Chapter

# Phytochemical Composition, Antioxidant Potential, and Medicinal Significance of *Ficus*

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## Abstract

*Ficus*, a genus of plant family *Moraceae*, includes about 850 species. Most of the species of *Ficus* are used as a source of nutrition for humans. The roots, aerial roots, stem, bark, leaves, latex, fruit, and pulp of the *Ficus* plants are medicinally important due to the presence of a variety of bioactive phytochemical compounds, such as polyphenols, phenolic acids, triterpenoids, flavonoids, flavonols, anthocyanins, carotenoids, glycosides, polysaccharides, reducing compounds, and vitamins K, E, and C. Most of these phytochemical compounds possess strong antioxidant potential in terms of metal chelating, metal reducing, lipid reducing, and free radical scavenging capacities, which may be helpful in reducing the oxidative stress in the biological systems. On account of their high phytochemical content and strong antioxidant potential, these plants show several biological activities including antimicrobial, antidiabetic, anti-obesity, hepatoprotective, cardioprotective, and renal-protective, and anticancer activities. These plants have been found to be effective in the treatment of diabetes, stomachache, piles, skin diseases, inflammation, and cancer.

**Keywords:** Moraceae, Ficus, Phytochemical composition, Antioxidant potential, Medicinal significance

## 1. Introduction

*Ficus* is a genus of family *Moraceae* and consists of about 850 species. About 200 different varieties of *Ficus* are present as woody trees, shrubs and vines in the forests of tropical and subtropical regions [1]. About 500 species of *Ficus* are found in the region of Asia and Australia [2]. Some species of *Ficus* are also grown as indoor as well as outdoor ornamental plants. *Ficus* species are rich in nutritional components and used as a source food in Egypt, India, south China, Turkey and Malaysia. The plants of *Ficus* species are well known in the field of traditional medicine. *Ficus* species have been found to be rich source of phenolic acid and flavonoids which make them able to protect against disorders of oxidative stress [3]. Extract of these plants have been reported to be effective in the treatment of diabetes, stomachache, piles, ulcer, dysentery, inflammation, oxidative stress and cancer [4]. Ethno-medicinal uses of *Ficus* plants have been also supported by their anti-cancer, anti-inflammatory and anti-diabetic activities [5].

*Ficus* plants are among the earliest cultivated fruit and ornamental tree which attract birds and mammals. *Ficus* species, such as, *Ficus carica*, *Ficus religiosa*, *Ficus benghalensis* and *Ficus racemosa* are the most important species of this genus as a spiritual, religious and historical plants to be used as folk medicine to treat various

ailments, infectious diseases and cancer [6, 7]. Various parts of *Ficus religiosa*, have been reported to be used to treat high fever, chronic asthma and cancer and regulate menstrual cycle [8–11]. *Ficus carica* also known as edible fig, its fruit had been used from ancient times due to its activity against cancer, hepatomegaly, ulcer, platelets and inflammatory disorders. Leaves of *Ficus carica* used to treat dermatitis. It can activate potassium ATP channels and, hence, is used effectively in gut motility [12]. *Ficus racemosa* traditionally named as sacred fig is popular as its latex is used in treatment of ulcer, tumor, gout and aphrodisiac and fruits are used as laxative and digestive due to antitumor and antibacterial activity [13]. *Ficus benghalensis* commonly called Indian banyan has been reported to possess anti-insulinase, anthelmintic, and antitumor activity [14, 15]. Different species of *Ficus* shows different colors due to the presence of various pigments like polyphenols, flavonoids and anthocyanins. The skin of *Ficus* fruits contains comparatively higher content of phytochemicals and antioxidants than fruit pulp [16]. The wood of the *Ficus* plants contains latex like material within their vasculatures that provide protection and wound healing from physical assaults [17].

The genus *Ficus* is classified as:

| | |
|---|---|
| Domain | Eukaryota |
| Kingdom | Plantae |
| Subkingdom | Viridaeplantae |
| Phylum | Tracheophyta |
| Subphylum | Euphyllopsidia |
| Infra phylum | Radiatopses |
| Division | Magnoliophyte |
| Class | Magnoliopsida |
| Subclass | Dilleniidae |
| Superorder | Urticaneae |
| Order | Urticales |
| Family | *Moraceae* |
| Genus | *Ficus* |

## 2. Biochemical and nutritional composition

Since ancient times, *Ficus* species has been used as a source of food to improve the health of mankind [17]. Most of the species of *Ficus* are used in industrial products as nourishing foods. These are composed mainly of water, lipids, essential amino acids, minerals and vitamins [18]. *Ficus* genus worked as food additives that use frequently as health-promoting Mediterranean diet. It has great importance as nutraceutical and in biopharmaceutical industries [19]. They are known as rich sources of amino acids that are totally free from cholesterol and fat contents. *Ficus carica* is an excellent source of minerals containing copper, manganese, magnesium, potassium and calcium according to human needs [15, 20–22].

## 3. Phytochemicals of *Ficus* species

Phytochemicals are the bioactive components of plants having great importance in pharmaceutical and medicinal field. The genus *Ficus* consist of a variety

| Ficus species | Plant parts | Extracting solvent | Class | Phytochemical components | References |
|---|---|---|---|---|---|
| *Ficus religiosa* | Barks | Water, methanol, organic solvents, helium | Polysterols | Bergapten, bergaptol, lanosterol, β-sitosterol, stigmasterol, β-sitosterol-D-glucoside (Phytosterolin) | [24, 25] |
| | | | Flavonoids | Leucocyanidin-3-O-β-glucopyranosid, leucopelargonidin-3-O-β-D-glucopyranoside, leucopelargonidin-3-O-α-L-rhamnopyranoside, lupeol, cetyl behenate, acetate and α-amyrin acetate | |
| | | | Polyphenols | Tannin, wax, saponin, leucoanthocyanidin, leucoanthocyanin | |
| | Fruit | Water | Flavonols | Kaempferol, quercetin, and myricetin | [26, 27] |
| | | | Miscellaneous compounds | Undecane, tridecane, tetradecane, (e)-β-ocimene β-bourbonene, β-caryophyllene, α-trans bergamotene, α-thujene, α-pinene, β-pinene, α-terpinene, limonene, dendrolasine, dendrolasine α-ylangene, α-copaene, aromadendrene, α-humulene, alloaromadendrene, germacrene, bicycle-germacrene, γ-cadinene and δ-cadinene | |
| | Leaves | Ethanol | Polyphenols | Eugenol, 2-phenylethyl alcohol, and benzyl alcohol, hexenol, n-hexanol, phytol, benzyl alcohol | [28] |
| | | | Miscellaneous compounds | Phenol, salicylaldehyde, phenylacetaldehyde, allyl caproate, linalool, n-nonanal, adipoin, methylcyclopentane, 2-dione, itaconic anhydride, 2-phenylethyl alcohol, benzeneacetonitrile, nonadienal, nonen-1-ol, nonadienol, linalool oxide, catechol, coumaran, cinnamyl alcohol, vinylguaiacol, hexenyl tiglate, eugenol, hexenyl hexenoate, β-ionone, dihydroactinidiolide, α-copaene, hexenyl benzoate, eudesmol, eudesmol, epi-α-cadinol, β-eudesmol, α-eudesmol, α-cadinol, pentadecanal, palmitic acid and itaconic anhydride, 3-methylcyclopentane-1, 2-dione | |
| *Ficus auriculata* | Leaves and fruits | Ether, chloroform and ethanol | Flavonols | Kaempferol, quercetin, myricetin | [29] |
| | | | Phenolic acids | Betulinic acid, lupeol | |
| | | | Sterols | Stigmasterol, bergapten, scopoletin, β-sitosterol-3-O-β-D-glucopyranoside | |

