dehiscent pods with 10-15 seeds. These plants also contain beautiful colorful flowers that bear fragrant and used in perfumes. *B. variegata* also grew as ornamental plants are broadly used in local and various traditional medicines. The leaves are rich in reducing sugar and have good nutritive value for the healthy development of tasar silkworms. The leaves are used for the preparation of biddies. They are propagated by seeds. Constituents like fiber, oil, tannins, and gum are mostly procured from its species which can play an important role in industries. The juice of flower is used to treat diarrhea, dysentery, and other stomach disorders. The flowers and flower buds are used as a vegetable and laxative. It is used in the treatment of various diseases like worms, piles, diarrhea, and dysentery (Patil *et al.*, 2015).

2.1.1. Antimicrobial Activity:

Ethanolic extract of *Bauhinia variegata* (EBV)shows the antibacterial effect. The Result obtained in the present study revealed that EBV display potential antibacterial activity against all the five tested bacterial organisms (*E. coli, S. aureus, K. pneumonia, S. typhi, and V.cholera*).The EBV showed a broad spectrum of activity against all the bacterial strains at the tested concentration of 100 - 1000 µg/disc. Except for *S. aureusV. cholera, E. coli, K. pneumonia*, and *S. typhi* were inhibited at 100 µg/disc concentration. EBV showed antibacterial activity against *S.aureus* and *V.cholera* at a concentration of 250- 1000 µg/disc (Figure 1.1). EBV exhibited a greater zone of inhibition for *Salmonella typhi* (27mm). This is followed by *Vibrio cholera*, *K.Pneumonia*, *E.coli*, and *S.aureus*. The minimum activity was observed for *S.aureus* (18mm) at 1000 µg/disc. The antimicrobial activity has been screened because of their great medicinal apposite with recent years, infections have increased to a great extent and resistant against antibiotics becomes an ever-increasing therapeutic problem.

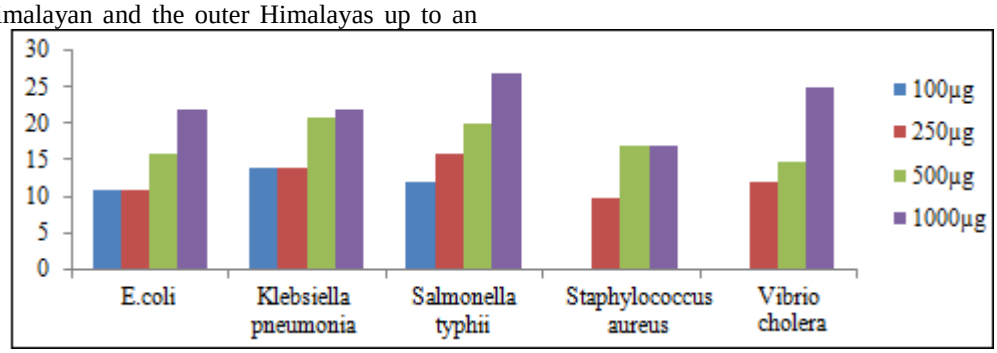


Figure 1.1: Antibacterial activity of ethanol extract of *Bauhinia variegata* (Venkatesan and Karrunakaran, 2010).

2.1.2. Phytochemical Activity

Phytochemical Screening of *B. variegata* Leaf Extracts *B. variegata* displayed the differential distribution of phytoconstituentsin leaf extracts (Table 1.1). The reducing sugar, anthraquinone, and saponins were noted in polar extractsEthyl acetate and water, while terpenoids and alkaloids were present inPetroleum, Benzene, and Ethyl acetate extracts. All the extracts tested positive for tannins.

Extracts were notable by the absence of cardiac glycosides. None of the extracts showed the presence of all the phytoconstituents tested.

Table 1.1: Phytochemical profile of *B. variegata* leaf extracts (Mishra, 2013)

Extract	Petroleum Ether	Benzene	Chloroform	Ethyl Acetate	Acetone	Ethyl Alcohol	Water
Reducing Sugar	-	-	-	-	-	+	-
Anthraquinone	-	-	-	-	-	+	+
Terpenoids	+	+	-	-	-	+	
Phenols	+	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+	+
Saponins	-	-	-	-	-	+	+
Tannin	+	+	+	+	+	+	+
Alkaloids	+	+	-	-	-	+	-
Cardiac Glycosides	-	-	-	-	-	-	-

2.1.3. Antioxidant Activities:

DPPH scavenging activity the percentage of DPPH radical scavenging activity of *Bauhinia* extracts are presented in Figure 1.2. Ethanol extract of *Bauhinia variegata* produced only a weak radical scavenging activity in this assay. The observed inhibition in test extract given groups was found to be statistically non-significant in comparison to control tubes. The aqueous extract of *Bauhinia variegata* shows dose-dependent marked anti-oxidant activity at the higher dose level. The free radical scavenging effect observed with 40, 60, 80, and 100 µg/ml dose level was found to be statistically highly significant. The weak to moderate activity observed at a lower dose level of 10 and 20 µg/ml dose level was found to be statistically non-significant.

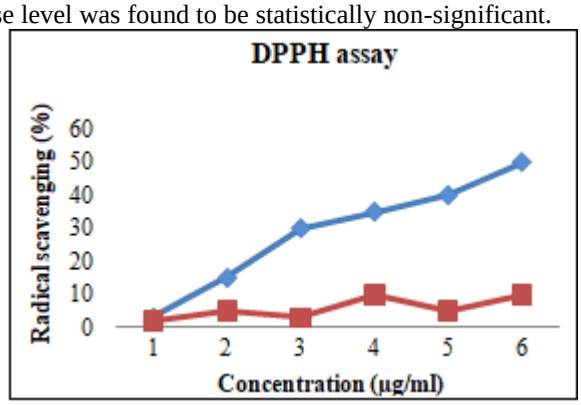
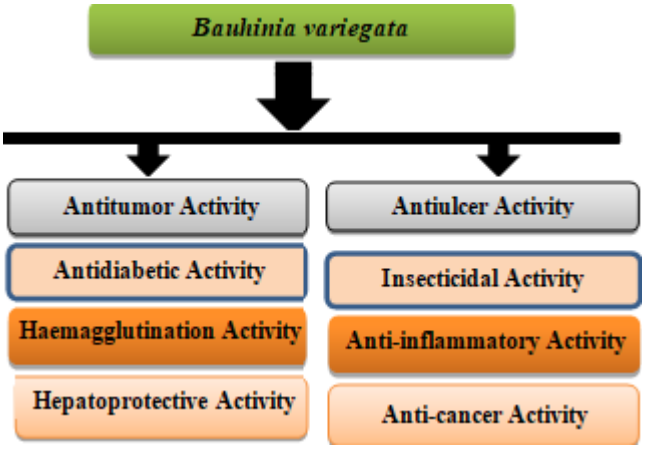


Figure 1.2: Antioxidant Activities of *Bauhinia variegata* extracts (Bhaskar 2013)

2.1.4. Pharmacological Studies:

Bauhinia variegata is a medicinal plant of the family Caesalpiniaceae. In recent history this plant is described various medicinal properties:



2.1.4.1. Antitumor activity

The result from the study carried out by shows the extract of *B. variegata* increasesthelife span of mice and the size of the tumor should be reduced. *B. variegata* acts against the anti-tumor activity. Another study conducted by Rajkapoor*et al.*, 2006 ethanolic extracts of *B. variegata* shows a significant character in chemopreventive and cytotoxic effect and helpful to reduce human cancer lines and liver tumor.

