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A comprehensive review on phytochemical, pharmacognostical properties and pharmacological activities of *Ficus lacor* L. (Moraceae)

Prakash Ghimire, Sandhya Pandey, Abinash Chandra Shrestha

Abstract
Ficus lacor Linn. Is a large deciduous, fast-growing closely foliaceous tree approximately 20 m in height with a finely shaped crown distributing extensively in tropical and subtropical areas of the globe. It has a wide variety of chemical constituents and traditionally it is used as remedies for many health problems such as gastric problems, ulcer, wound, typhoid, hay fever, dysentery, and leucorrhoea. Moreover, pharmacological activities like anti-arthritic, anti-inflammatory, anti-diabetic and anti-oxidant properties were also reported lately. Phytochemical screening of plant exposed that they are rich in alkaloids, tannin, flavonoids, saponins, phenolic compound, sterols, glycosides, coumarins, triterpenoids, amino acids and carbohydrates. The main aim of this article is to draw attentiveness to the latest review on its pharmacognosy and phytochemistry, and detailed account on its scientifically proven pharmacological activities. Furthermore, this review provides the baseline for the researcher to develop scientific evidence relevant to pharmacological activities along with their mechanism of action.

Keywords: *Ficus lacor* Linn, traditional medicine, elephant fig, java fig, phytochemical, pharmacological activities

1. Introduction
Explore for perpetual health and durability and to seek out a remedy to alleviate discomfort provoked man to develop different ways and means of health care. The early man discovered his instant natural surroundings, endeavoured many things like plants, minerals and animals and developed an assortment of curative agents. The information collected by generations was either documented or passed on to the future generations and this practice was generally termed as "Traditional Medicine" [1]. The World Health Organization (WHO) defines traditional medicine as ''the total of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness'' [2]. The World Health Organization (WHO) estimates that about eighty per cent of the populace living in developing countries depends on almost completely on traditional medicine for their prime health care needs. Medicinal herbs play a chief role and comprise the backbone of traditional medicines [1].
The genus, Ficus, is composed of over 800 species and is one of around forty genera of the Moraceae family of mulberry. Numerous Ficus species consists of plentiful diversities, significant genetic diversity, exceptional pharmacological properties and these are of astonishing commercial importance [3]. This family is a basic hereditary asset because of its high money related and nutritional benefits and a significant piece of the biodiversity in the rainforest environment. It is likewise a decent wellspring of nourishment for organic product eating creatures in tropical territories [4].
Ficus lacor Buch. -Ham (*Ficus infectoria* Roxb) is a huge deciduous, fast-growing closely foliaceous tree approximately 20 m in height with a finely shaped crown. It is widely dispersed in tropical and subtropical areas of the world [5]. It is distributed worldwide in South East Asia, Burma, Indochina, Australia, India, Myanmar, Bhutan, and Nepal [6, 7]. *Ficus lacor* is known as Kabro in Nepal. It is found in all regions of Nepal, up to about 1600 m. It is a small deciduous or nearly evergreen tree, which grow good on moderately deep soils with an adequate moisture supply. Although it has tolerance to frost, its seedling is very susceptible to damage by browsing and fire. There is only one type of fig, containing both seed and gall flower. A seed is generally collected between March and May. *Ficus lacor* is commonly propagated by cutting [8].

F. lacor leaves has wound healing [9] and antioxidant activity [10]. The stem bark is used in gastric and ulcer [11-14]. Milky latex of stem is used in hay fever, typhoid and dysentery [15]. The decoction of buds is considered for leucorrhoea and ulcer, [5, 16] gargle in salivation [17] and boils [18]. Harsa is treated with dried buds [19]. As being tonic in nature, seeds are used in curing of stomach disorder [20]. The bark of the plant is used for the treatment of edema, leucorrhoea, and wounds in Jatasankar Region of Girnar Forest, Gujarat, India [21]. In Nepalese culture, ripe fruits are eaten fresh whereas pickle is prepared from leaves and tender buds of *F. lacor* [22] and immature shoots are eaten as a vegetable [23].