| Ficus species | Plant parts | Extracting solvent | Class | Phytochemical components | References |
|---|---|---|---|---|---|
| *Ficus sycomorus* | Whole plant | N-butanol, ethanol and methanol | Flavonoids | Quercetin 3-O-L-rhamnopyranosyl (1-6)-β-D-glucopyranoside, quercetin 3-O-β-D-glucopyranoside (isoquercitrin), quercetin 3,7-O-α-L-dirhamnoside, quercetin, 3-O-β-D-galactopyranosyl(1-6)-glucopyranoside | [30] |
| | | | Sterol | β-Sitosterol-3-β-D-glucopyranoside | |
| | | | Phenolic acids | Gallic acid | |
| *Ficus carica* | Dried fruit | Water | Flavonoids | Alkaloids, flavonoids, coumarins, saponins, rennin, caoutchouc, resin, albumin, cerin, sugar and terpenes | [31] |
| | Latex | Water | Enzymes | Proteolytic enzymes, diastase, esterase, lipase, catalase, and peroxidase | [32] |
| | | | Phenolic acids | Malic acid | |
| | Leaves | Water | Coumarins | Psoralen and bergapten | [33] |
| | | | Flavonoids | Rutin, quercetin, and luteolin | |
| | | | Phenolic acids | Ferulic acid | |
| | | | Phytosterols | Taraxasterol, psoralen and bergapten (5-methoxypsoralen) | |
| | Pulp | Water | Phenolic acids | Chlorgenic acid | |
| | Peel | Water | Coumarins and sterol | Quercitin-3-O-rutinoside, psoralen | |
| *Ficus benghalensis* | Aerial roots | Water and methanol | Polyphenols | Saponins, tannins, glucoside and flavonoids | [14] |
| | | | Sterol | β-Sitosterol-α-D-glucose and meso-inositol | |
| *Ficus capensis* | Stem bark | Water | Polyphenols | Alkaloids, balsams, carbohydrates, flavonoids, free anthraquinones, tannins, glycosides, terpenes, resins, sterols and saponins, glycosides | [34] |
| | Leaves | Water | Volatile compounds | Carvacrol, α-caryophyllene, caryophyllene oxide, linalool, 3-tetradecanone, geranylacetone, 3,7,11-trimethyl-3-hydroxy-6;10-dodecadiene-1-yl acetate, hexahydrofarnesyl acetone, α-caryophyllene, 2-methyl-3-hexyne and scytalone | [35] |
| *Ficus polita Vahl* | Roots | Water | Phenolic acids | Betulinic acid and ursolic acid | [36] |
| | | | Anthocyanins | Trihydroxy-stilbene-3, 5-O-β-D-diglucopyranoside, euphol-3-ocinnamate, lupeol, taraxar-14-ene | |
| *Ficus microcarpa* | Aerial roots | | Triterpenoids | Friedelin, lupeol, oleanolic acid, ursolic acids | [37] |
| | Leaves | | Flavoinoids | Catechin, epicatechin and isovitexin | |

| Ficus species | Plant parts | Extracting solvent | Class | Phytochemical components | References |
|---|---|---|---|---|---|
| *Ficus retusa* | Leaves | Methanol | Polyphenols | 1,2-Benzenedicarboxylic acid-dibutyl ester, phenol, 4-(2aminopropyl), butyrolactone | [38] |
| | Aerial parts | Ethanol | Flavonols | Luteolin, afzelechin, catechin, vitexin, β-sitosterol acetate, β-amyrin acetate, moretenone, β-amyrin | [39] |
| | | | Sterols | β-Sitosterol, friedelenol | |
| *Ficus palmata* | Stem bark | Water | Anthocyanins | Cetyl behenate, lupeol, α-amyrin acetate | [40] |
| | Leaves and bark | Water | Sterols | β-Sitosterol and a new tetracyclic tritepene-glaunol acetate | |
| *Ficus thunbergii* | Fresh leaves and stem | Methanol | Anthocyanins | Amyrin acetate, α-amyrin acetate, lupeol, β-amyrin, α-amyrin, rhoiptelenol, 3α-hydroxyisohop-22(29)-en-24-oic acid, lupenyl acetate | [41] |
| | | | Phenolic acids | Ursolic acid, betulinic acid | |
| *Ficus cordata* | Stem bark | Water | Terpenes | Pentacyclic triterpenes 8,26-cyclo-urs-21-en3β, 20β-diol and 3β-acetoxy-8, 26-cyclo-ursan-20β-ol and also 3-friedelanone | [42] |
| | | | Phenolic acids | Oleanolic acid, betulinic acid | |
| | | | Anthocyanins | Lupeol acetate, α and β amyrine, 3,5,7,4′-tetra hydroxyl flavones | |
| *Ficus deltoidea* | Leaves | Hot and cold water | Flavonols | Triterpene, conrauidienol, and dihydroflavonol, conrauiflavonol, 3,4',5-trihydroxy-6'',6''-dimethylpyrano[2,3-g]flavone | [43–45] |
| | | | Anthocyanin | β-amyrin acetate, 6β-hydroxystigmasta-4,22-dien-3-one, 8-prenylapigenin | |
| | | | Phenolic acid | Betulinic acid, ursolic acid | |
| | | | Flavonoids | Luteolin, catechin, epigallocatechin, orientin | |
| | | | Sterol | β-Sitosterol glucoside | |
| *Ficus tsiela* | Whole plant | Water | Phenolic acid | Gallic acid | [46] |
| | | | Anthocyanin | 3, β-hydroksilup-20(29)-en, (lupeol) | |
| | | | Polyphenols | Carbohydrates, glycosides, saponins, resins, fat, flavonoids, tannins, and phenolic compounds. Alkaloids and steroid were absent | [47] |