2.1.4.2. Anti-inflammatory activity

B. variegata flower buds are mainly used to cure cough, piles, liver, and eyes problem (Mali *et al.*, 2009). Another study conducted by Bansal *et al.*, 2014 shows that the plant extracts has an adequate source of anti-inflammatory actions.

2.1.4.3. Antidiabetic Activity:

B. variegata leaf and stem bark contain insulin-like protein which is mainly used as an anti-diabetic agent (Azevedo *et al.*, 2006).

2.1.4.4. Insecticidal activity:

The stem extract of *B. variegata* has a significant role against *Dysdercuscingulatus* nymphs, (Srivastava*et al.*, 1985).

2.1.4.5. Haemagglutination activity:

The seed extract of *B. variegata* exhibited haemagglutination activity against erythrocytes of man, monkey, rabbit, rat, cow, goat, sheep, buffalo, horse mule (Roy *et al.*, 1981).

2.1.4.6. Anti-ulcer activity:

B. variegata extract displays strong anti-ulcer activity and also beneficial for the handling of diabetes, pain, infections, leprosy, and an ulcer (Arain *et al.*, 2012).

2.2 Botanical description of *Ficusracemosa* (Gular)

Classification	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Urticales
Family	Moraceae
Genus	*Ficus*
Species	*racemosa*

Languages	Vernacular names
Sanskrit	Udumbara
Hindi	Gular
Marathi	Umbar
Telugu	Paidi
Nepali	Gular
Kannada	Rumadi
Tamil	Atti

Ficus racemosa

Ficus racemosa iscommonly known as, "Gular", "Cluster fig" in English. The large deciduous tree distributed all over India from outer Himalayan ranges, Punjab, West Bengal, Rajasthan, and common in South India (Warrier *et al.*, 1996). It is one of the herbs mentioned in all ancient scriptures of Ayurveda. Udumbara is observed sacred to God Dattaguru, has various synonyms like yajnanga, yajniya, yajnayoga, and yajnyasara suggesting the use in ritual sacrifice. The ksiriviksa provided on cutting or plucking the leaf, latex oozes out. The plant is from a group, called pancavalkala. Maharishi Charaka has categorized Udumbara as an anti-diuretic herb (mutrasangrahaniya). The plant was located on the south-western coast (middle-earth) of the Bay of Belfalas. The plant grows all over India in many forests and hills. It is frequently found around the water streams and is also cultivated. The tree is up to 18m high, leaves ovate. Leaves are falling in December and replenished by January and April when the tree becomes bare for a short period. The cork is made up of polygonal or rectangular cells. The phellogen is made up of 1-2 layers of thin-walled cells. Phelloderm is well marked compact tissue consisting mainly of parenchymatous cells with isolated or small groups of sclereids, particularly in the inner region. Sclereids are lignified with simple pits. Several parenchymatous cells carry a single prism of calcium oxalate or some brownish content. The cortex is wide with numerous sclereids and some cortical cells carry resinous mass. Prismatic crystals of calcium oxalate are present in some of the cells. The tree is without aerial roots unlike its many family members (Anita and Mittal, 2011). Traditionally leaves are used in bilious affection and also to improve skin complexion. The leaves are good for wash wounds and ulcers. Roots are used in hydrophobia, Barks are used in galactogogue, Fruits are used in blood disorders, dry cough, burning sensation, leprosy, menorrhagia, and Leaves are used in astringent, bronchitis. They are useful in dysentery and diarrhea miscarriage, menorrhagia, spermatorrhoea, epididymitis, cancer, myalgia, scabies, hemoptysis, intrinsic hemorrhage, excessive thirst, visceral obstructions.

2.2.1. Antimicrobial Activity

The Methanolic extract of *Ficus racemosa* was tested for antibacterial activities against a number of both gram-positive and gram-negative bacteria. Standard kanamycin discs (30 mg/disc) were used for the comparison purpose. The zone of inhibition for the *Ficus racemosa* (leaves) against both gram-positive & gram-negative bacteria was 6-10 mm, 6-11 mm, 6-14 mm & 8-14 mm respectively. As shown in figure 2.1 Methanolic extract of *Ficus racemosa* (leaves) has more effective to gram (+) ve than a gram (-) ve bacteria.

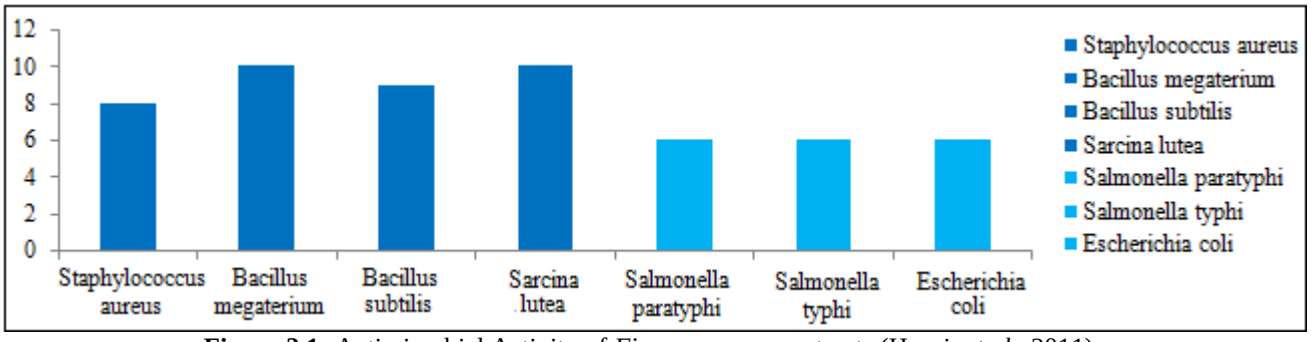


Figure 2.1: Antimicrobial Activity of *Ficus racemosa* extracts (Hosain*et al*., 2011).

2.2.2. Phytochemical Analysis:

The extract of leaves of *F. racemosa* was prepared in Ethanol, Methanol, Ethyl acetate, Acetone, and n-Hexane. Various phytochemical tests performed on the extracts and the results are reported in Table 2.1. It is reported that phenol and flavonoids phytochemical presence reported in all extracts. Quinones and steroids are reported in all except ethyl acetate and n-hexane respectively. Tannins and cardiac glycosides are reported in ethanol and methanol solvents only. Terpenoids and saponins tested positive in ethyl acetate and acetone respectively.

Table 2.1: Phytochemicals Analysis of different extracts of *F. racemosa* leaves (Ganatra*etal*., 2012).

