Ciencia e Investigación 2021 24(2):33-40
DOI: https://doi.org/10.15381/ci.v24i2.22524

ISSN Online: 1609-9044
ISSN impreso: 1561-0861
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Artículo Original

Phyto-pharmacology of *Tamarindus indica*

Fitofarmacología de *Tamarindus indica*

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Recibido: 17/09/2021 Aceptado: 02/12/2021 Publicado: 29/03/2022

Abstract

Tamarindus indica is a well-known medicinal plant which belongs to Fabaceae family, and it is a tropical perennial plant, which is broadly consumed as conventional system of pharmaceutical in whole world. *T. indica* is generally cultivated in Africa and Southern Asian zones. This review precis the Phytochemistry as well as pharmacological properties of *T. indica*. The chemistry of this plant detailed have place to various classes such as tannins, glycosides, flavonoids, steroids, unstable oils, tars, sugars, and mucilage. *T. indica* has various therapeutically properties, numerous of which have been confirmed by logical researchers. Phytochemical composition of T. indica confers it important pharmacological properties at present to recommend its habitual consumption to chronics disseases.

Keywords: Medicinal Uses; Phytochemistry; Pharmacological Activity and *Tamarindus indica*.

Resumen

Tamarindus indica es una conocida planta medicinal que pertenece a la familia Fabaceae, y es una planta perenne tropical, que se consume ampliamente como sistema convencional de productos farmacéuticos en todo el mundo. *T. indica* se cultiva generalmente en África y zonas del sur de Asia. Esta revisión precisa las propiedades fitoquímicas y farmacológicas de *T. indica*. La química de esta planta detallada tiene lugar para varias clases, como taninos, glucósidos, flavonoides, esteroides, aceites inestables, alquitranes, azúcares y mucílagos. *T. indica* tiene varias propiedades terapéuticas, muchas de las cuales han sido confirmadas por investigadores lógicos. La composición fitoquímica de *T. indica* le confiere importantes propiedades farmacológicas en la actualidad para recomendar su consumo habitual a enfermedades crónicas.

Palabras Clave: Usos Medicinales; Fitoquímica; Actividad Farmacológica y *Tamarindus indica.*

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Citar como:
Akram M., Muddasar M., Adamu G., Kalum A. and Islam S. (2021). Phyto-pharmacology of *Tamarindus indica*. Ciencia e Investigación 2021 24(2):33-40. doi: https://doi.org/10.15381/ci.v24i2.22524

INTRODUCTION

There is an increasing interest in researches about medicinal plants due to their potential to cure many diseases, because of fewer incidence of side effects and low costs when compared to synthetic drugs [1, 2, 3]. Tamarind or *Tamarindus indica* is belong to Fabaceae family. Tamarind is a significant tree with medicinal and food uses [4]. Traditionally *T. indica* is used in inflammations, wound healing, colds, diarrhea, snake bite, abdominal pain, fever and helminth infections. It may well serve as antimicrobial, antiinflammatory antidiabetic and effective on the control of satiety, playing a potential role in the treatment or prevention of obesity and other chronic diseases. *T. indica* possesses a wide variety of bioactive compounds in the flowers, seeds, leaves, pulp and bark, and with useful effects to human health and the possibility of application in the pharmaceutical industry. Tamarind has been familiarized and adopted to whole world in above 50 nations but it is native from tropical Africa. In the Asian nations like Thailand and India are the main production zones but also cultivated in Indonesia, Sri Lanka and Bangladesh. In America, the major production zones are Costa Rica and Mexico. And in Africa Tamarind commonly used in native population but has not cultivated on a commercial base. Gambia, Senegal, Kenya, Tanzania and Zambia are minor producing countries in Africa [5].