**Table 1.**
*Phytochemical quality of various parts of commonly used species of Ficus.*

| *Ficus* species | Plant parts | ES | TPC | TFC | TF | AAC | TAC | TSC | TA | References |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ficus benghalensis* | Roots | Ethanol | 70 mg/g extract | 5 mg QE/g extract | 3 mg QE/g extract | | | | | [48] |
| *Ficus deltoidea* | Pulp | Water | 0.49–0.88 mg GAE/g | | | | | | | [49] |
| *Ficus microcarpa* | Leaves | Hexane | | 6.6–9.5 M/TE | | | | | | [50] |
| *F virens* | Dried leaves | Hexane | 17.44 mg/g | 3.87 mg/g | | | | | | [51] |
| *F racemosa* | Dried leaves | Methanol | 7.83 mg/g | 1.05 mg/g | | | | | | [51] |
| *Ficus carica* | Fruit | Ethanol | 28.6–211.19 mg GAE/100 g FW, 11.9 mg/g of DM | 2.75 μg CE/mg sample | | | 9.6% | 0.59% | 0.0–298.6 μg cy-3-rutinoside/g FW | [52, 53] |
| *Ficus deltoidea* | Fruit | Hexane | 259.2 mg GAE/g | | | | | | | [54] |
| | | Methanol | 245.2 mg GAE/g | | | | | | | |
| | | Chloroform | 159.2 mg GAE/g | | | | | | | |
| *Ficus indica* | Pulp | Methanol | | | | 28–30 mg/100 g extract | | | | [55] |

*ES: extracting solvents, TPC: total phenolic content, TFC: total flavonoid content, TF: total flavonols, AAC: ascorbic acid content, TAC: total alkaloid content, TSC: total saponin content, TA: total anthocyanins, DM: dried material, QE: quercetin equivalent, TE: trolox equivalent, ep: edible pulp, GAE: gallic acid equivalent, FW: fresh weight.*

**Table 2.**
*Phytochemical content of various parts of commonly used species of Ficus.*

of phytochemicals including phenolics, polyphenols, flavonoids, tannins, anthocyanins, coumarins, volatile components, glycosides, saponins, carotenoids, alkaloids, triterpenoids and vitamins. Most of these phytochemical compounds show health promoting effects in human due to their strong antioxidant potential. Higher concentrations of phytochemicals are responsible for the strong antioxidant potential of plants of genus *Ficus* and are helpful in the prevention of certain cardiovascular, neurodegenerative, and hepatic diseases caused by oxidative stress [23]. The phytochemical quality of various parts of some of the species of *Ficus* is presented in **Table 1**. It is reported that the roots, stem bark or wood, branches, fruit pulp, peel, leaves, and seeds of different species of *Ficus* plant contain the flavonoids and phenolic compounds as major phytochemical components along with polyphenol, polysterols and triterpenoids. The phytochemical content of various parts of some of the species of *Ficus* in terms of total phenolic, flavonoids, flavonols, ascorbic acid, alkaloids, saponins and anthocyanins contents in different solvents is presented in **Table 2**. The leaves and fruit pulp of various species of *Ficus* have been found to show relatively higher concentration of phenolic components due to which these parts comparatively have greater pharmacological as well as medicinal usage.

## 4. Antioxidant composition

Antioxidants are the substances which can scavenge free radicals and reduce the oxidative stress in the living and nonliving systems. The antioxidants possess electron donating ability and inhibit the free radical-mediated oxidative reactions by various mechanisms, such as, hydrogen donation, metal chelation, metal and lipid reduction, inhibition of lipid peroxidation and free radical inhibition [56–60]. Free radicals are the reactive oxygen and nitrogen species which are produced during various biochemical reactions particularly redox reactions. If not controlled properly, these free radicals may initiate the chain reactions in the biomolecules particularly the lipids and protein, cause the oxidative stress, and finally lead to the oxidative damage to the cell organelles, cells and tissues [24]. The oxidative damage to the cells and tissues may further lead to various health problems including cardiovascular, neurological, hepatic, and musculoskeletal abnormalities and aging. In nonliving system, the free radicals cause oxidative stress and rancidity in the food stuff for human [25]. The naturally occurring antioxidant compounds have been proved to be effective in preventing the oxidative damage to the living and nonliving systems [26]. These substances are either synthesized endogenously or taken from exogenous natural sources such as plants. The naturally occurring antioxidants include some enzymes such as glutathione peroxidase, catalase, superoxide dismutase and some non-enzymatic phytochemicals compounds including phenolic acids, polyphenols, flavonoids, anthocyanins, ascorbic acid, tocopherols, and β-carotenes [27, 28]. Some synthetic antioxidant compounds have been also reported to be effective against free radical-induced oxidative damage [29].

The antioxidant profile of various parts of *Ficus* species is presented in **Table 3**. Different parts of *Ficus* plants have been reported to showed antioxidant activity in terms of Trolox equivalent antioxidant capacity, ferric reducing antioxidant power, lipid reducing activity, inhibition of lipid peroxidation, and free radical scavenging capacity against 2,2-diphenyl picryl hydrazyl (DPPH) and 2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radicals in a dose dependent vstronger antioxidant activity due to relatively higher concentration of phenolic components [30].