2. Pharmacognostical Characteristic

2.1 Geographical Distribution

Ficus lacor is widely distributed around the world in both tropical and subtropical regions [5]. It is distributed in Australia, South East Asia, Bhutan, Burma, India, Myanmar, Indochina, and Nepal all over the world [6, 7]. It grows on a variety of soils; however good growth is only obtained on moderately deep soils with an adequate moisture supply. It has some tolerance to frost, but seedlings are extremely vulnerable to damage by browsing and fire. In Nepal, it is found up to the altitude about 1600 m, [8] mainly in central and western part like Kathmandu, Lalitpur, Bhaktapur, Kabhreplanchowk, Sindhupalchowk, Rasuwa, Nuwakot, Dhading, Bara, Parsa, Rautahat, Makawanpur, Chitwan, Ramechhap, Gorkha, Dolpa, etc [24].

2.2 Taxonomy [25].

Kingdom: Plantae
Sub Kingdom: Tracheobiota
Superdivision: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Hamamelidae
Order: Urticales
Family: Moraceae
Genus: Ficus
Species: *Ficus lacor*

2.3 Vernacular names

Vernacular names are as in English- Elephant fig, Java fig; Hindi-Pakar; Nepali-Kavro, Gular, Pakadi; Danuwar-Kushi; Darai-Kabro; Limbu-Khatarumba; Magar-Kapara; Rai-Chaspou, Chokchi; Tamang-Nakkali, Katho; Tharu-Kapro – Tharu [26, 27].

2.4 Macroscopic Description

Ficus lacor Buch. -Ham (*Ficus infectoria* Roxb) is a huge deciduous or nearly evergreen tree, swiftly growing closely foliaceous approximately 20 m in height with a finely shaped crown and with some aerial roots [5] as shown in fig. 1 [28].

Bark: Rough, quilled pieces, flat to curved, 0.4-0.7 cm thick; outer surface ash or whitish-grey; numerous transversely arranged lenticels; ranging from 0.1 cm to 1.3 cm long, lip-shaped and exfoliating; inner surface rough, fibrous, longitudinally striated, reddish-brown; fracture, fibrous [29].

Leaves: Alternate, elliptic-oblong, 11-17 cm by 4-7 cm, abruptly narrowed to a point, three-veined at base; leaf stalks 3-8 cm long, joined at ape; branchlets usually densely hairy [30].

Fruit type and maturity: One type of fig usually red or purple when ripe [8].

Collection season of fruit: Mar-May [8]

Seed type: Orthodox [8]

Growth Habit: Perennial [8]

Fig 1: *Ficus lacor* Plant

2.5 Microscopic Description

2.5.1 Microscopy of Leaves

The anatomy of leaves was observed under a light microscope after treating them with eighty-eight per cent lactic acid in a water bath at 100°C for 20-40 min followed by softening the tissue with a drop of lactic. The observation revealed the presence of polygonal-shaped pavement cell which is 21.5 (15-25) µm and 27 (22.5-30) µm lengths, respectively in both adaxial and abaxial surface of a leaf of *Ficus lacor*. Moreover, the width is 18 (12.5-20) µm and 42 (25-67.5) µm in both adaxial and abaxial surface of a leaf. Paracytic type of stomata [11.5 (10-12.5) µm in length] is present only on the abaxial side of leaf whereas trichomes are absent and smooth cuticular membrane is present on both sides of leaf [6].

2.5.2 Microscopy of Roots

The dried root was sectioned using the rotatory microtome and incredibly fine section was selected from the thickness of about 10-20 µm. It was then stained with 1% safranin and light green (0.2%). Slides were cleared in xylol and positioned in DPX mounting where trinocular microscope was used to take photomicrograph as shown in fig. 2 [31].

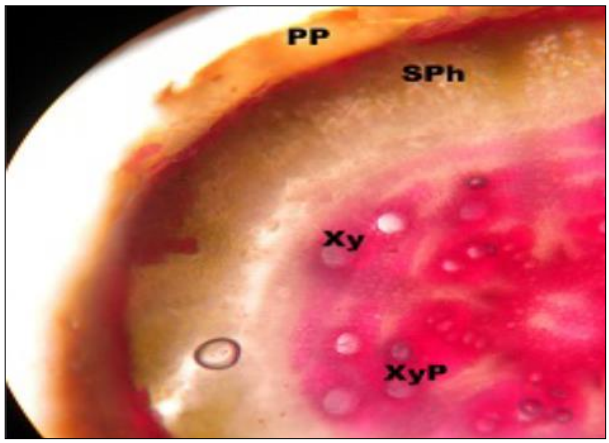

Fig 2: Microscopy of roots powder (PP: Primary Phloem; SPh: Secondary Phloem; Xy: Xylem Vessels; XyP: Xylem Parenchyma)

The coarse powder of air-dried root was sifted through forty mesh sieve where observation was done under a microscope by taking a little amount of powder on a slide and after mounting with phloroglucinol, hydrochloric acid and glycerin. The observation was shown in fig. 3 [31].