Phytochemicals	Ethanol	Methanol	Ethyl Acetate	Acetone	n-Hexane
Phenol	+	+	+	+	+
Flavonoids	+	+	+	+	+
Quinones	+	+	-	+	+

Steroids	+	+	+	+	-
Tannins	+	+	-	-	-
Cardiac Glycosides	+	+	-	-	-
Terpenoids	-	-	+	-	-
Saponins	-	+	-	-	-

2.2.3. Antioxidant Activity

DPPH (1, 1-diphenyl-2-picrylhydrazyl) Radical Scavenging Assay the 1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) has been widely used to evaluate the free radical scavenging capacity of antioxidants. DPPH free radical is decreased to the corresponding hydrazine when it reacts with hydrogen donors. DPPH can make stable free radicals in aqueous or methanol solution. With this method, it is possible to determine the antiradical power of antioxidant activity by measurement of the decrease in the absorbance of DPPH at 519 nm. In the free radical assay, take absorbance at 519 nm which disappeared after acceptance of an electron or hydrogen radical from an antioxidant compound to become a stable diamagnetic molecule. 1.0 ml of methanolic extracts solution of *F. racemosa* leaf and bark sample was taken for the experiment. Decolorization of DPPH by the effect of the extracts was measured at 517 nm. Butylated hydroxytoluene (BHT) (standard) and plant extracts. Figure 2.2 showed the free radical scavenging activity of the two extractives used in the current paper. At a concentration of 200 µg /ml, the scavenging activity of the *F. racemosa* leaves and bark extracts were found to be 48.54701% and 73.46154% respectively, while at the same concentration, the activity of BHT was 96.35%. Thus, *F. racemosa* stem and bark exhibited significant free radical scavenging activity (Figure 2.2). The IC50 of stem and bark of *F. racemosa* was 19µg/ml.

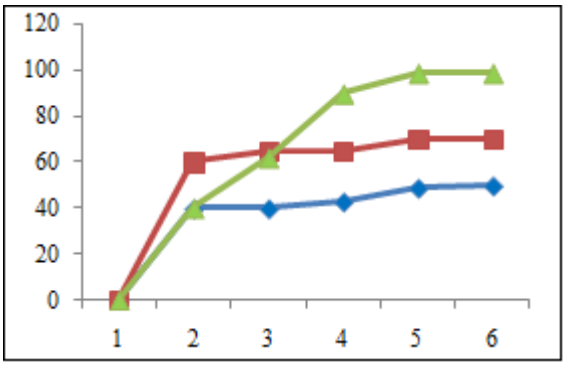
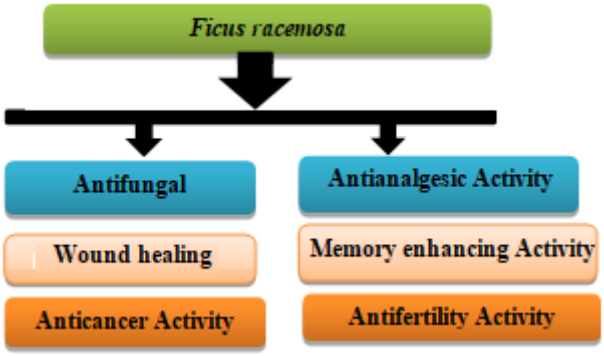


Figure 2.2: Antioxidant Activities of *Ficus racemosa* extracts(Sultana, 2013).

2.2.4. Pharmacological Studies:

Ficus racemosa is a medicinal plant of the family Moraceae. In recent history this plant is detailed for various medicinal properties:



2.2.4.1. Antifungal:

F. racemosa displays strong antifungal activity against species i.e., *T. rubrum, T. soundanense, Candida albicans, Candida krusei,* and*Torulopsisglabrata* (Jahan*et al*., 2008).

2.2.4.2. Wound healing:

F. racemosa carried a vital part in wound healing. Ethanol extract of stem bark shows potent wound headline in excised & incised wound models in rats (Biswas *et al*., 2003).

2.2.4.3. Antianalgesic:

Bark and leaves extract of *F. racemosa* assessed for analgesic activity by antianalgsiometer at 100, 200 & 500 mg/kg was found to possess dose-dependent analgesic activity (Malairajan *et al*., 2006).

2.2.4.4. Memory enhancing activity:

It shows activity on Alzheimer's disease which is caused by a decrease in acetylcholine level and it is an extrapyramidal disease (Faiyaz *et al*., 2011).

2.2.4.5. Anticancer activity:

The methanolic extract shows cytotoxic effects on more than one hepatic cancer cell lines like HL-60, HepG2, NCI-H23, and HEK-293T. Among this evaluation, more cytotoxic activity was observed in HL-60 and HepG2 cells at 50% inhibitory concentration (IC50) (Yadav *et al*., 2015).

2.2.4.6. Antifertility activity:

The extract shows anti-fertility about 70% reduction in sperm count, motility, viability & abnormal morphology was determined reduction in weight of reproductive organ and the level of sialic acid in epididymis and fructose in seminal vesicle the 80% bark extract shows vaginal contraception (Dheeraj *et al*., 2011).

2.3Botanical description of *Ficus palmata*(Fegra Fig)

Classification	
Kingdom	Plantae
Sub-kingdom	Tracheobionta
Class	Magnoliopsida
Order	Urticales
Family	Moraceae
Genus	*Ficus*
Species	*Palmata*

Ficus palmata

Languages	Vernacular Names
Hindi	Bedu, Khemri
Gujarat	Pepri
Punjab	Anjir
Himachal Pradesh	Daghla
Dehradun	Khemri

***Ficus palmata* leaves**

Ficus palmata commonly known as 'Fegra Fig' belongs to the family of *Moraceae*. It is found to be growing wild in the Himalayan region, so also named Wild Himalayan Fig, and is mainly the native of North-Western India and Rajasthan regions. These trees are occasionally found in the forests but grow well around the villages, in wastelands, fields, etc. A deciduous tree of height up to 6 to 10 m (30 feet approx.), leaves are alternate, broad, ovate, and membranous with a size range 12.92 cm long and 14-16 cm broad. Flowering starts in March and continues up until the end of April. The fruiting season starts from the second fortnight of June and continues till the first half of July. *F. palmata* is used as fuel wood and traditionally used for the effective treatment of many diseases viz. skin diseases, ringworm, wound infections, and haemorrhoids (Sabeen*et al*., 2009). The fruits are juicy, containing 45.2% extractable juice, and 80.5% moisture, soluble solids 12.1%, total sugars 6%, pectin content 0.2%, and protein content 1.7%, ash content 0.9%. Some of the mineral elements like phosphorus, potassium, calcium, magnesium, and iron were found to be 0.034, 0.296, 0.071, 0.076, and 0.004% respectively. *Ficus palmata* plant is used in different diseases e.g. gastrointestinal, hypoglycemic, anti-tumor, anti-ulcer, anti-diabetic, lipid-lowering, and antifungal activities. Traditionally stem latex is applied to extract spines deeply lodged in the flesh (Manandhar*et al.*, 2002).