| *Ficus* species | Part | ES | TEAC* | FRAC | DPPH-RSC | ABT-RSC | ILP | LRA | References |
|---|---|---|---|---|---|---|---|---|---|
| *Ficus racemosa* | Stem | Methanol | | | 16.2% | 8615.3 mmol/g DM | | | [61] |
| | Bark | Ethanol | | | 79% | 10884.6 μmol/g DM | | | |
| | Roots | Water | | 0.5–0.26 mg/ml | | | | | |
| *Ficus virens sublanceolata* | Leaves | Water | | 0.13–0.66 mg/ml | $IC_{50}$: 0.34 mg/ml | $IC_{50}$: 0.23 mg/ml | 83.30% | | [51] |
| *Ficus vasculosa* | Leaves | Methanol | | 0.07–0.26 mg/ml | $IC_{50}$: 0.69 mg/ml | $IC_{50}$: 0.97 mg/ml | | | [51] |
| *Ficus indica* | Mouse liver | Normal saline | | | | 4.20–5.31 μmol TE/g ep | $EC_{50}$: 313.3 μg/ml | | [55, 62] |
| | Chicken liver | Normal saline | | | | | $EC_{50}$: 333.8 μg/ml | | |
| *Ficus callosa* | Fruit | Methanol | | 0.08–0.33 mg/ml | $IC_{50}$: 0.95 mg/ml | $IC_{50}$: 0.35 mg/ml | 41–83% | | [51] |
| *Ficus palmate* | Fruit | Methanol | | 77.6 mg AC/100 g FW | 104.9 mg CE/100 g FW | 577.09 mg BH/100 g FW | | | [63, 64] |
| | | Ethanol | | 146.67 mg AC/100 g FW | 146.9 mg CE/100 g FW | 729.45 mg BH/100 g F W | | | |
| *Ficus auriculata* | Roots | Acetone | | 0.1–0.45 mg/ml | $IC_{50}$: 0.29 mg/ml | $IC_{50}$: 0.25 mg/ml | 41–83% | | [51] |
| *Ficus virens* | Bark | Water | | 0.06–0.32 mg/ml | $IC_{50}$: 1.03 mg/ml | $IC_{50}$: 0.48 mg/ml | | | [51] |
| | Leaves | Methanol | | | $SC_{50}$ (74.00 μg/ml) | | | | [65] |
| *Ficus oligodon* | Leaves | Acetone | | 0.04–0.22 mg/ml | $IC_{50}$: 2.54 mg/ml | $IC_{50}$: 0.86 mg/ml | 41.40% | | [51] |
| *Ficus benghalensis* | Aerial roots | Methanol | | | 71% | 6096.1 μmol/g DM | | | [61, 66] |
| | | Acetone, Water | | 0.1–1.0 mg/ml | 96.07% | 6182.7 μmol/g DM | | | |
| *Ficus auriculata* | Stem bark | Methanol | | | 84.088% | | | | [67] |
| | Stem bark | Chloroform | | | 83.864% | | | | |
| | Stem bark | Hexane | | | 42% | | | | |
| *Ficus caprefolia* | Leaves | Acetone | 2.32%, 4.73 mg GAE/g DW | | | | | | [68] |

| ***Ficus* species** | **Part** | **ES** | **TEAC*** | **FRAC** | **DPPH-RSC** | **ABT-RSC** | **ILP** | **LRA** | **References** |
|---|---|---|---|---|---|---|---|---|---|
| *Ficus carica* | Leaves | Hexane, water | 14.04%, 23.50 acetate/g DW | 7.9–16.1 mmol/kg FW | 11.42 mmol/100 g DW | 6.48 mmol/100 g DW | | | [52, 69, 70] |
| *Ficus carica* | Fruit | Dichloromethane | | | | | $IC_{50}$: 0.02 mg/ml | | [71] |
| | | N hexane | | | | | $IC_{50}$: 1.64 mg/ml | | |
| *Ficus glomerata* | Root, Bark | Water | | | $IC_{50}$: 1.62–47.50 μg/ml | $IC_{50}$: 0.91–6.48 μg/ml | | 86.13% | [72] |
| *Ficus cordata* | Leaves | Acetone | 2.65%, 8.23 mg GAE/g DW | | | | | | [68] |
| *Ficus pumila* L | Leaves | Ethanol | | | $SC_{50}$ > 0.4 mmol/100 g DW | | | | [73] |
| *Ficus sur* | Bark | Water | 489.4 mg GAE/g DW | 104.57 μmol FSE/mg DE | 56.50 QE/mg DE | | | | [74] |
| | Unripe fruit | | 62.34 GAE/g DW | 19.61 μmol FSE/mg DW | 7.3 QE/mg DE | | | | |
| *Ficus craterostoma* | Leaves | Acetone | 2.60%, 9.80 mg GAE/g DW | | | | | | [68] |
| *Ficus religiosa* | Fruit | Methanol | | | 55.9% | | | 93.91% | [75] |
| *Ficus deltoidea* | Fruit | Water | 5.89 mg GAE/g DW | 1.82 mmol FSE/g DE | $IC_{50}$ = 111.20 μg/ml | 1.01–1.04 mmol TE/g DE | | | [76] |
| *Ficus glumosa* | Leaves | Acetone | 2.60%, 19.24 mg GAE/g DW | | | | | | [68] |
| *Ficus microcarpa* | Bark | Ethyl acetate | 436 mg GAE/g DW | 63.2 μg/ml | 1.2 μg/ml | 4.83 μg/ml | | | [71] |
| | Leaves | Ethanol | | | | | | 86.13% | |
| | | Hexane | | | | | | 86.76% | |

| *Ficus* species | Part | ES | TEAC* | FRAC | DPPH-RSC | ABT-RSC | ILP | LRA | References |
|---|---|---|---|---|---|---|---|---|---|
| *Ficus cunninghamii* | Leaves | Ethanol | | | | | | 90.70% | [71] |
| | | Hexane | | | | | | 88.97% | |
| *Ficus mysorensis* | Leaves | Ethanol | | | | | | 90.13% | [71] |
| | | Hexane | | | | | | 94.38% | |
| *Ficus microcarpa* | Fruit | Water organic solvents | 17.9 g GAE/g DW | | | | | | [22] |
| *Ficus lyrata* Warb | Leaves | Ethanol | | | $SC_{50}$ (8.27, 12.14 μg/ml) | | | 80.41% | [65] |
| | | Methanol | | | $SC_{50}$ (38.37 mg/ml) | | | | [65] |
| | | | | | | | | | |
| *Ficus nitida* L. | Dried leaves | Methanol | | | $SC_{50}$ (61.67 μg/ml) | | | | [65] |
| *Ficus afzelii* G. | Pulp | Methanol | | | $SC_{50}$ (60.22 μg/ml) | | | | [65] |
| *Ficus decora* Hort | Leaves | Methanol | | | $SC_{50}$ (81.62 μg/ml) | | | | [65] |
| *Ficus lutea* | Leaves | Acetone | 3.70%, 56.85 mg GAE/g DW | | | | | | [68] |
| *Ficus natalensis* | Leaves | Acetone | 2.35%, 4.75 mg GAE/g DW | | | | | | [68] |
| *Ficus polita* | Leaves | Acetone | 3.15%, 8.04 mg GAE/g DW | | | | | | [68] |
| *Ficus religiosa* | Leaves | Acetone | 2.45%,5.40 mg GAE/g DW | | | | | | [68] |

| ***Ficus* species** | **Part** | **ES** | **TEAC*** | **FRAC** | **DPPH-RSC** | **ABT-RSC** | **ILP** | **LRA** | **References** |
|---|---|---|---|---|---|---|---|---|---|
| *Ficus sycomorus* | Leaves | Acetone, hexane and methanol | 2.60%, 12.33 mg GAE/g DW | | $SC_{50}$ (79.50 μg/ml) | | | 82.35% | [65, 68] |
| *Ficus thonningii* | Leaves | Acetone | 2.40%, 4.64 mg GAE/g DW | | | | | | [68] |
| *Ficus macrophylla* | Leaves | Ethanol | | | | | | 86.40% | [71] |

