AN OVERVIEW OF *TAMARINDUS INDICA* Linn.: CHEMISTRY AND PHARMACOLOGICAL PROFILE.

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Summary

Tamarindus indica Linn (Caesalpiniaceae) is a tropical evergreen tree, extensively used as traditional medicine in all countries. *T. indica is* commonly found in fertile areas throughout the Africa and Southern Asia. The chemical constituents reported from this plant belong to different classes such as glycosides, tannins, flavonoides, volatile oils, steroids, resins, mucilage and sugars. *T. indica* has number of medicinal uses, many of which have been verified by scientific methods. This review article summarizes the chemistry and pharmacological profile of *T. indica*.

Key word: *Tamarindus indica,* Caesalpiniaceae, triterpenes, phytochemistry, pharmacological activity.

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Introduction

Tamarindus indica family: Fabaceae, subfamily: Caesalpiniaceae, is a tropical evergreen tree native to fertile areas throughout the Africa and Southern Asia.[1] It is commonly called as tamarind and widely cultivated as an ornamental tree. Due to its acidic fruits it is used in making drinks and a popular component of many decoctions used as health remedies. Tamarindus is a monotypic genus distributed throughout much of the tropics. Different parts of the plant such as leaves, fruits and seeds have been extensively used in traditional Indian and African medicines.[2] The aqueous extract of seed reduced blood sugar level showed hypolipidemic effect, reduced 14-17% of plasma lipid, total lipid, cholesterol, lipoprotein and triglyc erides.[3,4] The seed coat extract has strong antioxidant property, used as additive to food, in cosmetics and pharmaceutical preparations.[5] The seeds also inhibit the growth of urinary crystals and are used in the treatment of recurrent kidney stones.[6] The fruit also has antimicrobial and antibiotic activity.[7] The plant has a great phytochemical significance. On literature survey it was revealed that a variety of secondary metabolites have been reported from tamarind.

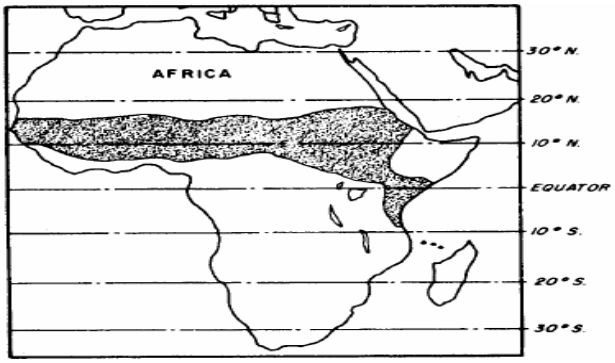


Figure 1: Geographical distribution of *T. indica* in Africa (Shaded area represent approximate native range of tamarind).

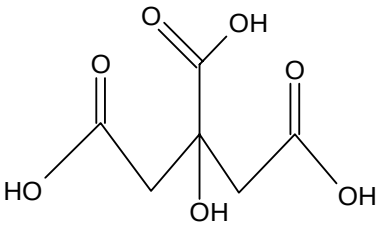
Figure 2: Foliage and fruit of *T. indica*

Phytochemistry

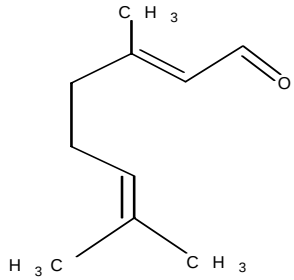
Table 1: Chemical constituents of *T. indica*