2.3.1. Antimicrobial and Antifungal Activity:

The methanolic extract of *Ficus palmata* exhibited antimicrobial activity towards the *Bacillus cereus, Salmonella entericatyphim, Staphylococcus aureus, Staphylococcus epidermidis*,and *Streptococcus pyogenes*. The activity ranged strongly based on the diameter of inhibition zones. However, no antifungal activity was observed against the two species of fungi. The antibacterial screening on the compounds showed that Genistein and Catechin exhibited stronger antibacterial activity. As shown in figure 3.1.

Table 3.1: Antimicrobial activity of *Ficus palmata* extracts (Chandra and Saklani, 2017)

Bacterial name Genus/Species /Subspecies	Erythromycin 50µg/ml	Catechin 100µg/ml	Genistein 100µg/ml	β-sitosterol 100 µg/ml	Stigmasterol 100 µg/ml
Bacillus cereus	35	22	23	19	18
Salmonella entericatyphm	30	20	21	15	16
Staphylococcus aureus	30	21	20	16	17
Staphylococcus epidermidis	25	18	19	18	15
Streptococcus pyogenes	30	22	20	16	14

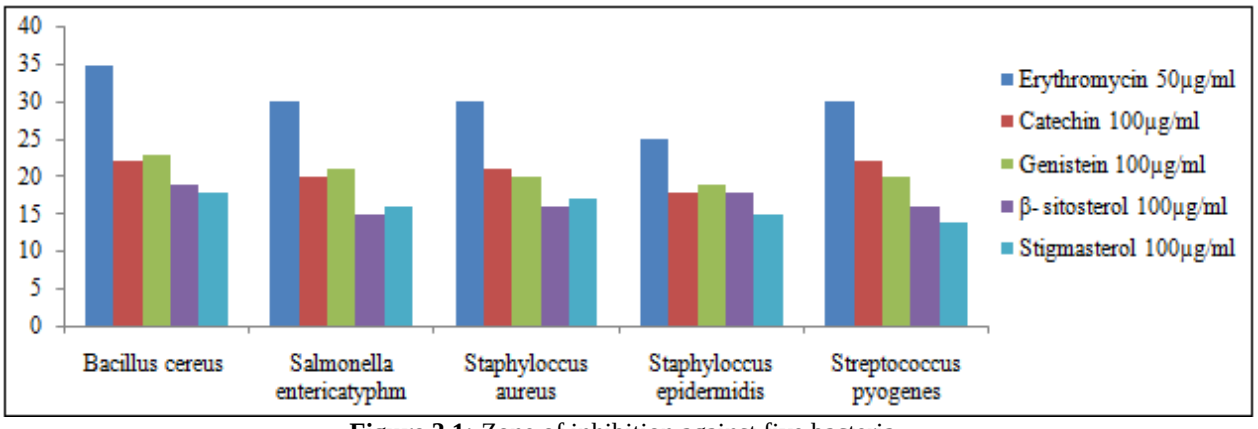


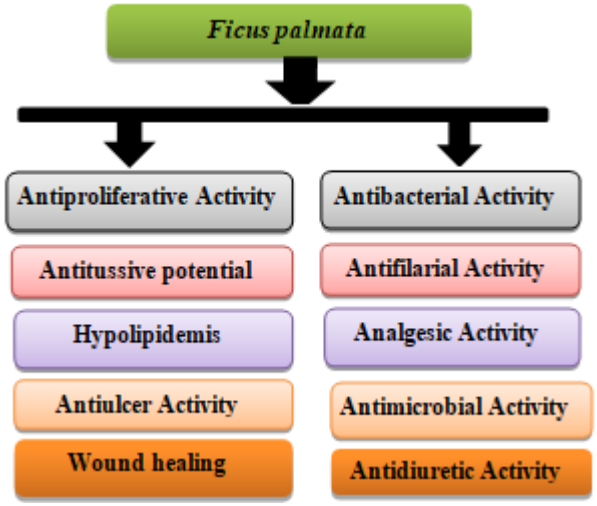
Figure 3.1: Zone of inhibition against five bacteria.

2.3.2. Phytochemical Screening:
The phytochemical screening of plants for the presence of glycosides, flavonoids, phenols, resin, and tannins. This analysis exhibited that the fruit contained a higher value of fat, protein, fiber, and minerals as compared to the cultivated fruits with mango and 500gm fruits contain a sufficient amount of nutrients required per day by a person.

Table 3.2: Phytochemical screening of *Ficus palmata* plant bark, (+) Present, (-) Absent (Saklani *et al*., 2012)

Test /Extracts	Petroleum Ether	Benzene Extract	Chloroform Extract	Methanolic Extract	Ethanolic Extract	Water Extract
Carbohydrates	-	-	-	-	-	-
Alkaloid	-	-	+	+	+	+
Flavonoids	-	-	-	+	+	+
Saponins	-	-	-	+	+	+
Tannins	-	-	-	+	+	+
Unsaturated Sterol	+	+	+	+	+	-
Resin	-	-	-	+	+	-
Phenolic Compound	-	-	-	+	+	-
Protein and Amino acid	-	-	-	-	-	-

2.3.3. Pharmacological Studies:
Ficus palmata is a medicinal plant of the family Moraceae. In recent history this plant is reported for various medicinal properties:



2.3.3.1. Antimicrobial activity:
Various extracts of *Ficus palmata* (petroleum ether, chloroform, ethyl acetate, acetone, methanolic, ethanolic and water) were displayed strong activity was tested against ten bacterial strains and three fungal strains by disc diffusion method. The ethanolic bark extracts of *Ficus palmata* showed significant against *Staphylococcus aureus* (Saklani *et al*., 2011).

2.3.3.2. Antiproliferative activity:
It has shown antiproliferative potential against C33A cells (cervical cancer cell lines) of methanolic extract was 22% and acetone extract was 63%. The extracts did not show cytotoxicity to PBMCs or HeLa (Saini *et al*., 2012).

2.3.3.3. Coagulation effect of *Ficus palmata* in yogurt production:
The concentration of the latex of *Ficus palmata* increases in raw milk, the time needed for the coagulation effect decreases. The result also showed that as the temperature increases the coagulation time decreases because bacteria found in milk are activated or initiated for coagulation within the temperature increase. The effect of yogurt coagulated by the plant latex on the health of human beings is not known so the further study should be conducted (Tasfey *etal*., 2015).

2.3.3.4. Antidiuretic:
The bark of *F. palmata* has shown an antidiuretic effect at doses of 250, 500, or 1000 mg/kg body weight. It had a quick onset (within 1 h), peaked at 3 h, and lasted throughout the study period (5 h). It also caused a reduction in urinary Na+ level and Na+/K+ ratio and an increase in urinary osmolarity indicating multiple mechanisms of action (Ratnasooriya*et al*., 2003).

2.3.3.5. Antitussive:
The extract of stem bark was checked for its antitussive potential against a cough induced model by sulfur dioxide gas in mice. The extract exhibited maximum inhibition of 56.9% at a dose of 200 mg/kg 90 min after administration (Bhaskara*et al*., 2003).

2.3.3.6. Antibacterial:
The alcoholic extract of leaves was developed effective against *Actinomyces viscosus*. The minimum inhibitory concentration was found to be 0.08mg/ml (Shaikh*et al*., 2010).