**ES: extracting solvent, ABTS-RSC: azino-bis-tetrazolium sulfate radical scavenging capacity, DE: dry extract, DM: dry matter, DPPH-RSC: 2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity, DW: dry weight, FRAC: ferric-reducing antioxidant capacity, FSE: ferrous sulfate equivalent, FW: fresh weight, GAE: gallic acid equivalent, $IC_{50}$: inhibitory concentration required for 50% inhibition, QE: quercetin equivalent, $SC_{50}$: scavenging concentration for required for 50% scavenging, TEAC: trolox equivalent antioxidant capacity, TE: trolox equivalent, BH: butylated hydroxyanisole, FW: fruit weight, CE: catechin equivalents, ILP: inhibition of lipid peroxidation, LRA: lipid reducing ability.*

**Table 3.**
*Antioxidant potential of extracts from various parts of Ficus species.*

## 5. Biological activities

On the basis of their phytochemical composition and antioxidant profile, *Ficus* species have been found to show several biological activities (**Table 4**). The studied species of *Ficus* plants were found to possess anticancer, hepatoprotective, hypoglycemic, antitumor, antioxidant, anthelmintic, analgesic, antimicrobial activity, anti-parasitic, hypolipidemic, anti-inflammatory, antibacterial, anti-ulcerogenic, mucoprotective, gastroprotective, antifungal, antiviral, antimalarial, and antiparasitic activities [43, 69]. However, the antibacterial activity has been found to be more common in different species of *Ficus*.

| ***Ficus* species** | **Plant part** | **Extracting solvent** | **Activity** | **References** |
|---|---|---|---|---|
| *Ficus racemosa* | Whole | Ethanol | Anticancer activity by reduction of lipid peroxidation, γ-glutamyl transpeptidase and xanthine oxidase and by generation of hydrogen peroxide | [77] |
| | Bark | Methanol | Hepatoprotective activity by reducing the activities of ALT, AST and ALP | [4] |
| | Whole | Ethanol | Hypoglycemic activity by decreasing blood glucose level | [4] |
| *Ficus religiosa* | Fruit | Water | Antitumor activity due to blockage of calcium uptake in pituitary cells | [13] |
| | Whole | Water | Antioxidant and antidiabetic activity with lowering the superoxide dismutase exaggerated activity | [78] |
| | Whole | Methanol | Anthelmintic activity with 100% effectiveness | [79] |
| | Whole | Water | Antimicrobial activity with inhibition zone against *B. subtilis* | [4] |
| | Bark | Methanol | Anti-parasitic effect with 100% lethality for *Haemonchus contortus* worms | [79] |
| *Ficus benghalensis* | Bark | Water | Antioxidant and hypolipidemic activity by reduction in lipid peroxidation, cholesterol level and triacylglycerol | [80] |
| | Fruit | Water | Anticancer and antibacterial activity but no antifungal activity | [81] |
| | Roots | Various polarity solvents | Anti-inflammatory and analgesic activity | [82] |
| | Whole | Methanol | Anti-inflammatory and analgesic activity due to inhibition of malanodialdehyde formation | [82] |
| *Ficus hispida* | Roots | Methanol | Antiulcerogenic activity with cytoprotective nature of constituents | [83] |
| *Ficus arnottiana* | Leafs | Methanol | Mucoprotective activity and gastric antisecretory | [23] |
| *Ficus carica* | Leaves | Methanol | Hepatoprotective activity with decrease in lipid peroxides with cytochrome p450 complex inhibition | |
| *Ficus glomerata* | Fruit | Ethanol | Gastroprotective effect | [84] |
| | Fruit | Phenol | Anti ulcerogenic, antimutagenic and anti cancerogenic compounds | [84] |

| ***Ficus* species** | **Plant part** | **Extracting solvent** | **Activity** | **References** |
|---|---|---|---|---|
| *Ficus polita* Vahl | Whole | Water | Antiviral activity due to inhibition of reverse transcriptase activity of HIV-1 | [85] |
| | Leaves | Water | Antimalarial action against *Plasmodium falciparum*. | [86] |
| *Ficus lyrata* | Leaves | Water, ethanol | Significant antibacterial activity | [35] |
| | Leaves | Water | Activate against standard human pathogenic yeasts strains | [87] |
| *Ficus Tsiela* | Leaves | Diethyl ether | Anti-pneumonia activity | [88] |
| *Ficus sycomorus* L | Leaves | Water | Significant antibacterial activity but no antifungal activity | [35] |
| *Ficus deltoidea* | Leaves and fruits | Alcohol | Antifungal and antibacterial activities | [89] |
| *Ficus platyphylla* | Stem bark | Water | Antimicrobial activities against *S. aureus* | [65] |
| *Ficus thonningii* | Leaf | Water | Significant antimicrobial effect | [90] |
| *Ficus lutea* | Leaves | Acetone | Act as potent inhibitor of α-amylase | [68] |

**Table 4.**
*Biological activities of extracts from various parts of Ficus species.*

## 6. Medicinal importance

*Ficus* species have been used as traditional medicines to cure diseases, such as, astringents carminatives, stomachic, vermicides, hypotensive, anthelmintic and anti-dysentery drugs [18]. *Ficus* species, such as, *Ficus racemosa*, *F. glomerata*, *F. glumosa*, *F. carica*, *F. religiosa* and *F. benghalensis* are known from ancient times as herbal medicines to treat diabetic disorders as regulating enzymatic activities, carbohydrates absorption rate, increasing insulin sensitivity, insulin secretion, hepatic glycogen synthesis, peripheral glucose uptake and antioxidant status of body [19]. The extracts of these species also reduce oxidative stress by improving weight gain in diabetic male rats [20]. Aqueous bark extract of *F. benghalensis* have been found to be active in lowering the cholesterol level in hypercholesterolemic rats [14, 15]. Methanolic extract of *F. carica* leaves prevent elevation of lipid peroxide in rats by acting as hepatoprotective agent [21]. Methanolic extracts of *F. hispida* roots exhibit anti ulcerogenic activity due to higher concentration of flavonoids in roots. Methanolic leaf extract of *F. arnottiana* exhibits both mucoprotective as well as gastric antisecretory activities due to antioxidant constituents [22, 23].