Tamarind plant height can reach 12-25m, with very thick shrubbery that does not permit the sunlight to sieve through them, therefore no plants could grow in this plant shade. Tamarind plant leaves have light green color, the flowers have yellow-orange, frequently striped or spotted of purple-red, leaves are consist of 7 to 12 sets of leaflets [6]. The fruits of tamarind have pendulous pods, through a woody coat, slightly curved, 5 to 15cm lengthy and comprising from 4 to 7 seeds for each pod. The fruits of tamarind ripen season is winter and have a brown bark, but the unripen fruits of tamarind bark have greenish color. The yellowish or brown pulp are filled in the ripe fruits. The fruits have an acidic but pleasant taste which is fibrous and edible; the seeds convert into shiny and hard; the pulp gets thinner and the bark can be easily broken by hand, the bark of the pod becomes fragile when riped [7, 8]. By using purification method, the fruit pulp needs to be sufficiently prepared, to begin with dissolving it in hot water and then after filtration, concentrate the solution using an appropriate heat source. This concentrate is utilized both for medicinal uses and arrangement of refreshments with reviving properties [9]. Up to 1943, the seeds of tamarind has not been used as a source of nourishment from ancient time. Indian communities mixed roasted and shelled tamarind seeds with other cereal flour as animal feed during starvation time. Nowadays it has appeared that the almond composition of tamarind seeds is exceptionally comparable to cereal seeds and is an amazing source of nourishment [7] (Fig. 1).

2. Temperament (Mizaj)

A few Unani clinicians categorized the temperament of Tamarind as Cold (Barid) 1 degree and Dry (Yabis) 2 degree [11]. Ibn Baitar expressed it as Cold (Barid) and Dry (Yabis) in 3 degree, while Ibn Sina marked it as

Fig. 1 Fruit, leaves, flower and stem bark of *T. indica* [10]

Cold (Barid) and Dry (Yabis) in 2 degree [12]. Mizaj of Tukhm-e-Tamar Hindi is Cold (Barid) and Dry (Yabis) in 3 degree [13]. Whereas some others thought that the Mizaj of sweet kind as Muatadil ba Mayal ba Hararat [12].

3. Chemical constituents of various parts of Tamarind

Phytochemistry analysis done on *T. indica* indicated the presence of many bioactive constituents**,** such as triterpenes [14], cardiac glycosides, phenolic compounds [15], l-(-) malic acid [16], tartaric acid, pectin and the mucilage, xylose, arabinose, glucose, uronic acid and galactose [17, 18] *T. indica* ethanolic extract revealed the presence of different essential elements and fatty acids.

The leave contains isoorientin, orientin [19], pipecolic acid, invert sugar, nicotinic acid, citric acid, volatile oils (limonene, geraniol) are contain in the leaf oil amongst which benzyl benzoate (40.6%) and limonene were dominant among 13 other components [20], lupanone and lupeol (Fig. 2) [14], isovitexin, vitamin B3, vitexin, vitamin C [21] serine, cinnamates, betaalanine, proline, pectin, leucine, phenylalanine, tannin, potassium, glycosides, 1-malic acid, and peroxidase [22].

The seed extract comprises cardenolide (uzarigenin-3-O-β-Dxylopyranosyl (1-2)-α-L rhamnopyranoside) and bufadienolide (Scilliphraside 3-O-β-D glucopyranosyl - (1-2)-L rhamnopyranoside) [23, 24]. Oleic acid, palmitic acid, eicosanoic acid and linoleic acid are the major fatty acids of seeds, β-amyrin, Campesterol, β-sitosterol and seven hydrocarbons are obtained from the unsaponifiable matter from the seed oil. Other constituents also present include pectin, galactose, the Mucilage, arabinose, glucose (β-1,4), uronic acid, keto acids, and xylose (alpha-1,6) [17], albuminoid, phytohemaglutinins, amyloids, chitinase and Cellulose [25].

Phenolic antioxidants are contain in *T. indica* seeds and pericarp. Proanthocyanidins dominated the profile of polyphenolics of the pericarp in different forms, such as procyanidin B2, apigenin, epicatechin, catechin (Fig. 3), procyanidin dimer, eriodictyol, procyanidin trimer, naringenin along with taxifolin [26]. *T. indica* seeds content comprised of only procyanidins, such as procyanidin pentamer, procyanidin hexamer, oligomeric procyanidin tetramer and lower amounts of procyanidin B2 epicatechin [26].

Phytochemical analysis of the root bark of Tamarind revealed the presence of octacosanyl ferulate, b-sitosterol, eicosanoic acid, n-hexacosane, (+)-pinitol and 21-oxobehenic acid [20, 27]. The bioactive compound (+)-pinitol availability in this plant was reported for the first time by Jain et al. [27].