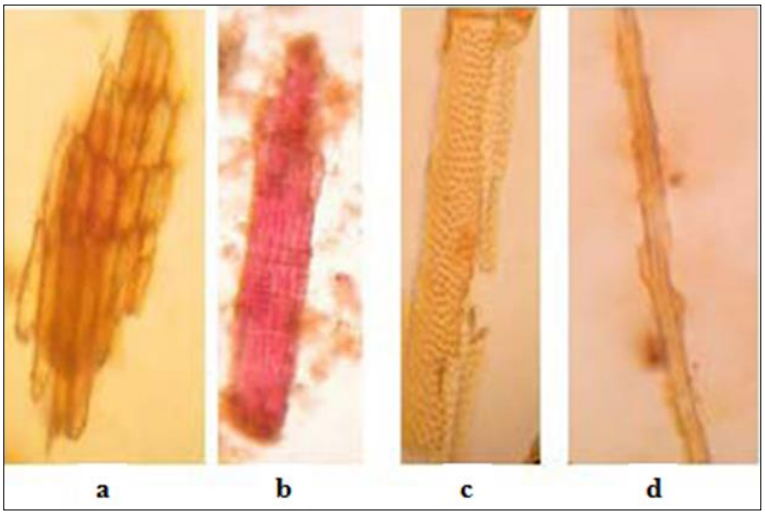

Fig 3: T.S of the aerial root (a: Parenchymatus cells; b: Spiral; c: Pitted cessles; d: Fiber)

2.5.3 Microscopy of Fruit

Transverse section of fruit was divided into 3 sections via epidermis, hypodermis and ground tissue where the epidermis is single-layered, thin-walled. The epidermis is surrounded by 2-5 layered hypodermis consisting of oval, round, rectangular, lignified stone cells with broad lumen; the remaining portion of very large mesocarp cells consisting of an oval to polygonal, colenchymatous cells containing brownish contents; a few vascular traces found sprinkled in this zone; the interior consists of stone cells similar in shape and size to those found sprinkled in the outer zone. As shown in Fig. 4(b) and 4(c), male and female flowers attached to the inner layer of mesocarp the inner mesocarp layer. Microscopy of powder illustrates the segments of epidermal cells, single or group of lignified stone cells, collenchymatous cells and lignified unicellular trichomes, a little male and female flowers debris are also present as shown in Fig 4(d), 4(e) and 4(f) [27].

Fig 4: Microscopic plates of *Ficus lacor*: (a) *Ficus lacor* fruit. (b-c) Transverse section of fruit. (d) Unicellular trichomes. (e) Lignified stone cells. (f) Vessels elements. (UE - Upper Epidermis; CC- Cholenchymatous Cells; SC - Lignified Stone Cells; T – Trichomes and MR - Medullary Rays)

3. Phytochemical Constituents

Ficus lacor leaves have been accounted for the presence of numerous compounds counting β-sitosterol, lupeol, α-amyrin, β-amyrin, stigmasterol, and campesterol. The further chemicals namely such as scutellarein glucoside, scutellarein, infectorin, sorbifolin, bergaptol, and bergapten were identified from the whole plant [31].

Besides these principal chemical constituents, *Ficus lacor* contains alkaloids, tannin, flavonoids, saponins, phenolic compound, sterols, glycosides, coumarins, triterpenoids (α-hydroxyursolic acid, oleanolic acid, protocatechuic acid, ursolic acid, maslinic acid), three amino acid *viz*. ornithine, alanine, tyrosine and methionine and 3 carbohydrates i.e. lactose, sucrose and galactose [31]. It also contains fibre (Acid Detergent Fibre and Neutral Detergent Fibre) and antioxidants i.e. Vitamin–C and β-carotene [32].

The chemical structures of a few important compounds isolated from *Ficus lacor* Buch. Ham are shown in Fig5 [33, 34].