Almost all of the *Ficus* species belonging to family *Moraceae* haven traditionally used as folk medicine to cure respiratory disorders and skin diseases. The roots of *Ficus* species are important to treat gout and gums diseases that have anthelmintic activity. Fruit of *Ficus* species, such as, *F. carica*, *F. hispida*, *F. microcarpa* and *F. sycomorus* has been found to be helpful improving digestion or treating vomiting. Dried powder of bark has importance to treat burns or Asthma [4]. *F. benjamina* exhibits antitumor activity or antibacterial activity but is unable to work on fungal disorders [13, 14]. Leaves of *F. religiosa* exhibit hypotensive activity and help in treating the gastrointestinal problems [9, 56, 57]. Bark of *F. religiosa* shows hypoglycemic activity and is used against gonorrhea, bleeding, paralysis, diarrhea, bone fracture, antiseptic, astringent and antidote [58, 59]. It has been also used against liver disorders, hemorrhoid, urinary tract infections and inflammatory conditions by different mechanisms [60].

## 7. Conclusion

All species of *Ficus* plant possess antioxidant potential due to higher concentration of phytochemical compounds. They have a valuable role in human nutrition or have a great medicinal importance due the presence of a variety of bioactive phytochemical compounds. The principal phytochemicals present in *Ficus* species are polyphenols, phenolic acids, flavonoids, anthocyanins, glycosides, carotenoids, and some water-soluble vitamins. The presence of these phytochemicals makes *Ficus* a medicinal plant which shows various biological activities particularly the antioxidant activity. On the account of its high antioxidant potential, all parts of *Ficus* plant can be used for the management of oxidative stress and the treatment of various diseases.

## Conflict of interest

The authors have no conflict of interest regarding this chapter.

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## References

[1] Awad NE et al. Hypolipidaemic and antioxidant activities of *Ficus microcarpa* (L.) in hypercholesterolemic rats. Natural Product Research. 2011;**25**(12):1202-1207

[2] Al-Aboudi A, Afifi FU. Plants used for the treatment of diabetes in Jordan: A review of scientific evidence. Pharmaceutical Biology. 2011;**49**(3):221-239

[3] Sirisha N et al. Antioxidant properties of *Ficus* species—A review. International Journal of PharmTech Research. 2010;**2**(4):2174-2182

[4] Joseph B, Raj SJ. Phytopharmacological and phytochemical properties of three *Ficus* species—An overview. International Journal of Pharma and Bio Sciences. 2010;**1**(4):246-253

[5] Khedr AI et al. Panduramides A-D, new ceramides from *Ficus pandurata* fruits. Phytochemistry Letters. 2018;**23**:100-105

[6] Shanahan M et al. Fig-eating by vertebrate frugivores: A global review. Biological Reviews. 2001;**76**(4):529-572

[7] Wilson D, Wilson A. Figs as a global spiritual and material resource for humans. Human Ecology. 2013;**41**(3):459-464

[8] Prasad P et al. Medico-historical study of "aśvattha" (sacred fig tree). Bulletin of the Indian Institute of History of Medicine (Hyderabad). 2006;**36**(1):1-20

[9] Ghimire K, Bastakoti RR. Ethnomedicinal knowledge and healthcare practices among the Tharus of Nawalparasi district in Central Nepal. Forest Ecology and Management. 2009;**257**(10):2066-2072

[10] Shah N. Herbal folk medicines in northern India. Journal of Ethnopharmacology. 1982;**6**(3):293-301

[11] Singh A, Raghubanshi A, Singh J. Medical ethnobotany of the tribals of Sonaghati of Sonbhadra district, Uttar Pradesh, India. Journal of Ethnopharmacology. 2002;**81**(1):31-41

[12] Gilani AH et al. Ethnopharmacological studies on antispasmodic and antiplatelet activities of *Ficus carica*. Journal of Ethnopharmacology. 2008;**119**(1):1-5

[13] Mousa O et al. Bioactivity of certain Egyptian *Ficus* species. Planta Medica. 1992;**58**(S1):632-633

[14] Aswar M et al. Anthelmintic activity of *Ficus benghalensis*. International Journal of Green Pharmacy (IJGP). 2008;**2**(3):170-172

[15] Shukla R et al. Antioxidant effect of aqueous extract of the bark of *Ficus benghalensis* in hypercholesterolaemic rabbits. Journal of Ethnopharmacology. 2004;**92**(1):47-51

[16] Solomon A et al. Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.). Journal of Agricultural and Food Chemistry. 2006;**54**(20):7717-7723

[17] Lansky EP et al. *Ficus* spp. (fig): Ethnobotany and potential as anticancer and anti-inflammatory agents. Journal of Ethnopharmacology. 2008;**119**(2):195-213

[18] Trivedi C, Shinde S, Sharma R. Preliminary phytochemical and pharmacological studies on *Ficus racemosa* (Gular). The Indian Journal of Medical Research. 1969;**57**(6):1070-1074

[19] Deepa P et al. A role of *Ficus* species in the management of

diabetes mellitus: A review. Journal of Ethnopharmacology. 2018;**215**:210-232

[20] You T, Nicklas BJ. Chronic inflammation: Role of adipose tissue and modulation by weight loss. Current Diabetes Reviews. 2006;**2**(1):29-37

[21] Mohan GK et al. Hepatoprotective activity of *Ficus carica* Linn leaf extract against carbon tetrachloride-induced hepatotoxicity in rats. DARU Journal of Pharmaceutical Sciences. 2007;**15**(3):162-166

[22] Ao C et al. Evaluation of antioxidant and antibacterial activities of *Ficus microcarpa* L. fil. extract. Food Control. 2008;**19**(10):940-948

[23] Gregory M et al. Anti-ulcer (ulcer-preventive) activity of *Ficus arnottiana* Miq. (*Moraceae*) leaf methanolic extract. American Journal of Pharmacology and Toxicology. 2009;**4**(3):89-93

[24] Al-Snafi AE. Pharmacology of *Ficus religiosa*-a review. IOSR Journal of Pharmacy. 2017;**7**(3):49-60

[25] Rajiv P, Sivaraj R. Screening for phytochemicals and antimicrobial activity of aqueous extract of *Ficus religiosa* Linn. International Journal of Pharmacy and Pharmaceutical Sciences. 2012;**4**(5):207-209

[26] Grison-Pigé L et al. Fig volatile compounds—A first comparative study. Phytochemistry. 2002;**61**(1):61-71

[27] Makhija IK, Sharma IP, Khamar D. Phytochemistry and pharmacological properties of *Ficus religiosa*: An overview. Annals of Biological Research. 2010;**1**(4):171-180

[28] Poudel A, Satyal P, Setzer WN. Composition and bioactivities of the leaf essential oil of *Ficus religiosa* Linn. American Journal of Essential Oils and Natural Products. 2015;**2**(3):16-17

[29] El-Fishawy A, Zayed R, Afifi S. Phytochemical and pharmacological studies of *Ficus auriculata* Lour. Journal of Natural Products. 2011;**4**:184-195

[30] Mohamed AE-HH et al. Chemical constituents and biological activities of *Artemisia herba-alba*. Records of Natural Products. 2010;**4**:1