Sr. no	Parts	Chemical constituents
1	Leaves	Pulps contains invert sugar, pipecolic acid, citric acid (I), nicotinic acid, 1-malic acid, volatile oils (geranial(II), geraniol, limonene),[8] pipecolic acid, lupanone (III), lupeol (IV),[9] orientin (V), iso-orientin(VI),[10] vitamin B_3 (VII), vitamin C (VIII), vitexin (IX), isovitexin (X), [11] benzyl benzoate (40.6%), cinnamates, serine, beta-alanine, pectin, proline, phenylalanine, leucine, potassium, 1-malic acid, tannin, glycosides, and peroxidase.[12]
2	Fruit	Furan derivatives (44.4%) and carboxylic acid (33.3%).[13] Phlobatannine, grape acid, apple acid, tartaric acid (XI), [14] succinic acid, citric acid, pectin and invert sugar. [15, 16]
3	Seeds	Campesterol (XII), β-amyrin (XIII), β-sitosterol (XIV), palmitic acid (XV), oleic acid, linoleic acid and eicosanoic acid. The Mucilage, pectin, arabinose, xylose, galactose, glucose and uronic acid were also found.[17] A new bufadienolide (Scilliphraside 3-O-β-D glucopyranosyl -(1-2)-L-rhamnopyranoside) and cardenolide (uzarigenin-3-O-β-D-xylopyranosyl (1-2)-α-L rhamnopyranoside) were identified from the seed extract.[18,19] Cellulose, albuminoid. amyloids, phytohemaglutinins, chitinase (XVI),[20]
4	Bark	Tannins, saponins, glycosides, peroxidase and lipids.[21]

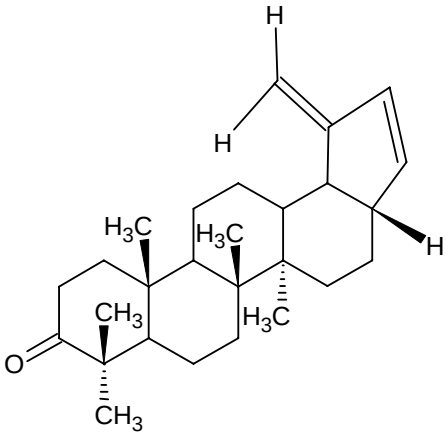
Figure 3: Chemical structures of various phytoconstituents from *T. indica.*