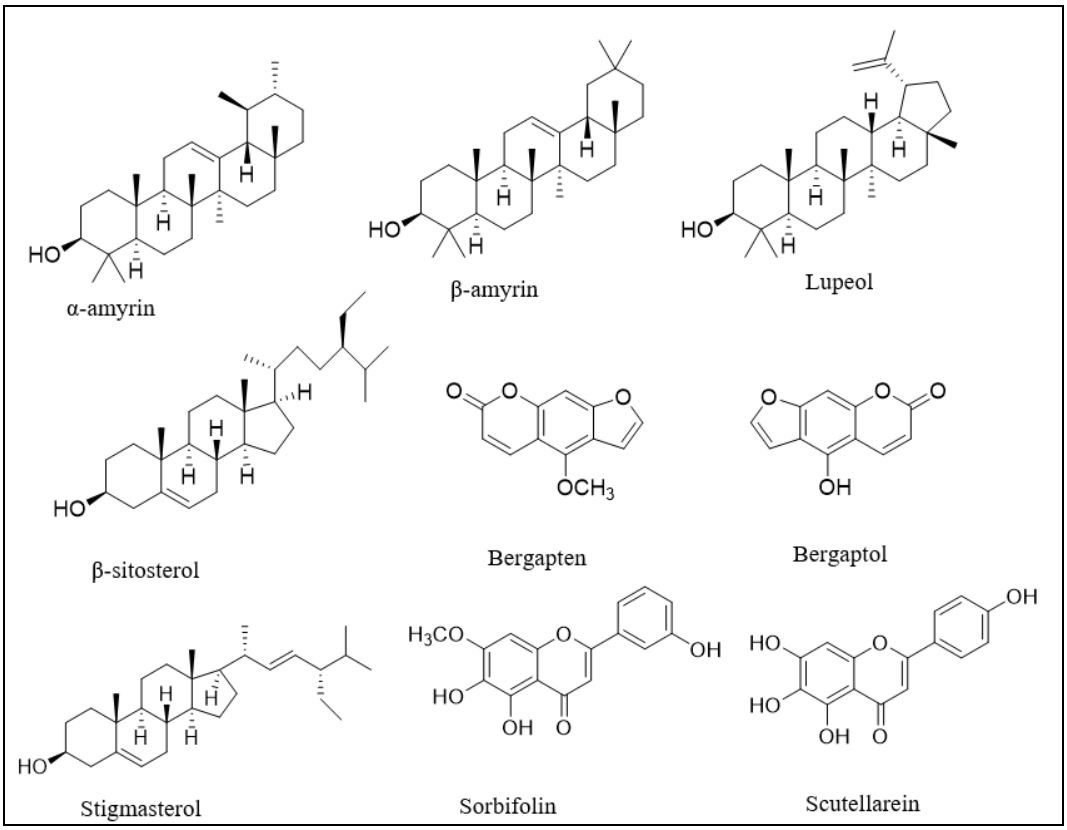

Fig 5: Structure of important active constituents present in *Ficus lacor* Bunch. Ham.

3.1 Spectroscopic Data of Some Important Compounds

3.1.1 Stigmasterol [33].

Color-white or off- white powder
M.P. 160-164 °C
UV λ max: 257 nm
IR ($CHCl_3$): 3320, 2946, 2854, 1480, 1388, 1189, 1096, 1035, 668 cm^{-1}
^{1} HNMR ($CDCl_3$) δ: 5.14 (m, 1H, H-6), 4.16 (s, 1H), 4.14 (s, 1H), 3.62 (tdd, OH, H-3), 1.27 (s, 3H), 1.19 (s, 3H), 1.07 (s, 3H), 0.99 (s, 3H), 0.91 (s, 3H)
^{13}CNMR ($CDCl_3$) δ: 140.80, 130.10, 128.60, 71.60, 58.10, 56.10, 52.10, 42.28, 40.28, 37.40, 33.40, 31.71, 28.40, 27.10, 24.10, 21.80, 19.10, 17.10, 15.10, and 12.80
GCMS (m/z): 412 (M+, $C_{29}H_{48}O$), 55 (100), 394 (8), 255 (16), 213 (9), 199 (8), 159 (25), 145 (29), 133 (26), 121 (19), 105 (32), 91 (34), 83 (64), 81 (59), 69 (52), 41 (39)