[31] Vaya J, Mahmood S. Flavonoid content in leaf extracts of the fig (*Ficus carica* L.), carob (*Ceratonia siliqua* L.) and pistachio (*Pistacia lentiscus* L.). BioFactors. 2006;**28**(3-4):169-175

[32] Aref HL et al. In vitro antimicrobial activity of four *Ficus carica* latex fractions against resistant human pathogens (antimicrobial activity of *Ficus carica* latex). Pakistan Journal of Pharmaceutical Sciences. 2010;**23**(1):53-58

[33] Jeong M-R, Kim H-Y, Cha J-D. Antimicrobial activity of methanol extract from *Ficus carica* leaves against oral bacteria. Journal of Bacteriology and Virology. 2009;**39**(2):97-102

[34] Oyeleke S, Dauda B, Boye O. Antibacterial activity of *Ficus capensis*. African Journal of Biotechnology. 2008;**7**(10):1414-1417

[35] Salem MZ et al. Antimicrobial activities and phytochemical composition of extracts of *Ficus* species: An over view. African Journal of Microbiology Research. 2013;**7**(33):4207-4219

[36] Kuete V et al. Antimicrobial activities of the methanol extract, fractions and compounds from *Ficus polita* Vahl. (*Moraceae*). BMC Complementary and Alternative Medicine. 2011;**11**(1):6

[37] Chiang Y-M, Kuo Y-H. Novel triterpenoids from the aerial roots of *Ficus microcarpa*. The Journal of Organic Chemistry. 2002;**67**(22):656-7661

[38] Aly HI et al. The value-added uses of *Ficus retusa* and *Dalbergia sissoo* grown in Egypt: GC/MS analysis of extracts. Journal of Forest Products & Industries. 2013;**2**(3):34-41

[39] Sarg TM et al. Two new polyphenolic compounds from *Ficus retusa* L. variegata and the biological activity of the different plant extracts. Journal of Pharmacognosy and Phytotherapy. 2011;**3**(7):89-100

[40] Mubashir S, Shah WA. Phytochemical and pharmacological review profile of *Adiantum venustum*. International Journal of PharmTech Research. 2011;**3**:827-830

[41] Kitajima J, Arai M, Tanaka Y. Triterpenoid constituents of *Ficus thunbergii*. Chemical & Pharmaceutical Bulletin. 1994;**42**(3):608-610

[42] Poumale HM et al. Pentacyclic triterpenes and other constituents from *Ficus cordata* (*Moraceae*). Zeitschrift fuer Naturforschung B. 2008;**63**(11):1335-1338

[43] Abdel-Hameed E-SS et al. Phytochemicals, nutritionals and antioxidant properties of two prickly pear cactus cultivars (*Opuntia ficus-indica* Mill.) growing in Taif, KSA. Food Chemistry. 2014;**160**:31-38

[44] Kengap RT et al. Isoprenoids and flavonoids with antimicrobial activity from *Ficus conraui* Warburg (*Moraceae*). Helvetica Chimica Acta. 2011;**94**(12):2231-2238

[45] Omar MH, Mullen W, Crozier A. Identification of proanthocyanidin dimers and trimers, flavone C-glycosides, and antioxidants in *Ficus deltoidea*, a Malaysian herbal tea. Journal of Agricultural and Food Chemistry. 2011;**59**(4):1363-1369

[46] Hakiman M et al. Total antioxidant, polyphenol, phenolic acid, and flavonoid content in *Ficus deltoidea* varieties. Journal of Medicinal Plant Research. 2012;**6**(33):4776-4784

[47] Bunawan H et al. *Ficus deltoidea* Jack: A review on its phytochemical and pharmacological importance. Evidence-based Complementary and Alternative Medicine. 2014;**2014**:1-9

[48] Kumari M, Sharma A, Jagannadham M. Religiosin B, a milk-clotting serine protease from *Ficus religiosa*. Food Chemistry. 2012;**131**(4):1295-1303

[49] Suryati S et al. Structure elucidation of antibacterial compound from *Ficus deltoidea* Jack leaves. Indonesian Journal of Chemistry. 2011;**11**(1):67-70

[50] Van Kiem P et al. Antioxidant activity of a new C-glycosylflavone from the leaves of *Ficus microcarpa*. Bioorganic & Medicinal Chemistry Letters. 2011;**21**(2):633-637

[51] Shi Y-X et al. Preliminary assessment of antioxidant activity of young edible leaves of seven *Ficus* species in the ethnic diet in Xishuangbanna, Southwest China. Food Chemistry. 2011;**128**(4):889-894

[52] Çalişkan O, Polat AA. Phytochemical and antioxidant properties of selected fig (*Ficus carica* L.) accessions from the eastern Mediterranean region of Turkey. Scientia Horticulturae. 2011;**128**(4):473-478

[53] Meshram MS, Itankar P, Patil A. To study pharmacognostic, physicochemical and phytochemical study of stem bark of bauhinia purpurea linn. Journal of Pharmacognosy and Phytochemistry. 2014;**2**:19-22

[54] Aris SRS et al. Phenolic content and antioxidant activity of fruits of *Ficus deltoidea var angustifolia* sp. The Malaysian Journal of Analytical Sciences. 2009;**13**(2):146-150

[55] Butera D et al. Antioxidant activities of Sicilian prickly pear (*Opuntia ficus-indica*) fruit extracts and reducing properties of its betalains: Betanin and indicaxanthin. Journal of Agricultural and Food Chemistry. 2002;**50**(23):6895-6901

[56] Ayinde BA, Omogbai E, Amaechina FC. Pharmacognosy and hypotensive evaluation of *Ficus exasperata* Vahl (*Moraceae*) leaf. Acta Poloniae Pharmaceutica. 2007;**64**(6):543-546

[57] Rout S, Panda T, Mishra N. Ethno-medicinal plants used to cure different diseases by tribals of Mayurbhanj district of North Orissa. Studies on Ethno-Medicine. 2009;**3**(1):27-32

[58] Mazumder PM, Farswan M, Parcha V. Hypoglycaemic effect of *Ficus arnottiana* Miq. bark extracts on streptozotocin induced diabetes in rats. Natural Product Radiance. 2009;**8**(5):478-482

[59] Singh D, Goel RK. Anticonvulsant effect of *Ficus religiosa*: Role of serotonergic pathways. Journal of Ethnopharmacology. 2009;**123**(2):330-334

[60] Ahmed F, Urooj A. Traditional uses, medicinal properties, and phytopharmacology of *Ficus racemosa*: A review. Pharmaceutical Biology. 2010;**48**(6):672-681