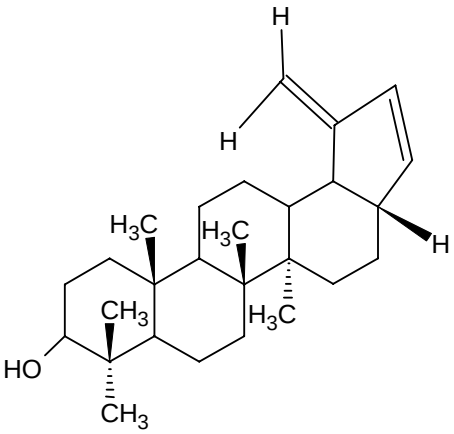
I Citric acid



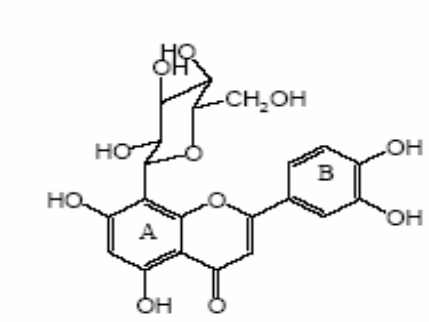
II Geranial



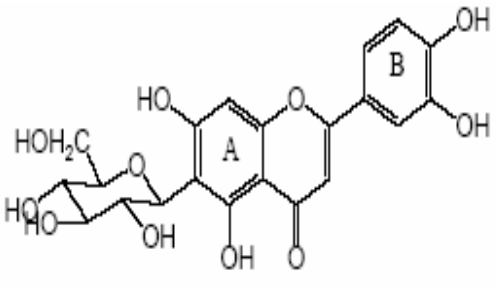
III. Lupanone



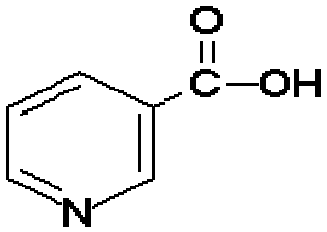
IV. Lupeol



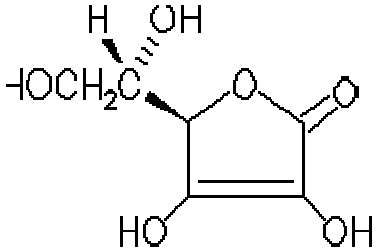
V Orientin



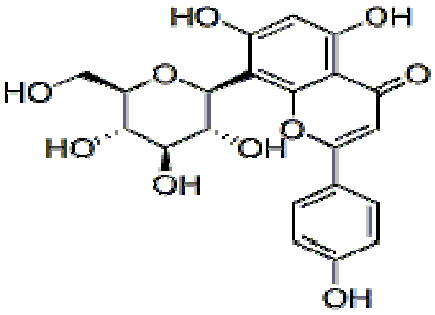
VI Iso-orientin



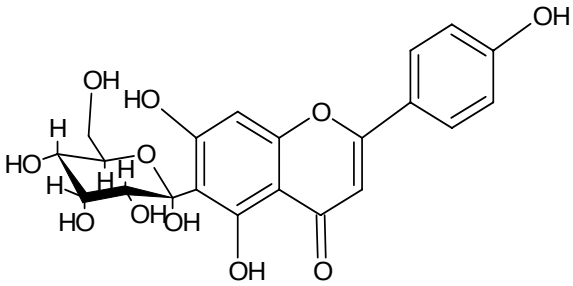
VII Vitamin B_3



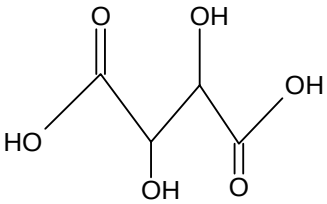
VIII Vitamin C



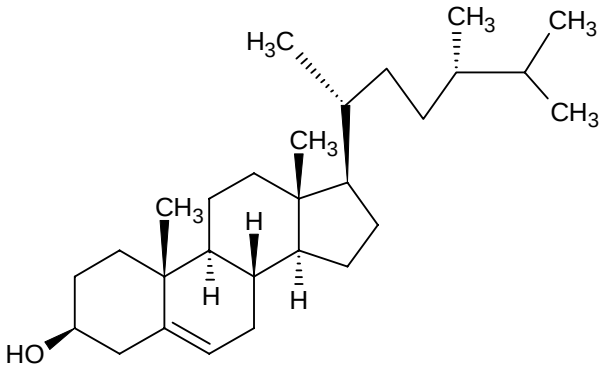
IX Vitexin



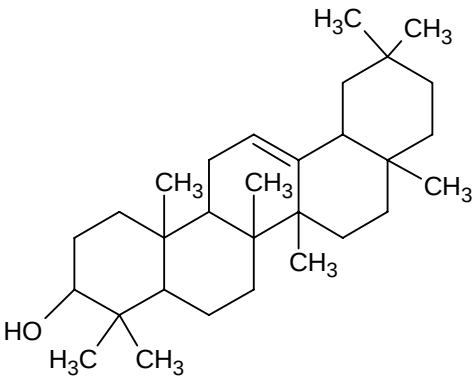
X Iso-vitexin



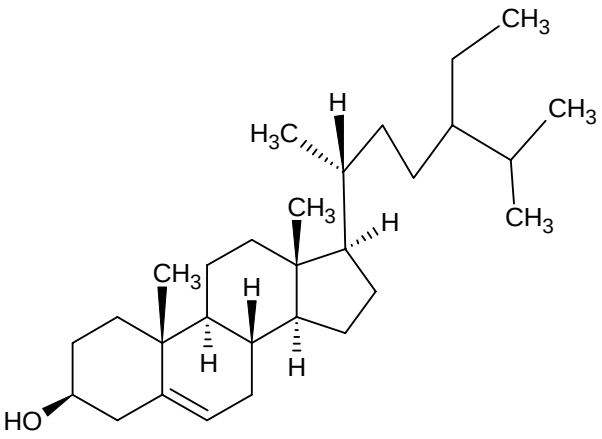
XI Tartaric acid



XII Campesterol

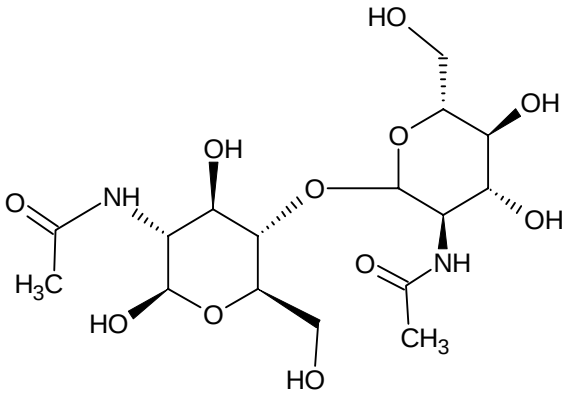


XIII B-amyrin



XIV **β-sitosterol**

XV. Palmitic acid



XVI chitinase

Pharmacological activity

Antioxidant activity:
The antioxidant activity of tamarind has been found by many researchers, so the tamarind has advantages for used in human health as a herbal medicines for degenerative diseases and used especially in color cosmetics and sun screen.[22, 23]