The fruit pulp contain Furan derivatives (44.4%) and carboxylic acid (33.3%) as the volatiles constituents [28]. Other constituents present are organic acids, such as grape acid, apple acid [29], malic acid, tartaric acid, formic acid, citric acid, succinic acid and acetic acid; amino acids; some pyrazines (trans-2-hexenal); phlorotannins; invert sugar (25-30%); fat; some thiazoles (2-ethylthiazole, 2 methylthiazole) as fragrant and pectin.

The stem bark of *T.indica* saponins, tannins, peroxidase, lipids and glycosides (Agarwal and Paridhavi, 2007). Other phytoconstituents of the plant include cardiac glycosides, alkaloids, phenols, flavonoids, steroids and terpenoids [30].

4. Pharmacological Activities and Studies of *T. indica*

Tamarind has long been utilized in conventional system of medicine by indigenous publics for numerous

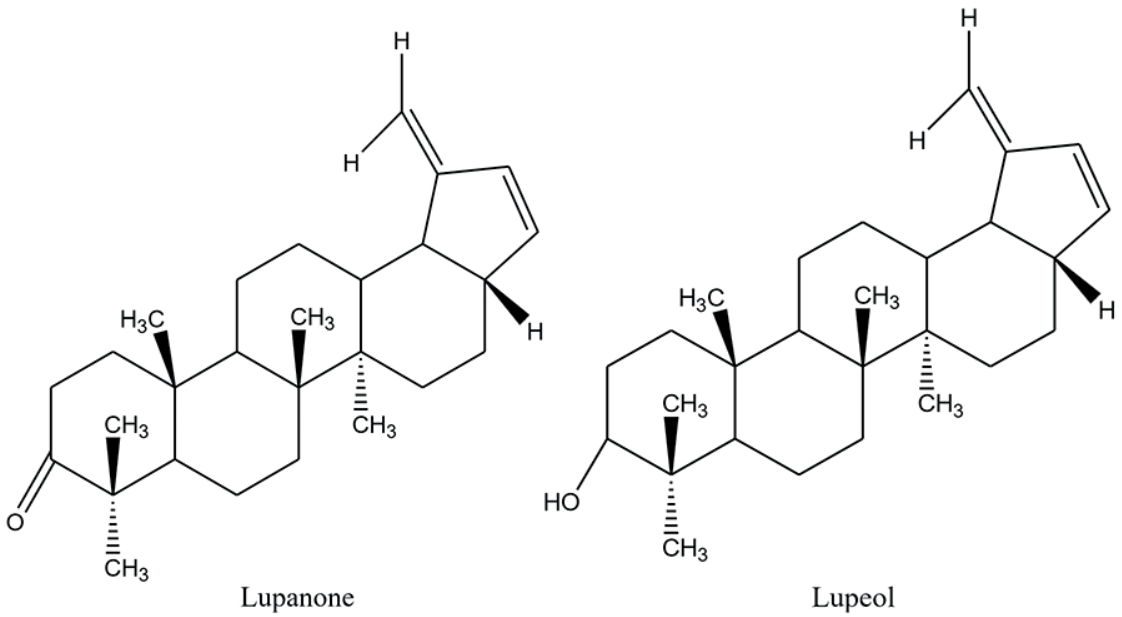

Fig. 2 Triterpenes of leaf of T. indica: Lupanone and Lupeol

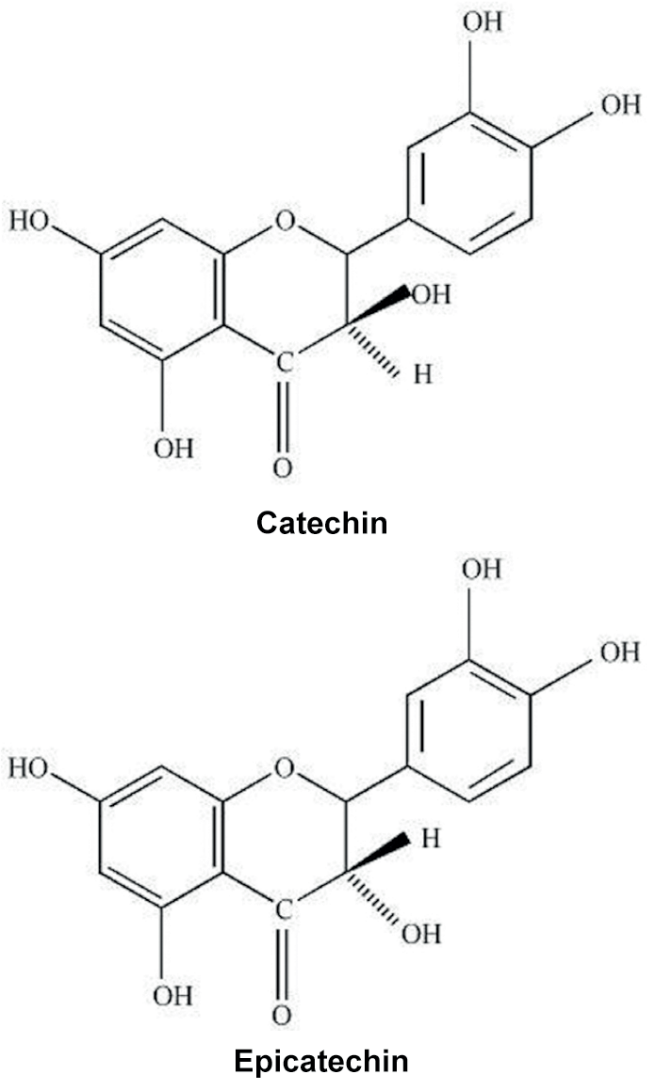

Fig. 3. Phenolic antioxidants present of seeds and pericarp of T. indica: Catechin and Epicathechin

ailments, without reported logical prove; advanced investigate is in understanding on the helpful adequacy of this plant [31]. The tamarind fruit pulp contains tartaric acid and malic acid; so it has many properties like laxative, digestive, preventing liver ailments, it also helps with abdominal pain and diarrhea [32]. The native individuals of Mauritius blend salt with mash and utilize this poultice to treat ailment of rheumatism, Tamarind pulp used to treat dysentery among Bengalis population. The decoctions of tamarind leaves used for the anti-helminthic activity and treat malarial fever; the root decoction is utilized as therapy of asthma; leaves and roots are also showed activity as wound curative medicine [33, 34]. The methanolic extract of tamarind has antileismanial properties and anti-microbial actions, whereas the fluid extract has hypoglycemic properties [35, 36]. An ingredient distinguished within the tamarin mash, Tamaridina bitter has antibacterial and molluscicidal action [37, 38].

