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Ethnomedicinal Potential of Indian Coffee Plum: *Flacourtia Jangomas*

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Abstract

Medicinal plants are large-scale sources of indigenous medicines and they have been used for centuries to treat various diseases. Bioactive compounds are being isolated from medicinal plants day by day and serve as an important source of raw materials for drug discovery. *Flacourtia jangomas* is a plant belonging to the family of Flacourtiaceae growing in various parts of the world. Common names of *F. jangomas* are Coffee plum, Indian plum, Manila cherry, and Paniala. Aerial parts of the plant are used in the treatment of diabetics, asthma, anemia, and antibacterial, antidiarrheal, and antioxidant activities. *F. jangomas* revealed several bioactive constituents, including carbohydrates, protein, lipids, alkaloids, glycosides, tannins, etc. The fruits are rich in nutrients, protein, fat, sugars, amino acids, vitamin C, and minerals including calcium, potassium, phosphorous, iron, magnesium, sodium, manganese, copper, and zinc. The ripe fruits have high fiber content together with good protein content, low fat, and higher amount of monounsaturated fatty acids as compared to polyunsaturated fatty acids. It contains a significant amount of beta-carotene followed by lutein and zeaxanthin, retinol, and phylloquinone which are important in the regulation of hemoglobin and fibrinogen in the human body. Flacourtiaceae family elaborates a diverse array of compound classes which include terpenoids, alkaloids, flavonoids and tannins, lignans and flavanolignans, glucosides, coumarins, and isocoumarins.

Keywords

Flacourtiaceae, antioxidant, alkaloids, phylloquinone, coumarins

1. Introduction

Medicinal plants are large-scale sources of indigenous medicines and they have been used for centuries to treat various diseases [1]. Yu et al. [2] recommended that bioactive compounds like alkaloids, flavonoids, phenolics, tannins, glycosides, and volatile oils possess a great potential for therapeutic activity. Atanasov et al. [3] also mentioned in their article that extensive varieties of these bioactive compounds are being isolated from medicinal plants day by day and serve as a dominant source of raw materials for drug discovery.

Flacourtia jangomas is a plant belonging to the family of Flacourtiaceae growing in various parts of the world (The Wealth of India [4]. The Wealth of India [4] also communicated that the common names of *Flacourtia jangomas* are Coffee plum, Indian plum, Manila cherry, and Paniala and it is widely cultivated in Southeast and East Asia and has escaped cultivation in a number of places. Aerial parts of the plant are used in the handling of diabetics, asthma, anemia, and antibacterial, antidiarrheal, and antioxidant activities [5]. Das et al. [6] updated that *F. jangomas* revealed several bioactive constituents, including carbohydrates, protein, lipids, alkaloids, glycosides, tannins, etc. They also suggested that fruits are rich in nutrients, protein, fat, sugars, amino acids, vitamin C, and minerals including calcium, potassium,

phosphorous, iron, magnesium, sodium, manganese, copper, and zinc. Srivastava et al. [7] also dispute in their research article that the ripe fruits of *F. jangomas* contain a good amount of potassium, have high bioaccumulation, and thus, may serve as a good source for adequate potassium intake. The ripe fruits have high fiber content together with good protein content, low fat, and a higher amount of monounsaturated fatty acids as compared to polyunsaturated fatty acids [8]. It contains an appreciable amount of beta-carotene followed by lutein and zeaxanthin, retinol, and phylloquinone which are supreme in the regulation of hemoglobin and fibrinogen in the human body (Srivastava et al. [7]. The aim of the review is to present an updated and comprehensive overview of its active chemical constituents, and various pharmacological properties including, antibacterial, anti-diarrheal, antioxidant, cytotoxic, antidiabetic, and anti-amylase activity of *F. jangomas* to highlight its ethnopharmacological use and to explore its therapeutic potentials thereby providing a basis for future research.

2. Phytochemistry

Wealth of India [4] reported that Flacourtiaceae elaborates a diverse array of compound classes which include terpenoids, alkaloids, flavonoids and tannins, lignans and flavanolignans, glucosides, coumarins and isocoumarins. Sashi et al. [8] updated in their review article that the plant contains tannin and a fixed oil whereas the bark principally contains tannins; leaves and young shoots are also rich in tannins. Mishra and Rai [9] also reported that they have xanthones, quinones, limonoids and phenazines, and two limonoids, namely limolin and jangomolide in the stem and bark of *F. Jangomas.* Rai and Mishra [5] also described in their review article that the fruit and stem bark yielded a coumarin named ostruthin. The phenolic glucoside ester, flacourtin was reported in bark whereas, a butyrolactone lignan disaccharide named ramontoside and steroids including β- sitosterol and its β-D-glucopyranoside were reported in the heartwood [10]. Shrinet et al. [11] have reported that *F. jangomas* that they have bioactive compounds namely corymbulosine, tremulacin, hydnocarpic acid and chaulmoogric acid which play a crucial role in the life of animals with having great potential for human well-fare, mostly with pharmacological or toxicological effects, against microbial pathogens and diseases including cancer in humans and animals.