[61] Manian R et al. The antioxidant activity and free radical scavenging potential of two different solvent extracts of *Camellia sinensis* (L.) O. Kuntz, *Ficus benghalensis* L. and *Ficus racemosa* L. Food Chemistry. 2008;**107**(3):1000-1007

[62] Zhong X-K et al. Chemical analysis and antioxidant activities in vitro of polysaccharide extracted from *Opuntia ficus-indica* Mill. cultivated in China. Carbohydrate Polymers. 2010;**82**(3):722-727

[63] Saini R, Garg V, Dangwal K. Comparative study of three wild edible fruits of Uttrakhand for antioxidant, antiproliferative activities and polyphenolic composition. International Journal of Pharma and Bio Sciences. 2012;**3**(4):158-167

[64] Alqasoumi SI et al. Phytochemical and pharmacological study of *Ficus palmata* growing in Saudi Arabia. Saudi Pharmaceutical Journal. 2014;**22**(5):460-471

[65] Abdel-Hameed E-SS. Total phenolic contents and free radical scavenging activity of certain Egyptian *Ficus* species leaf samples. Food Chemistry. 2009;**114**(4):1271-1277

[66] Gupta VK, Sharma SK. In vitro antioxidant activities of aqueous extract of *Ficus benghalensis* Linn. root. International Journal of Biological Chemistry. 2010;**4**(3):134-140

[67] Gaire BP et al. Phytochemical screening and analysis of antibacterial and antioxidant activity of *Ficus auriculata* (Lour.) stem bark. Pharmacognosy Journal. 2011;**3**(21):49-55

[68] Olaokun OO et al. Evaluation of the inhibition of carbohydrate hydrolysing enzymes, antioxidant activity and polyphenolic content of extracts of ten African *Ficus* species (*Moraceae*) used traditionally to treat diabetes. BMC Complementary and Alternative Medicine. 2013;**13**(1):94

[69] Konyalıoğlu S, Sağlam H, Kıvçak B. α-Tocopherol, flavonoid, and phenol contents and antioxidant activity of *Ficus carica*. leaves. Pharmaceutical Biology. 2005;**43**(8):683-686

[70] Piluzza G, Bullitta S. Correlations between phenolic content and antioxidant properties in twenty-four plant species of traditional ethnoveterinary use in the Mediterranean area. Pharmaceutical Biology. 2011;**49**(3):240-247

[71] Awad NE et al. Phytochemical and in vitro screening of some *Ficus* and

*Morus* spp. for hypolipidaemic and antioxidant activities and in vivo assessment of *Ficus mysorensis* (Roth). Natural Product Research. 2012;**26**(12):1101-1111

[72] Channabasavaraj KP, Badami S, Bhojraj S. Hepatoprotective and antioxidant activity of methanol extract of *Ficus glomerata*. Journal of Natural Medicines. 2008;**62**(3):379-383

[73] Leong CNA et al. Antioxidant flavonoid glycosides from the leaves of *Ficus pumila* L. Food Chemistry. 2008;**109**(2):415-420

[74] Saloufou KI et al. Chemical composition and antioxidant activities of different parts of *Ficus* sur. Journal of Herbmed Pharmacology. 2018;**7**(3):185-192

[75] Sultana B, Anwar F, Ashraf M. Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts. Molecules. 2009;**14**(6):2167-2180

[76] Misbah H, Aziz AA, Aminudin N. Antidiabetic and antioxidant properties of *Ficus deltoidea* fruit extracts and fractions. BMC Complementary and Alternative Medicine. 2013;**13**(1):118

[77] Khan N, Sultana S. Modulatory effect of *Ficus racemosa*: Diminution of potassium bromate-induced renal oxidative injury and cell proliferation response. Basic & Clinical Pharmacology & Toxicology. 2005;**97**(5):282-288

[78] Kirana H, Agrawal S, Srinivasan B. Aqueous extract of *Ficus religiosa* Linn. reduces oxidative stress in experimentally induced type 2 diabetic rats. Indian Journal of Experimental Biology. 2009;**47**:822-826

[79] Iqbal Z et al. In vitro anthelmintic activity of *Allium sativum*, *Zingiber officinale*, *Curcurbita mexicana* and *Ficus religiosa*. International Journal of Agriculture and Biology. 2001;**3**(4):454-457

[80] Geetha B, Mathew B, Augusti K. Hypoglycemic effects of leucodelphinidin derivative isolated from *Ficus benghalensis* (Linn.). Indian Journal of Physiology and Pharmacology. 1994;**38**:220-220

[81] Sharma S et al. Evaluation of the phytochemicals and antidiabetic activity of *Ficus benghalensis*. International Journal of Diabetes in Developing Countries. 2007;**27**(2):56-59

[82] Patil V, Pimprikar R. Pharmacognostical studies and evaluation of anti-inflammatory activity of *Ficus benghalensis* Linn. Journal of Young Pharmacists. 2009;**1**(1):49

[83] Sivaraman D, Muralidharan P. Anti-ulcerogenic evaluation of root extract of *Ficus hispida* Linn. in aspirin ulcerated rats. African Journal of Pharmacy and Pharmacology. 2010;**4**(2):079-082

[84] Rao CV et al. Gastroprotective effect of standardized extract of *Ficus glomerata* fruit on experimental gastric ulcers in rats. Journal of Ethnopharmacology. 2008;**115**(2):323-326

[85] Ayisi NK, Nyadedzor C. Comparative in vitro effects of AZT and extracts of *Ocimum gratissimum*, *Ficus polita*, *Clausena anisata*, *Alchornea cordifolia*, and *Elaeophorbia drupifera* against HIV-1 and HIV-2 infections. Antiviral Research. 2003;**58**(1):25-33

[86] Gbeassor M et al. In vitro antimalarial activity of six medicinal plants. Phytotherapy Research. 1990;**4**(3):115-117

[87] Tkachenko H et al. In vitro antimicrobial activity of ethanolic

extracts obtained from *Ficus* spp. leaves against the fish pathogen *Aeromonas hydrophila*. Archives of Polish Fisheries. 2016;**24**(4):219-230

[88] Fazili A et al. Nutritional status of school age children (5-14 years) in a rural health block of North India (Kashmir) using WHO Z-score system. Online Journal of Health and Allied Science. 2012;**11**(2):1-3

[89] Kamazeri TSAT et al. Antimicrobial activity and essential oils of *Curcuma aeruginosa*, *Curcuma mangga*, and *Zingiber cassumunar* from Malaysia. Asian Pacific Journal of Tropical Medicine. 2012;**5**(3):202-209

[90] Oyelana O et al. Antimicrobial activity of *Ficus* leaf extracts on some fungal and bacterial pathogens of *Dioscorea rotundata* from Southwest Nigeria. Journal of Biological Sciences. 2011;**11**(5):359-366