2.3.3.7. Wound healing:
Ethanol extract of stem bark showed wound healing in excised and incised wound model in rats (Biswas*et al*., 2003).

2.3.3.8. Antifilarial:
Alcoholic and aqueous extracts caused inhibition of spontaneous motility of whole worm and nerve-muscle preparation of *Setaria cervi* characterized by an increase in amplitude and tone of contractions. Both extracts caused the death of microfilariae in vitro. LC50 and LC90 were 21 and 35 mg/ml, respectively for an alcoholic, which were 27 and 42 µg/ml for aqueous extracts (Mishra *et al*., 2005).

2.3.3.9. Hypolipidemic:
The pronounced hypocholesterolemia effect was induced when the dietary fiber content of fruits was fed to rats in diet, as it increased fecal excretion of cholesterol as well as bile acids (Agarwal*et al*., 1988).

2.3.3.10. Analgesic

The ethanol extract of leaves exhibited dose-dependent analgesic activity when evaluated for analgesic activity by analgesiometer at 100, 300, and 500 mg/kg and was found to possess (Malairajan*et al*., 2006).

2.3.3.11. Antiulcer:

The 50% ethanol extract of fruits was studied in different gastric ulcer models, viz pylorus ligation, ethanol, and cold restraint stress-induced ulcers in rats at a dose of 50, 100, and 200 mg/kg body weight p.o. for 5 days twice daily. The extract showed dose-dependent inhibition of ulcer index in all three models of ulcer (Rao*et al*., 2008).

2.4 Botanical description of *Bombax ceiba* (Red silk-cotton tree)

Classification	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnolipsida
Order	Malvales
Family	Bombacaeae
Genus	*Bombax*
Species	*B. ceiba*

Bombax ceiba

Languages	**Vernacular names**
Sanskrit	Moca
Hindi	Semal
Gujarati	Shemalo
English	Silk-cotton tree
Telugu	Buruga
Assam	Simalu
Bengali	Shimool

***Bombax ceiba* Flower**

Bombax ceiba was commonly known as the “red silk-cotton tree” is a large, deciduous tree occurring in warm monsoon forests in southern Asia. It is one of the world’s most spectacular flowering trees, it is famous for its large, showy, six-inch flowers with thick, waxy, red petals that densely cloth leafless branch tips in late winter and early spring (Donald *et al*., 2012). *Bombax ceiba* belongs to the Family (Bombacaceae). It is a tall tree buttressed at the base, widely distributed throughout India and Ceylon, Malaya, up to 1500 m. The fruits are brown capsule-like up to 15 mm long, filled with numerous black seeds which are irregular obovoid in shape, smooth and oily with dense silky hair. The fruit pulp is sweet and edible. Semal trees have compound leaves which are palmate in appearance. It is large, spreading, glabrous which has common petiole and the size of the leaf is 15-30 cm long. The size of the leaflets varies from 10 cm to 20 cm. New leaves usually do not appear until flowering is over. Many parts of the plant (root, stem, bark, gum, leaf, flower, fruit, seed, and heartwood) are mainly used by various tribal communities and forest dwellers for the treatment of a wide variety of ailments (Vijendra*et al.*, 2011). Almost all parts of *Bombax ceiba* used in the treatment of hypertensive, antioxidant, hypoglycemic, antipyretic, and hepatoprotective. Traditionally it is used in diuretic, dysenteric, emetic, diarrhoeal, Wounds, Acne, skin blemish, and pigmentation, cold, and cough (Verma *et al*., 2011).

2.4.1. Antimicrobial activity:

Here the study exhibited that *Bombax ceiba* is active against both gram-positive (*Staphylococcus aureus*) and gram-negative bacteria *Shigella dysentariae*. All the extracts exhibited moderate activities in different dilutions against both the strains of bacteria. Phytoconstituents such as saponins, phenolic compounds inhibit bacterial growth and to be protective of plants against bacterial and fungal infections. As shown in figure 4.1, 4.2.

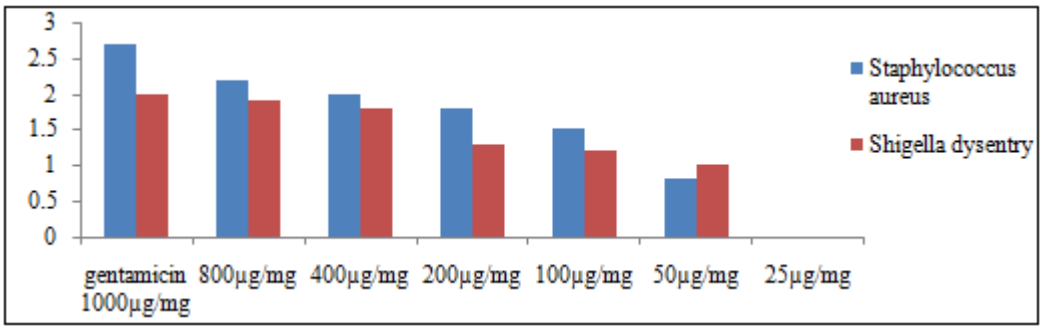


Figure 4.1: Zone of inhibition (mm) of aq. Leaves extract if different concentrations vs Standards (Nagamani *et al*., 2014).

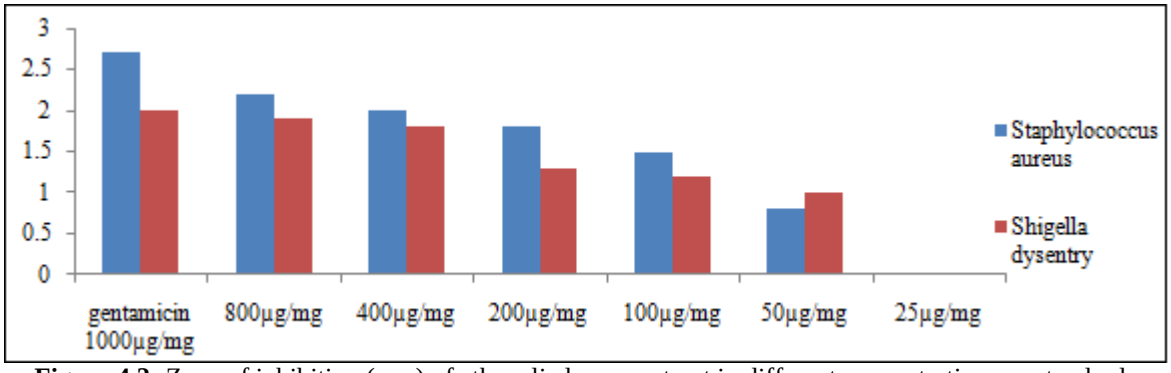


Figure 4.2: Zone of inhibition (mm) of ethanolic leaves extract in different concentrations vs standard.

2.4.2. Antioxidant Analysis:

The antioxidant activity (AA) of different solvent fractionated crude extracts of the flower obtained from the original methanol extracts was evaluated spectrophotometrically following the DPPH method (Figure 4.3).