4.1 Antioxidant Activity

The seed and pericarp of *T. indica* possess phenolic antioxidant compound as reported by Sudjaroen et al. [26]. In comparison to synthetic antioxidants such as anisole and butylated hydroxyl ascorbic acid, the seed and pericarp extracts showed good antioxidant activity against the linoleic acid emulsion system [39]. *T. indica* seed coat ethanolic extract antioxidant property was assessed by DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging technique using ascorbic acid as a standard. The antioxidant activity of extract may be as a result of its free radical-scavenging ability [40]. The ethanolic extract of fruit pulp exhibited great antioxidant and hypolipidemic activity in hypercholesterolemic hamsters [41]. The rich polyphenol content of seed and fruit of tamarind attributed to its great regulatory effect on neutrophils [42]

4.2 Cytotoxic Properties

Tamarind seeds have different polysaccharide which was tested to carcinogenic activity in both genders of B6C3F1 rats. This polysaccharide is not carcinogenic in B6C3F1 rats of other sex as the result verified. Separation of L-di-n-butyl maleate led from methanolic extract of tamarind seed by using Bioassay-guided fractionation

method. L-di-n-butyl maleate have cytotoxic properties beside sea urchin embryo cells [43].

4.3 Immunomodulatory Properties

T. indica shows immunomodulatory actions through a polysaccharide extracted and purified from the fruit pulp. The immunomodulatory activities are leukocyte migration inhibition, inhibition of cell proliferation and phagocytic boost. Therefore this polysaccharide have some biological uses as shown by above properties [44].