3.1.2 Lupeol [33].

White crystalline compound
M.P.: 210-212°C.
IR ν_{max} (KBr): 3449, 2961, 2926, 2849, 1452, 1254 and 1024 cm^{-1}.
^{1}H NMR ($CDCl_3$, 400 MHz, δ ppm): 0.74, 0.79, 0.85, 0.94, 0.97, 1.05 (each 3H, s, Me-28, Me-23, Me-24, Me-25, Me-26, Me-27), 1.66 (3H, s, Me-30), 3.18 (1H, H-3), 4.57 (1H, H-29), 4.67 (1H, H-29).
EIMS m/z (rel. int. %): 426 ($C_{30}H_{50}O$, M^+) (20), 411 $(M\text{-}Me)^+$ (25), 408 $(M\text{-}H_2O)^+$ (30), 393 $(M\text{-}Me\text{-}H_2O)^+$ (35), 385 $(M\text{-}41)^+$ (15), 220 $(M\text{-}C_{15}H_{26})^+$ (80), 218 $(M\text{-}C_{14}H_{24}O)^+$ (55), 207 $(M\text{-}C_{16}H_{27})^+$ (25), 189 $(M\text{-}C_{16}H_{29}O)^+$ (100) and 139 $(M\text{-}C_{21}H_{35})^+$ (70).
^{13}C NMR ($CDCl_3$, 400 MHz, δ ppm): 38.0 (C-1), 27.4(C-2), 78.0 (C-3), 38.7 (C-4), 55.3 (C-5), 55.3 (C-5), 18.3 (C-5), 18.3 (C-6), 34.0 (C-7), 40.1 (C8), 50 4 (C-9), 37.7 (C-10), 20.9 (C-11), 25.1 (C-12), 38.0 (C-13), 42.8 (C-14), 27.4 (C-15), 35.6 (C-16), 42.8 (C-17), 48.2 (C-18), 48.0 (C-19), 150.8 (C-20), 28.5 (C-21), 40.0 (C-22), 28.1 (C-23), 15.4 (C-24), 16.1 (C-25), 15.9 (C-26), 14.6 (C-27), 18.0 (C-28), 109.3 (C-29), 19.4 (C-30).

3.1.3 β- Sitosterol [33].

White shining crystals
M.P.: 134.5°C.
IR ν_{max} (KBr): 3420, 2924, 1463, and 884 cm^{-1}.
^{1} H NMR ($CDCl_3$, 400 MHz, δ ppm): 0.63, 0.77, 0.81, 0.83, 0.88, 0.92 (each 3H, s, Me-18, Me-29, Me-27, Me-26, Me-21, Me-19), 3.36 (1H, H-3), 5.32 (1H, H-6).
MS m/z (rel. int. %): 414, ($C_{29}H_{50}O$, M^+) (15), 399 $(M\text{-}Me)^+$ (10), 396 $(M\text{-}H_2O)^+$ (12), 381 $(M\text{-}Me\text{-}H_2O)^+$ (79), 329 $(M\text{-}H_2O\text{-}C_5H_7)^+$ (25), 303 $(M\text{-}H_2O\text{-}C_7H_9)^+$ (23), 275 $(M\text{-}H_2O\text{-}C_2H_{13})^+$ (12), 273 $(M\text{-}C_{10}H_{21})^+$ (17) and 255 $(M\text{-}C_{10}H_{20}O\text{-}H_2O)^+$ (30).
^{13}C NMR ($CDCl_3$, 400 MHz, δ ppm): 140.9 (C-5), 121.9 (C-6), 71.9 (C-3), 56.8 (C-14), 56.2 (C-17), 50.8 (C-9), 50.4 (C-24), 42.6 (C-13), 42.4 (C-4), 40.3 (C-12), 39.5 (C-20), 37.3 (C-1), 36.6 (C-10), 36.3 (C-20), 35.6 (C-8), 34.0 (C-22), 33.0 (C-6), 32.1 (C-7), 32.0 (C-8), 31.8 (C-2), 29.3 (C-23), 28.2 (C-16), 26.2 (C-25), 24.3 (C-15), 23.1 (C-28), 21.1 (C-21), 21.1(C-11), 19.8 (C-27), 19.4 (C-19), 19.1 (C-21), 18.8 (C-26), 11.9 (C-29), 11.9 (C18).