3. Anti-Microbial Activity

Sabri and Vimla [12] investigated the antibacterial activity of ethyl acetate extract of the stem and determined by agar diffusion method against Gram-positive bacteria *Staphylococcus aureus, Bacillus polymyxa, Bacillus megaterium, and Gram-negative bacteria E.coli, Salmonella typhi, Pseudomonas aeruginosa* and *Vibrio cholera*. The extracts show zone of inhibition, ranging from 13 mm-28 mm. The extracts had a profound effect on Gram-negative bacteria with the highest zone of inhibition against *Pseudomonas aeruginosa* showing 28 mm followed by *Vibrio cholerae* with 20 mm. Shukla et al. [13] designed to screen the antibacterial potential of bacterial endophytes isolated from different medicinal plants against Gram-positive and Gram-negative human pathogenic bacteria. They determined antibiotic susceptibility tests of pathogenic bacteria by disc diffusion method against a number of antibiotics. After screening, it was found that FjR1 and FjF2 isolated from *F. jangomas* showed potential antimicrobial activity against both Gram-positive and Gram-negative pathogenic bacteria. Sarker et al. [14] reported that the chloroform soluble fraction of *F. jangomas* and *F. sepiaria in vitro* antibacterial screening by disc diffusion method against two Gram-positive and two Gram-negative bacteria to know antimicrobial effectiveness. They concluded that the chloroform fraction of *F. jangomas* showed good activity against all the tested bacteria and among them E. coli was found the most susceptible bacterium with the zone of inhibition 14 ± 0.59 mm. *F. sepiaria* had no activity against E. coli and Bacillus cereus. In respect of the zone of inhibition of both plant fractions, *F. jangomas* had better activity than *F. sepiaria* (Sarker et al. [14]. They also reported that among all tested extracts, only *F. jangomas* extract showed significant MIC value, ranging from 0.325 to 5 mg/ml. Parvin et al. [15] experimented with a crude extract of the plant *F. jangomas in vitro* microbiological screening for studying the anti-microbial activity of the extract against a wide of Gram-positive and Gram-negative bacteria by disc diffusion method. They noted that the extract shows good activity against *Shigella shiga* and *Bacillus megaterium* and moderate activity against *Bacillus cerus* and poor activity against *E. coli*. The Minimum Inhibitory Concentration (MIC) values of the plant extract investigated were 31.25 µg/ml and 125 µg/ml for *Bacillus megaterium* and *E. coli* respectively [15].

4. Antifungal Activity

Mishra and Rai [9] updated in their review article that methanol extracts of different parts of *F. jangomas* including leaf, flower, bark, and root show antifungal efficacy against *Candida tropicalis*, a resistant strain that ranks second or third

causative agent of many candidal infections and several oral diseases such as dental caries, endodontic infections, periodontal diseases and oral candidiasis. George et al. [16] evaluated the antifungal activity of extracts of six plant species namely *F. jangomas, Acalypha hispida, Hydnocarpus pentandra, Euphorbia mili, Lucuma nervosa, and Couroupita guianensis against Candida tropicalis* of methanolic extracts of different parts of the plant like leaf, flower, bark and root by using agar disc diffusion method. They noted that significant antifungal activity was shown by *F. jangomas, Hydnocarpus pentandra* and *Acalypha hispida*. Sabri and Vimla [12] also reported that the antifungal activity was determined by Agar diffusion against four Fungal strains *Aspergillus niger, Aspergillus flavus, Trichoderma viridae and Neurospora crassa*. The extracts showed moderate inhibitory activity ranging from 2-15 mm.

5. Antidiabetic Activity

Singh et al. [17] tested the effect of methanolic extract of *F. jangomas* leaves and stem (1:1) in alloxan-induced diabetic rats using glibenclamide as a standard antidiabetic agent. The antidiabetic potency of the extract was assessed by fasting blood glucose level. Their result clearly demonstrated that methanolic extract induces significant decrease in blood glucose levels in diabetic rats and this effect was more potent after repeated dose (200 mg/kg and 400 mg/kg) administration, with a marked reduction of blood glucose level in these rats was achieved after 14 days of treatment. Sindu et al. [18] experimented by using *F. montana* to evaluate anti-hyperglycemic activity of methanolic leaf extract in STZ induced type I diabetes model. Animals were randomized into five groups of six each, all the groups except Group I were made diabetic by intraperitoneal injection of Streptozotocin (STZ) at the dose rate of 45 mg/kg body weight. Group I served as the normal control, Group II and III as STZ and Glibenclamide control. The group – IV and Group V were administered methanolic leaf extract @ 100 mg/kg and 250 mg/kg body wt for 15 days. The result revealed an increase in Blood glucose, Triglycerides, Total Cholesterol, LDL-C, AST, ALT levels and decrease in HDL-C, and non-significant decrease in body weight in all groups except normal control on day zero. The group IV and V exhibited reduced blood glucose levels and all other parameters within 15 days of treatment. Thus, the result revealed the anti-hyperglycemic activity of methanolic leaf extract of F. montana [18].