4.4 Wound Healing Activity

T. indica is being used in the treatment wounds, cuts and abscesses. Polysaccharide isolated from tamarind seed such as xyloglycan played a role in healing of corneal injuries in rabbit (in vivo) and integrin-substrate recognition system (in vitro, with cultured human conjunctival cells). The polysaccharide have ability to support corneal wound healing be influenced by integrin recognition system [45]. *T. indica* leaves decoction important agent used to clean up wounds by Guinea worm infections [46].

4.5 Ophthalmic Ailments Healing Properties

Tamarind seed polysaccharide used as eye drops, as the study showed, and it played a well role on relieving symptoms of trouble blinking, foreign particle sensation in one's eye, ocular burning [47].

4.6 Antidiabetic Activity

Tamarind seed water extract decreases blood sugar level in streptozotocin-induced diabetic male mice so tamarind seed have powerful antidiabetic activity [48].

4.7 Pain Relieving Property

By utilizing acetic acid induced writhing test and suitable models as hot plate test, Different extracts of T. indica bark showed an analgesic properties. The petroleum ether extracts appeared remarkable result at 50 mg/kg, i.p. as related to standard medicine pentazocine (10 mg/kg, i.p.). The ether extract of the tamarind contains primary phytochemicals like sterols and triterpenes. These Phytochemicals (triterpenes and sterols) showed analgesic and anti-inflammatory properties [49].

4.8 Anti- hypercholesterolemic Properties

The fruit pulp of *T. indica* extract have an antioxidant action in vitro, and early atherosclerotic lesion in hypercholesterolemic rats, on lipid serum level in vivo as stated by Martinello et al. The remedy for hypercholesterolemic rats with 5% extract of tamarind fruit pulp managed to rise low density lipoprotein (LDL), cholesterol level (61%), and to reduce in the levels of non-HDL cholesterol (73%), serum total cholesterol (50%), and triglyceride (60%). In vitro, the tamarind extract presented essential scavenging capability as considered by superoxide redicals and the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and also by the thiobarbituric acid reactive substances (TBARS). It decreases lipid peroxidation in serum. In vivo, the proficiency of the antioxidant resistance system, also improved by extract as judged by superoxide dismutase, glutathione peroxidase, and catalase actions. The above study stated that tamarind extract indicate the potential in decreasing risk of atherosclerosis development in human [41].

4.9 Anti-inflammatory Action

Ethanol, chloroform and aqueous extracts of *T. indica* were assessed for anti-inflammatory activity in rats (subplantar oedema influenced by carrageenan) and mice (ear oedema influenced by arachidonic acid) after administration. The Plant shows anti-inflammatory activity as shown by results [50].

4.10 Antifungal Properties

T. indica L. has anti-inhibitory as well as antifungal properties. The extracts of Tamarind fruit showed antifungal activity against cultures of *Candida albicans* and *Aspergillus niger* [5].

4.11 Anti-bacterial Properties

Tamarind fruit showed anti-bacterial as well as anti-fungal activity [5]. In an agar dissemination test, *T. indica* flower extracts appeared antibacterial properties against four microbes which *are Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli. T. indica* as Antimicrobial action has been credited to lupeol study [51].

4.12 Molluscicides Activity

Tamarind fruits contains saponins therefore the researchers said the extracts of tamarind fruit has moluscidal properties agains Bulinus trancatus snails [5].

4.13 To Get Rid of Deposited Fluoride from Bones

Researchers assessed the impact of tamarind on gastric as well as they delivers other useful impacts on mobilization of fluoride from the bone after children were provided with defluoridated water. In the fluoride endemic zone, mostly changes in urine parameters of tamarind ingested children are volume, fluoride, pH, calcium, magnesium and copper, in the trial groiup and within the control groups were compared. The results indicates that reduction in urinary copper excretion and calcium, in the trial group as related to control group and a substantial rise in fluoride excretion as well as increase in urinary pH but between these two groups no changes were found in urine volume [52].

5. Medicinal Uses of Tamarind

In all over the world, the tamarind has been used as traditional medicine [39]. A wide range of medicinal uses are found in different nations [53]. All parts of tamarind plant like fruit, seeds and leaves are use traditionally in African and Indian system of traditional medicine [5].