3.1.4 Bergapten [33].

White crystals
M. P. 188-190 ° C
UV (MeOH) λ_{max} (nm): 210, 260 and 310
^{1} H NMR ($CDCl_3$) δ/ppm: 8.21 (1H, d, J=9.8 Hz, H-4), 7.71 (1H, d, J=2.8 Hz, H-7), 7.16 (1H, s, H-9), 7.10 (1H, d, J=2.8 Hz, H-6),6.30 (1H, d, J=9.8 Hz, H-3) and 3.82 (3H, s, OCH_3);
^{13}C-NMR ($CDCl_3$) δ /ppm: 21.9 (9-CH_3), 60.1 (4-OCH_3), 105.0 (C-3), 106.4 (C-4a), 112.5 (C-6), 112.7 (C-3a), 139.2 (C-5), 144.8 (C-2), 149.6 (C-4), 152.7 (C-8a), 158.4 (C-9a), 161.1 (C-7)

4. Traditional and Current Uses

In Nepalese culture, ripe fruits are consumed fresh whereas pickles are prepared from leaves and tender buds of *F. lacor* and young shoots are taken as a vegetable. The stem bark is used in gastric ulcer. Moreover, it is useful in gastric and gynecological disorders. The plant's bark is used to treat leucorrhoea, as well as to remove roundworms. Exudates from the plant are used in hay fever and typhoid, dysentery, boils and effective against snake bite. As well as an anti-arthritic activity are present in aerial roots. *F. lacor* leaves have wound healing and antioxidant effect and are used for treating various skin problems. The decoction of buds is considered good for leucorrhoea and ulcer, an unnecessary salivation gargle, burns, acne and blisters. Fruits of *F. lacor* Ham is also used for diarrhea. Seeds are tonic and are used in stomach disorder treatment. It is also used as an antifungal, antibacterial, and anti-diabetic condition [27].

5. Pharmacological Activities

5.1 Anti-inflammatory

Sindhu RK and Arora S (2014) reported that various extracts (ethyl acetate, petroleum ether, ethanol and chloroform) of *Ficus lacor* aerial root has significant anti-inflammatory activity comparable to standard drugs (Indomethacin and Pyrilamine) using carrageenan-, histamine-, and serotonin-induced paw edema in animal models. The ethanol extract (100 mg/kg) showed significant anti-inflammatory activity of 75.40, 68.72 and 74.01% with carrageenan, serotonin and histamine-induced rat paw edema, respectively [35].

5.2 Anti-arthritic

Sindhu RK and Arora S (2013) studied the phytochemical screening and anti-arthritic effect of several extracts of *Ficus lacor* aerial roots against adjuvant-induced arthritis in rats. The extracts treated with higher doses reduced the lesions to a greater extent in a dose-dependent manner as compared to indomethacin. Petroleum ether and ethanol extract of *Ficus lacor* were significantly effective in inhibiting and suppressing the growth of adjuvant-induced arthritis [31].

5.3 Free Radical Scavenging Activity

Sindhu RK and Arora S (2013) performed preliminary phytochemical screening of aerial root extracts of *Ficus lacor* and result presented the presence of flavonoids, tannins, saponins, phenolic compounds, sterols, amino acid *viz*. methionine, tyrosine, ornithine, alanine and carbohydrates, i.e. galactose, lactose, and sucrose [31].

Sindhu RK and Sandeep A (2013) study revealed that ethanolic extract of *Ficus lac*or possessed the significant level of total phenolic and flavonoid content in contrast to antioxidant and nitric oxide scavenging activity with increased concentration of extract. It seems that ethanol extract appears to serve as a potential natural antioxidant [36].

Ghimire BK *et al.* (2011) used 24 commonly used therapeutic plants from Illam and Jhapa district, Nepal and screened for total flavonoids, phenols, and antioxidant activity [determined by using 1, 1-diphenyl-2-picryl-hydrazine (DPPH)] in which the highest radical scavenging activity was witnessed in *Artemisia vulgaris* followed by *Ficus lacor* and *Mallotus philippensis*. The investigated species showed a feeble linear relationship between total phenolic or flavonoid content and antioxidant activity, indicating that phenolic compounds may not be the main antioxidant components [10].