6. Hepatoprotective, Anti-Inflammatory and Antioxidant

Joshy et al. [19] evaluated the hepatoprotective, anti-inflammatory and antioxidant activities of *F. montana* methanolic extract. The hepatoprotective effect of F. montana was evaluated against paracetamol induced hepatotoxicity in Wistar rats. Administration of paracetamol (2 g/kg) showed a significant biochemical and histological deterioration in the liver of experimental animals. Pretreatment with *F. montana* (200 and 400 mg/kg b.wt. p.o) significantly (P 6 0.001) reduced the elevated levels of serum enzymes like serum glutamic-oxaloacetic transaminase (AST), serum glutamic-pyruvic transaminase (ALT), alkaline phosphatase (ALP) and reversed the hepatic damage in the liver which evidenced the hepatoprotective activity. The anti-inflammatory activity of *F. montana* was evaluated by carrageenan-induced paw edema and cotton pellet-induced granuloma models. *F. montana* (200 and 400 mg/kg) showed a significant (P 6 0.001) reduction in rat paw edema with 76.39% and 80.32%, respectively induced by carrageenan against the reference anti-inflammatory drug ibuprofen (10 mg/kg) (83.10%). Oral administration of *F. montana* (200 and 400 mg/kg) also significantly (P 6 0.001) reduced the granuloma mass formation in the cotton pellet granuloma method. The reducing power and hydrogen peroxide radical scavenging were increased at increasing doses of *F. montana*. Barua et al. [20] conducted to study tree morphology, flowering, and fruiting behavior as well as nutritional aspects of *F. jangomas*. They noted the biochemical profiling of fruit revealed the presence of moderate amount of crude fat (0.60%), a significant amount of crude fiber (1.13%), crude protein (6.04%), carbohydrate (89.73%), energy (388.43 kcal 100 g-1, total soluble sugar (13.77%), reducing sugar (9.82%), riboflavin (236.84 lg 100 g-1) and thiamine (42.97/ g 100 g-1). The fruit exhibited good amount of antioxidant activities (8.93% mg-1) due to the presence of ascorbic acid (24.00 mg 100 g-1) and phenol (1.28 mg 100 g-1). The study showed a significant presence of phosphorous (133.39 mg 100 g-1), sodium (73.66 mg 100 g-1), potassium (1554.19 mg 100 g-1) and other minor minerals like calcium, sodium, magnesium, iron, manganese, copper, and zinc [20]. Talukder et al. [21] studied, ethanol extract of leaves of *F. jangomas* pharmacologically investigated to explore and evaluate the analgesic, antioxidant and antidiarrhoeal activities to provide a suitable lead, which may be utilized in future to pursue a new line of investigation. The extract exhibited a significant inhibition of DPPH radical scavenging activity in concentration dependent manner with IC50 value of 11 µg/mL whereas the IC50 value for the standard ascorbic acid was 5 µg/mL. Total phenol content of the extract was 601.03 mg GAE/100 g of dried plant material measured by Folin Ciocalteu's reagent. In reducing power assay, the extract revealed strong ferric reducing power in concentration dependent manner as compared with

standard ascorbic acid; which was substantiated by high absorbance increased with the concentration. In the acetic acid-induced writhing test, the extract (250 and 500 mg/kg) exhibited significant ($p < 0.001$) inhibition of the writhing reflex in a dose-dependent manner; which was strongly comparable to the standard drug diclofenac sodium. Mutha et al. [22] described different types of polyphenolic compounds (flavonoids, phenolic acids) found in plants that have multiple biological effects, including the antioxidant activity of *F. jangomas*. Rahman et al. [23] evaluated antioxidant potential using DPPH (1,1-diphenyl-2-picryl hydrazyl) radical scavenging assay, reducing power method, total antioxidant capacity, total phenol, and total flavonoid content. The extract exhibited moderate to good antioxidant activity when compared with ascorbic acid (ASA). The IC50 value of the Chloroform, Methanol, and Pet ether extract were 523.15 µg mL−1, 1623.87 µg mL−1 and 5811.35 µg mL−1 respectively while, the IC50 value of well-known antioxidant ascorbic acid was 13.37 µg mL−1. He also noted that among the extracts chloroform extract was found displaying strong DPPH radical scavenging action and this extract also exhibited the highest phenol and flavanoid content as well as total antioxidant capacity in comparison with pet ether and methanol extract. In the case of reducing power, these three extracts exhibited antioxidant potential in a dose-dependent fashion. Since reactive oxygen species are important contributors to serious disorders such as atherosclerosis, alcoholic liver cirrhosis, and cancer, the antioxidant property of the extract of *F. jangomas*.