Tamarind is a multipurpose tropical tree which has many properties. Especially the fruit of tamarind is used as spice or seasoning agent it maybe fresh or after handled. Moreover it also used as drug. In reality, their fruits are the foremost considered and important remedial portion of the plant, which has been stated as

remedial in a few pharmacopoeias. Researchers stated that this plant has been used as medicine from old time and it is recognized around 400BC in Egypt, and it is indicated within the Indian Brahmasamhita Scriptures between 1200-200 BC.

5.1 Uses of Tamarind Fruit

Tamarindus indica fruit is used as stomach related drug which has digestive, purgative, blood tonic, expectorant and carminative properties in conventional system of medication [54]. Numerous other activities have been also described such as against gastrointestinal fits [18], antioxidant and Hypoglycemic [41], antimicrobial [55], anti-inflammatory [42], cytotoxic [16], and adjusting the complement system [56].

Tamarind can be used as single drug as well as with combination of other drugs like honey, lime juice, milk, spices, dates and camphor, which is considered to be active for stomach related ailments, certainly it is used for elephants, as a cure for biliousness, as antiscorbutic and disorders due to bile [57]. It has been approved by modern scientific research that the tamarind pulp have laxative as well as diuretic properties [5].

5.2 Uses of Tamarind Seeds

A combination of tamarind seeds with cumin seeds and palm sugar is used for dysentery as well as chronic diarrhoea. And it is believed that tamarind roots infusion use as a constituent of leprosy treatment as well as use for chest complaints [53].

5.3 Uses of Tamarind Bark

The bark of the tamarind tree have febrifuge and astringent activity [5, 58]. The bark is also utilized as a tonic and in moisturizers or poultices to release ulcers, bruises, rashes and bubbles [5]. It is used as effective treatment of colic and indigestion by browning with salt. Different cases of asthma, eye inflammation and gingivitis are treated by decoction of tamarind bark. For local application on caterpillar rashes and open sores, poultices and creams are prepared by bark of tamarind [53]. For medicinal uses the tamarind plant should be unpeeled in the season when the flowering finished or season when the tree is not flowering [5].

5.4 Uses of Tamarind flowers and leaves

For the treatment of boils, swollen joints and sprains, the tamarind flowers and leaves are used as decoction or powder form. The powder of Tamarind leaves and flowers are utilized for the preparation of ointments, which are used for the treatment of jaundice, dysentery, hemorrhoids, erysipelas and various other ailments. This ointment also have properties to cure the conjunctivitis, as vermifuge, as antiseptics. In various medicinal formulation the ash of tamarind fruit shells are used [53]. A combination with salt and water and tamarind leaves are used to treating coughs, throat infections, fever, intestinal worms, liver disorders and urinary ailments. The tamarind leaves and pulp have properties as a laxative, cholagogue, and are frequently utilized in handling liver ailments 'congestion', hemorrhoids and constipation [5].

6. Conclusion and Future Prospects

This work provides the identification, review and description of the sources of information available on the temperament, phytochemical components of the parts of the plant and pharmacological activities of T. indica. The main result has been the possibility of identifying scarce but sufficient information to estimate the importance of the consumption of T. indica as a nutraceutical food due to its low or no toxicity on the body and the diversity of its components assets. This is important as a starting point for the prevention and aid in the treatment of chronic non-communicable diseases associated with the antioxidant, immunomodulatory, antidiabetic, antihypercholesterolemic and anti-inflammatory activities of T. indica. The studies analyzed in this review have been of three types: qualitative ethnopharmacological, pre-clinical and clinical. The main problems detected have been the following: the first is that the studies mainly date between 1990 and 2010, which implies that no updated information is available, and that it is generally confined to descriptive and pre-clinical settings. The second is that there are serious limitations in the information derived from the dose or posology that must be used to take full advantage of its properties. In any case, and saving these limitations, the results of this review indicate that its phytochemical composition confers it important properties at present to recommend its habitual consumption.

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Competing Interests: The authors proclaim that they have no competing interests.
Funding: This work was via self-funded.