The objective of the sample preparation (set I-III) was to identify the individual crude fraction possessing better AA. These factions are semi-purified extracts. The AA for original methanol extract was found to be 73% which is low in comparison to individualized factions. This may be due to the presence of both radical scavenging and promoter type of compounds. However, the AA increases in semi-purified fractions inferring the separation of phytocompounds towards better AA. The highest antioxidant activity (>90%) among the analyzed extracts was shown by polar solvent fractions like acetone, methanol, and ethanol for the set I, methanol, and ethanol for set II and set III. They are found to be closure to the gallic acid. These fractions may be utilized in nutraceuticals and taken up for further investigations.

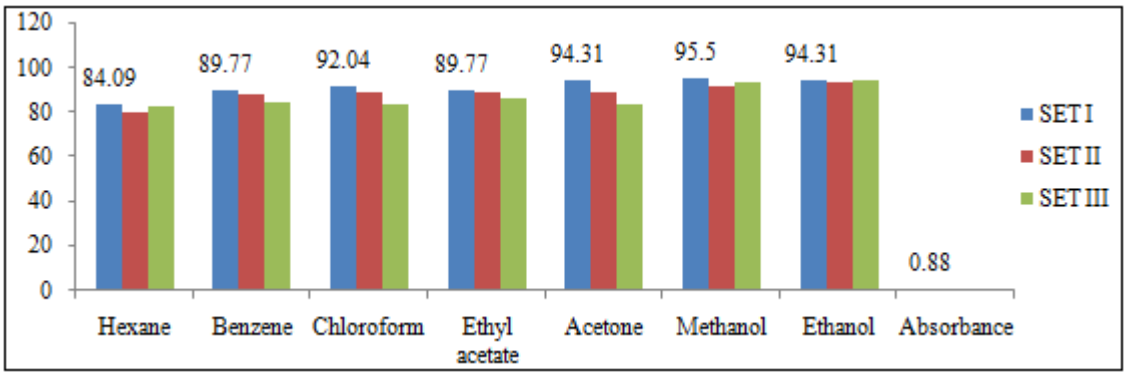


Figure 4.3: Antioxidant activity (aa%) of methanolic extract of *B.ceiba* flowers (Zahan 2013)..

Gallic acid: 95.56; Range of UV-visible spectrophotometer: 400 to 650 nm.

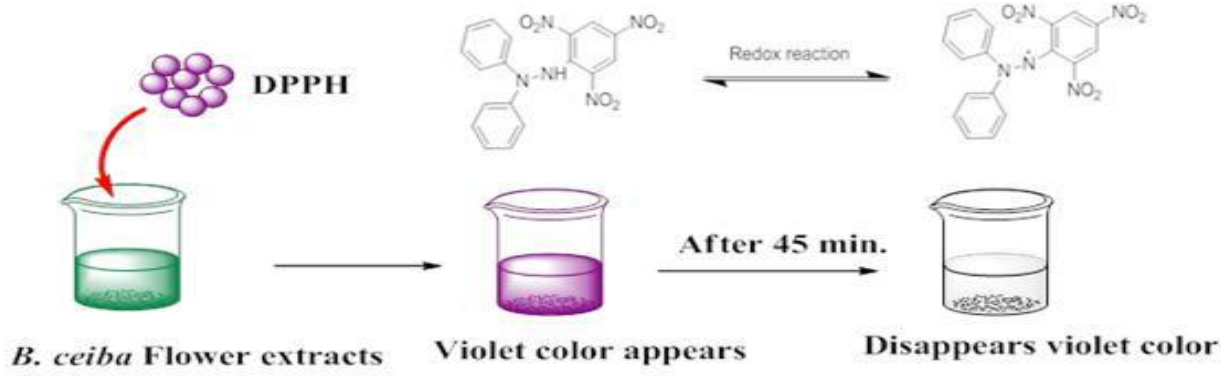


Figure 4.4: Antioxidant Evaluation

2.4.3. Phytochemical Activity

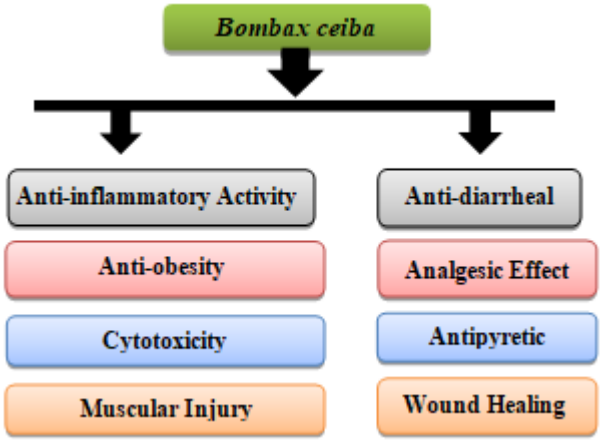
The preliminary phytochemical screening of the leaves and barks was found to exhibit the positive tests for carbohydrates, glycoside, saponin, phytosterol phenol, tannins, flavonoid, proteins, and diterpenes and a negative result for alkaloids in all the solvent extracts. The presence of glycosides, saponins, flavonoids, tannins phenolic compounds, proteins, phytosterols, carbohydrates, gums, and mucilages, have great potential as antimicrobial activity and can be used in the treatment of infectious diseases caused by resistant microorganisms.

Table 4.1: Phytochemical tests of leaves extract of *Bombax ceiba* (Umer*et al*., 2015)

Tests	Aqueous	Ethanol	Distilled water: Ethanol
Alkaloids	-	-	-
Carbohydrates	-	+	+
Glycosides	+	-	+
Saponins	+	+	+
Phytosterols	+	+	+
Phenols	+	+	+
Tannin	+	-	-
Flavonoids	+	-	-

2.4.4. Pharmacological Activities

Bombax ceiba is a medicinal plant of the family Malvales. In recent history this plant is reported for various medicinal properties:



2.4.4.1. Anti-inflammatory activity:

Traditionally fresh paste prepared from the bark of *B. ceiba* mixed with cow dung was applied over the back muscle of the leg at night to treat hotness and inflammation (Nima et al., 2009).

2.4.4.2. Anti-diarrheal:

The bark juice of *B. ceiba* was mixed with the bark juice of *Mangiferaindica* and *P. guajava* and drunk to cure dysentery and intestinal spasm. The resin of *B. ceiba* was mainly used to treatment of worms and diarrhea; root juice was consumed to treat abdominal pain and gonorrhea (Ghimire*et al.*, 1990).

2.4.4.3. Anti-obesity:

The extract of stem bark of *B. ceiba* has significant anti-obesity potential against high-fat diet-induced experimental obesity, possibly due to modulation of FAS and PTP-1B signaling in Wistar rats due to the presence of active flavonoids and lupeol, respectively (Gupta *et al*., 2013).

2.4.4.4. Analgesic Effect:

Methanolic extract of *B. ceiba* leaves, its fractions, and mangiferin induced a significant and dose-dependent analgesic effect in acetic acid writhing and hot plate test (Said *et al*., 2011).

2.4.4.5. Cytotoxicity:

Aqueous extracts of the plants were screened for their cytotoxicity using the brine shrimp lethality test (Alluri*et al*., 2005). The current study supports that brine shrimp bioassay is a simple reliable and convenient method for assessment of bioactivity of medicinal plants and lends support for their use in traditional medicine.