7. Analgesic and Anti-Inflammatory Effect

Jothimanivannan et al. [24] evaluated aqueous extract of leaves and aqueous extract stem part of *F. jangomas* sequentially prepared by maceration process and subjected to a preliminary phytochemical screening. The anti-inflammatory activity was assessed by the carrageenan-induced acute rat paw oedema model and analgesic activity was evaluated by acetic acid-induced writhing model and hot plate method in mice. The extracts showed significant anti-inflammatory and analgesic activities in a dose-dependent manner. The ethanolic extract from the leaf extract of *F. jangomas* at the dose of 200 mg/kg has 55.6% significant anti-inflammatory activity compared to the standard drugs (44.4%). Even at the low dose leave extract is more potent than aqueous stem extract. Where in the analgesic effect by Hot plate method basal reaction time results showed that aqueous extract of stem part at the dose of 200 mg /kg has a significant effect at 120 mts 10.0 sec when compared with std pentazocine 13.0 sec. Islam et al. [25] recently reported the analgesic, anti-inflammatory, and antipyretic effects of the ethanolic extract of *F. indica*. *F. indica* was extracted using 100% ethanol followed by assessing acute toxicity and doses selected for the studies were 500 and 1000 mg/kg body weight. Swiss albino mice of either sex weighing 25-30 gm and Sprague dawley rats weighing 180-200 gm were used in this study. Analgesic activity was evaluated by using acetic acid-induced writhing test, formalin-induced paw licking, and hot plate test. The anti-inflammatory effect was assessed using xylene and croton oil induced ear edema test and carrageenan-induced paw edema test. Also, the antipyretic effect was investigated. The *F. indica* extract exhibited a significant effect against pain in the acetic acid test ($p< 0.001$) and reduced pyrexia. Within these two doses, higher doses (1000 mg/kg body weight) had better aptitudes in the reduction of pain, inflammation and pyrexia. The FI extract shows strong analgesic, anti-inflammatory, and antipyretic capabilities, according to the study results, and more research is needed to assess these effects and the potential of the plants [25].

8. Cytotoxic Activity

Parvin et al. [15] also reported the Cytotoxic activity of the ethylacetate extract of *F. jangomas* by Brine shrimp lethality bioassay technique using Vincristine sulfate as a standard reference indicated significant efficacy in a dose dependant manner. They noted that maximum mortality was recorded at a concentration of 80 mg/ml, whereas the least mortalities were at 5 mg/ml concentration [15]. George et al. [26] experimented methanolic extract of flower and showed promising cytotoxic activity against the two cancer cell lines, Calu6 and SCC9 with IC50 values of 43.57±0.04 µg/ml and 53.42±0.15 µg/ml, respectively. The antiproliferative activity of extracts investigated by analyzing cell cycle through flow cytometry revealed that treatment with methanol extract of flower caused significant arrest in G2M phase of cell cycle [27].

9. Anti-Amylase Activity

Aklima et al. [28] reported that the ethanolic extract of *F. jangomas* fruit in several findings and suggested that phenolic synergies may play a role in mediating amylase inhibition and therefore have the potential to contribute to the management of type-2 diabetes. Sarkar et al. [29] also updated anti-amylase activity by phenolic bio-actives from plant-based foods for glycemic control and suggested that plant-based foods containing phenolic bioactives have human health protective functions relevant for combating diet and lifestyle-influenced chronic diseases, including type 2 diabetes (T2D). The molecular

structural features of dietary phenolic bioactives allow antioxidant functions relevant for countering chronic oxidative stress-induced metabolic breakdown commonly associated with T2D. [29].

10. Conclusion

Medicinal plants have been used for centuries as remedies for human diseases because they contain components of therapeutic value. The curative properties of medicinal plants are attributable to the presence of various bioactive phytochemicals which may explain their traditional uses against various ailments. In this review article, an effort has been taken to collect and compile the details regarding the ethnomedicinal, phytochemical, and pharmacological facets of *F. jangomas*, a less explored plant. Literature search has shown that the plant has immense medicinal uses in different systems of medicine in India as well as throughout the world. Bioactive chemical constituents isolated and characterized so far from the plant and a variety of pharmacological activities, including antibacterial, antifungal, analgesic, antidiabetic, antidiarrheal, anti-oxidant, and cytotoxic activity are presented in this review. Extensive research with regard to the isolation and characterization of the active principles responsible for the activity and to understand the precise mechanism of the therapeutic action is required so that better, safer, and cost-effective drugs can be developed.

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