5.4 Anti-diabetic

Gupta S *et al.* (2008) found that Plakhar (*Ficus lacor*) significantly lowered the level of blood glucose, serum cholesterol and serum triglycerides in alloxan-induced diabetic rats. The proximate compositions were examined that showed *Ficus lacor* contains antioxidants (β-carotene and Vitamin C) and high fibre (Acid and Neutral detergent fibre), which plays a significant role in the prevention of diabetes [32].

5.5 Hepatoprotective activity

Tripathi *et al.* (2007) studied the hepatoprotective activity of ethanolic extract of *Ficus lacor* Buch-Ham bark against carbon tetrachloride (CCL_4) induced hepatotoxicity in albino rats. The protective effect was determined by using biochemical assessment levels such as Serum glutamate pyruvate transaminase (SGPT), Serum glutamate oxaloacetate transaminase (SGOT), and total bilirubin. The extract exhibited a significant reduction in all parameters when compared with CCL_4 induced intoxication [37].

5.6 Genetic analysis

W. Phromthep reported genetic differences among 25 species of Ficus with 4 primers, OPAS10, OPG13, OPL05, and OPW06 using HAT-RAPD polymorphic DNA technique. It was observed that *F. Lacor* exhibited close genetic relationship allowing the identification, and characterization of plant species with high accuracy [38].

5.7 Anthelmintic activity

Kataria J *et al.* (2016) evaluated for the anthelmintic activity of petroleum ether, chloroform, ethanol and aqueous extract of *Ficus lacor* bark using *Eiseni afoetida* earthworm. It showed that both ethanol and chloroform extract was more efficient than standard drug piperazine citrate (10 mg/ml) at a concentration of 150 mg/ml in causing paralysis and killing the earthworms, indicating their efficacy in helminthiasis [39].

5.8 Antifilarial activity

Kumar *et al.* (2007) studied antifilarial *in vitro* activity on alcoholic and aqueous extract of *Ficus lacor* leaves on *Setaria cervi*. The spontaneous movement inhibition of whole warm and nerve-muscle preparation for alcoholic extract was 150 µg/ml and 30 µg/ml, whereas the aqueous extract was 260 µg/ml and 130 µg/ml, respectively indicating a cuticular restriction. The lethal alcoholic extract concentration (LC_{50} and LC_{90}= 10 and 21 ng/ml) showed more potent effect as compared to aqueous extract (LC_{50} and LC_{90} = 14 and 26 ng/ml), suggesting effective tool for filariasis [40].

5.9 Protective effect on A549 cells

Yang W (2017) investigated the extraction method of total flavonoid and the protective effect of *Ficus lacor* leaves on cellular damage in A549 human lung adenocarcinoma cells. It revealed that the ethanol extraction process, which can be used to extract the total flavonoid in *Ficus lacor* leaves, demonstrated a significant decrease in cell survival, ROS growth and protective effect on rotenone-induced A549 cell damage [41].

6. Conclusion

The present review demonstrates the phytochemical properties, traditional uses and pharmacological properties of various bioactive constituents present in *Ficus lacor* Linn.

Its pharmacological actions include antioxidant, anti-inflammatory, antidiabetic, and anti-arthritic activities. Moreover, various fascinating pharmacological activities of *F. lacor* have been done, which can be additionally investigated to utilize them as a recuperating strategy for what's to come. For instance, the aerial roots have indicated anti-arthritic, anti-inflammatory and antioxidant action; subsequently, they can be researched against diverge cardioprotective, anti-microbial activities and neuropsychiatric disorder. Most of the pharmacological investigations which have been completed on *F. lacor* were directed with uncharacterized crude extracts; it is hard to deliver the evaluations of these examinations and recognize the bioactive metabolites. Phytochemical research did on *F. lacor* have prompted the confinement of not many classes of plant metabolites. A large portion of the phytochemical works have been utilized on leaves and whole plants of *F. lacor*, while there is little data on stem, bark and root profiles. Anyway the tremendous ethnomedicinal uses and set up the pharmacological activity of *F. lacor* call attention to that a huge extension despite everything exists for its phytochemical investigation utilizing bioassay-guided isolation. Further research studies should be carried out to characterize and identify the active components of this plant for persuasive support for the potential clinical uses of *F. lacor* in contemporary remedies.

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