2.4.4.6. Antipyretic:

The methanol extract of *Bombax malabaricum* (syn*Bombax ceiba*) leaves (MEBM) was investigated for the antipyretic activity in rats (Hossain*et al*., 2011). MEBM acquired significant antipyretic activity in Baker's yeast-induced pyrexia. The phytochemical study showed the presence of steroids, carbohydrates, tannins,triterpenoids, deoxy-sugars, flavonoids, and Coumarin glycosides.

2.4.4.7. Muscular Injury:

An ethnobotanical study on medicinal plants around Mt Yinggeling, Hainan, China showed that *B. ceiba*barks and roots were used to treat muscular injury (Zheng*et al*., 2009).

2.4.4.8. Wounds:

Ethnomedicinal uses of useful plants from Mysore and Coorg districts, Karnataka included using the paste of *B.ceiba* bark externally for cattle wounds (Kshirsagar et al., 2001).

2.4.4.9. Abortifacient:
Tribal people throughout India are well-acquainted with the knowledge of the plant's usage. Preparation of about 30g of seed powder of *B. ceiba* and about 10 g Hing*(Ferula foeitida)* are used as an abortifacient by the Oraon tribe inWest Bengal (Mitra*et al*., 2009).

2.4.4.10. Birth control, sexual diseases:
An ethnobotanical survey of the tribal area of southern Rajasthan was carried out during the year 2001–2002 for ethnomusicological herbal medicines. *B. ceiba* was used as described: half a cup of ethanol extract of bark and flower was given for 3 days to both men and women with sexual diseases like hydrocele, leucorrhoea, gonorrhoea, and was also used to check menstrual disorders in women (Jain *et al*., 2004).

Studies on the ethnomedicobotany of the Kandha tribe of Orissa showed that one teaspoon juice of fresh stem bark of *B. ceiba*, one teaspoon juice of fresh root of *Asparagus racemosus*, powder of seven black peppers (dried seed of *Piper nigrum*, Piperaceae), and one teaspoon of processed sugar or gum obtain orally on an empty stomach two times daily for 21 days to cure gonorrhea, impotency, spermatorrhea, sterility, nocturnal emission and leucorrhoea. It is also prescribed for increasing sperm in semen and to act as an aphrodisiac (Behera*et al*., 2005).

2.5 Botanical description of *Carissa carandas* (Karonda)

Classification	
Kingdom	Plantae
Sub-Kingdom	Tracheobionta
Class	Mangnoliopsida
Sub-class	Asteridae
Order	Genitanales
Family	Apocynaceae
Genus	*Carissa*
Species	*C. carandas*

Languages	Vernacular Names
Sanskrit	Karamlaka
Hindi	Karando, Karonda
Tamil	Kalar
Telugu	Okalive
English	Christs thorn, Karanda
Marathi	Boranda
Malayalam	Keelay

Carissa carandas

Carissa carandas belongs to the family *Apocynaceae*, found to be widely distributed throughout India. The shrub is commonly known as karonda (Devanagari: करोंदा). *C. carandas* believed to be originated near the Himalayas (Jain, 1991). *Carissa carandas* an evergreen deciduous, in general, 2-4 m tall shrub.Its stem contain white latex, having sharp spines on branches. The leaves are ovate and conical, 4-6 inch long, and 2-3 inch wide, green on the top and brown below. The fruit is a berry, which is formed in clusters of 3-10 fruits, with 5-1 hard angles curving upwards, glabrous with five to seven wings, woody, and fibrous (Mahesawari *et al*., 2012). Traditionally Unripen fruit is used in a pickle. Ripe karonda fruit contains a high amount of pectin so it is also used in making jelly, jam, squash, syrup, tarts, and chutney, which are of great demand in the international market (Wani *et al*., 2014).

Traditionally, whole parts of the plants were used in the treatment of various ailments. Its fruits are mainly used in the treatment of liver dysfunction, to break fever, and putrefaction of blood while roots are used to improve digestion. Fruits are a beneficial and rich source of iron and vitamin C; fruits are mainly used for the treatment of anemia, astringent, antiscorbutic, and as a remedy for biliousness. The study conducted by Malik *et* al., 2010 studied the leaf is used against fever, diarrhea, and earache, whereas roots serve as a stomachic, vermifuge, remedy for itches, and insect repellent (Malik, 2010).

2.5.1. Antimicrobial Activity:
The leaf extracts of *Carissa carandas*, when subjected to antimicrobial screening at 0.1 µg/disc to 400 µg/disc the ethanol extract (EE) and n-hexane soluble fraction (nE), revealed antimicrobial activity against the tested microorganisms.

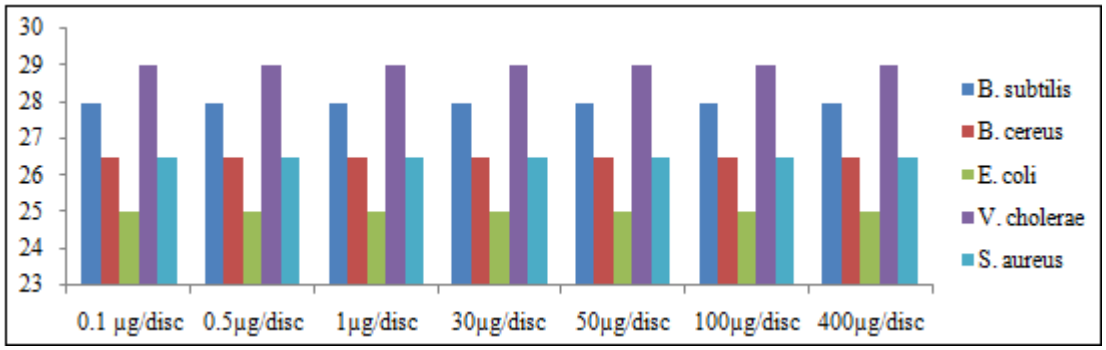


Figure 5.1: Antimicrobial Activity of extracts of leaves of *Carissa carandas* (Sadek*et al*., 2013).

2.5.2. Phytochemical Screening:
In preliminary phytochemical screening, the methanol extract of leaf of Carissa carandas demonstrated the presence of alkaloids, carbohydrate, unsaturated sterols, phenolics, and saponins (Table 5.1).

Table 5.1: Phytochemical analysis of leaves extract of *Carissa carandas* (Yakut, 2013)

Tests	Ethanol	n- Hexane
Alkaloids	+	+
Carbohydrates	+	+
Saponins	+	-
Test for unsaturated Sterols	+	+
Test for phenolic compounds	-	-
Alkaline	+	-
Lead acetate	+	-
Gelatin test	-	-

2.5.3. Antioxidant Activity:
Antioxidant activities of the *C. carandas*extracts were measured by 1,1-diphenyl-2-picrylhydrazyl (DPPH) and hydroxyl free radical scavenging assays. The DPPH radical scavenging activity of the juice and methanolic extracts of *C. carandas*at various concentrations of 25, 50, 100, 250, 500, and 1000 µg/mL showed a dose-dependentmanner as shown in Figure 1. Thejuice and methanolic extracts of *C. carandas*exhibited slightly DPPH radical scavengingactivity when compared with gallic acid (referencestandard) as shown in Table 1. The IC50 values ofgallic acid, the juice and methanolic extracts were 2.55 + 0.08, 222.20 + 7.76 and 242.82 + 17.51 µg/mL, respectively.

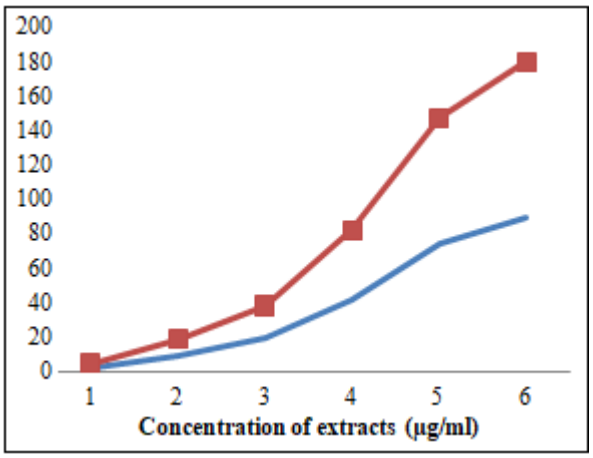
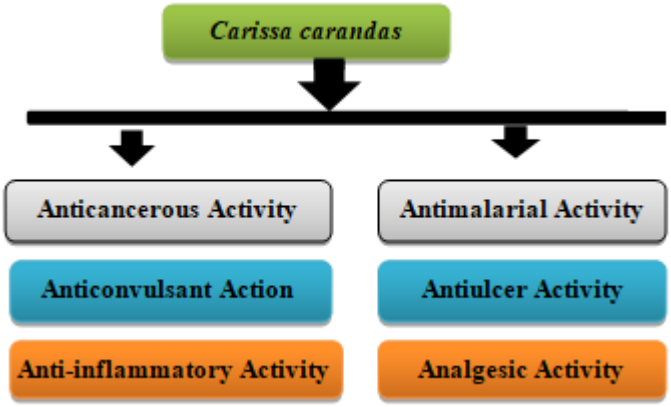


Figure 5.2: DPPH radical scavenging activity of *Carissa carandas* extracts (Ondee 2019).

2.5.4. Pharmacological Activities:
Carissa carandas is a medicinal plant of the family Apocynaceae. In recent history this plant is reported for various medicinal properties:



2.5.4.1. Anticonvulsant action:
Theethanolic extract of *C. carandas* has powerful anticonvulsant action on electrically and chemically induced seizures by unknown mode of action (Hedge, 2009).

2.5.4.2. Anti-cancerousactivity:
C. carandas leaves, the unripe and ripe fruits extract beneficial for the handling of their anti-cancer activity using n-hexane, chloroform, and methanol as the solvent systems. The extracts exhibited good anti-cancerous activity on the human ovarian carcinoma cells, and lung cancer cells (Sulaiman *et al*., 2015).

2.5.4.3. Antimalarial activity:
Analysis of *C. carandas* leaf, stem, bark, and fruit shows antimalarial activity against the *Plasmodium falciparum* 3D7 strain (Bapna *et al*., 2013).

2.5.4.4. Anti-ulcer activity:
The different extracts of *C. carandas* are more important in the cure of gastric ulcers. They evaluated that the alcoholic extract of *C. carandas* exhibited highly significant anti-ulcer activity (Merai and Jadhav *et al*., 2014).

2.5.4.5. Antimicrobial action:
The ethanolic extract of *C. carandas* carried an effective antimicrobial action against different test bacteria like *B. subtilis, S. aureus, S. faecalis, E. coli, P. aeruginosa*, and *S. typhimurium*. Ethanol extract has also shown anticandidal action (Jigna *et al*., 2005).

2.5.4.6. Analgesic, anti-inflammatory, and antipyretic activities
The ethanolic extract of *C. carandas* root can be used to cure complaints like analgesic, anti-inflammatory, and antipyretic activities (Bhaskar, 2009). Another study conducted by Anupama *et al.*2014evaluated the methanol extract of dried fruit anti-inflammatory effects on carrageenan-induced hind paw edema in rats.

2.6. Application of studied medicinal plants:

Table 2.6.1: Traditional Utilization as food

Edible tree parts	Traditional uses	References
Bauhinia variegata	In India (Himalayan region) flowers are cooked as a vegetable, used to prepare some local culinary dishes such as curry and raita as well as pickles.	Shrestha and Rai, 2012.
Ficus palmata	In Himachal Pradesh unripened fruits are cooked as a vegetable (bhrunikisabji).	Sharma and Singh, 2011.
Bombax ceiba	Buds and flowers are cooked and pickled in India. Dry stamens are used as spices for curry preparation. In China, fleshy flowers popular for curries, herbal tea;dried flowers used as an ingredient of five flower tea wuhua chai.	Freedman, 2013.
Carissa carandas	In many part of India fruits are commonly caring with green chilies to make a tasty dish taken with chapattis. At industrial scale, Karonda is mainly used for making pickle, jelly, jam, squash, syrup and chutney.	Siddiqui *et al*., 2003.

2.7. Ethenomedicinal utilization of studied medicinal plants

Tree Flowers	Ethenomedicinal Uses	Reference
Bauhinia variegata	Goiter, Anti-obesity Blood cleanser, Anti-tumor	Manoj , 2013.
Ficus racemosa	Leprosy, Menorrhagia, Leucorrhoea, Burns, Intestinal worms, Astringent, Stomachic, Menorrhea, Hemoptysis, visceral obstruction, Urinary tract infection and Blood disorders.	Ahmed *et al*., 2010.
Ficus palmata	Chronic diabetic complications such as Retinopathy, Nephropathy, Neurologic and Cardiovascular diseases.	Sheard*et al*., 2004.
Bombax ceiba	Aphrodisiac, in sexual diseases and as a tonic, Impotency, Spermatorrhea, Sterility.	Jain 2005.
Carissa carandas	Stomachic, Vermifuge, Remedy for itches, and Insect repellent	Malik , 2010.

3.1 Conclusion

Medicinal plants from local livelihoods because they have long been collected, consumed, and managed through local customs and knowledge. The present study revealed that the extracts of *Bauhinia variegata, Ficus racemosa, Ficus palmata, Bombax ceiba, Carissa carandas* contain different compounds that have health benefits. The plant extracts also showed antimicrobial, antioxidant, phytochemical compounds. Phytochemical screening revealed the richness of our plant in alkaloid, flavonoid, saponins, tannins, and sterol, which are present in large quantities in the powder of plant material and in all extract prepared. Also, the extract showed antioxidant activity. Natural products from dietary components such as medicinal plants are known to possess antioxidant activity. The pharmacological studies had validated the potency of these plants against diseases. Thus the result of this study supports the use of these plants as traditional medicines for the treatment of skin disease, leprosy, intestinal worms, cancer, anti-tumor, anti-diabetic and detailed investigation is suggested.

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