Immunomodulatory activities:
A polysaccharide isolated and purified from *T. indica,* shows immunomodulatory activities such as phagocytic enhancement, leukocyte migration inhibition and inhibition of cell proliferation. These properties suggest that this polysaccharide may have some biological applications.[24]

Carcinogenic activity:
The carcinogenic potential of tamarind seed polysaccharide was examined in both sexes of B6C3F1 mice. The results demonstrated that its polysaccharide is not carcinogenic in B6C3F1 mice of ether sex. Bioassay-guided fractionation of methanolic extract of tamarind seeds led to isolation of L-di-n-butyl maleate which is having pronounced cytotoxic activity against sea urchin embryo cells.[25] In order to study structure-activity relationships of its analogues, L-di-n-pentyl maleate was the most effective inhibitor to the development of the fertilized sea urchin eggs, and significant inhibitory activity was not in the esters of D-isomer.[26]

Wound healing activity:
Exploited the role of a natural polysaccharide from the tamarind seed (xyloglycan) and the integrin-substrate recognition system (in vitro, with cultured human conjunctival cells) and on repair of corneal wounds in rabbit (in vivo). The results concluded the ability of the polysaccharide (xyloglycan) to promote corneal wound healing might depend on its influence on the integrin recognition system.[27]

In ophthalmic use:
The study showed that use of tamarind seed polysaccharide in the eye drops and it showed significantly better result of relieving several key subjective symptoms of dry eye syndrome-namely, trouble blinking, ocular burning and sensation of having something in one's eye.[28]

Antidiabetic activity:
Water extract of tamarind seed was found to have potent antidiabetic activity that reduces blood sugar level in streptozotocin-induced diabetic male rats.[29]

Antioxidant and anti-atherosclerosis:
The effects of crude extract from pulp fruit of *T. indica* on lipid serum level and early atherosclerotic lesions in hypercholesterolemic hamsters in vivo, and antioxidant action in vitro, have been studied by Martinello et al. Treatment of hypercholesterolemic hamsters with 5% pulp fruit tamarind extract led to decrease in the levels of serum total cholesterol (50%), non-HDL cholesterol (73%) and triglyceride (60%), and to an increase of high-

density lipoprotein (LDL) cholesterol level (61%). In vitro, the extract presented radical scavenging ability, as assessed by the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and superoxide radicals assays, and to decreases lipid peroxidation in serum, as assessed by the thiobarbituric acid reactive substances (TBARS). In vivo, the extract also improved the efficiency of the antioxidant defense system, as assessed by superoxide dismutase, catalase and glucathione peroxidase activities. Together these results indicate the potential of tamarind (pulp fruits) extracts in diminishing risk of atherosclerosis development in humans.[30]

Acaricidal activity:

The crude-extract of *T. indicus* with water and 10% ethanol in water were tested for the acaricidal activity on the engorged female cattle tick (*Boophilus microplus)* by dipping method. The mature tamarind fruits taking off the seeds were extracted by water or 10% ethanol in the ratio of 1:2 and 1:5 W/V for 7 days. The corrected mortality of the ticks were observed after dipping at 24 h, 48 h and 7 days. The mean of corrected mortality of ticks of these 4 crude-extracts of tamarind fruits were 56-70 %, 70-89% and 77-99% by no statistically significant different after dipping at 24 h, 48 h and 7 days, respectively. The organic acids in tamarind fruits (oxalic, malic, succinic, citric and tartaric acids) were also bioassayed the acaricidal activity by dipping method. The oxalic acid of 0.5% and 1% concentration exhibited the highest acute acaricidal activity (56% and 62% mortality of ticks at 24 h after dipping, respectively). The tartaric acid 1% concentration showed the highest delayed acaricidal activity (73% mortality of ticks at 7 days after dipping). The mixture of 0.5% of oxalic acid with 0.5% of malic, succinic, citric and tartaric acids by concentration of 1:1 V/V were tested the acaricidal activity. The acaricidal activity of these acid mixtures was not stronger than those of each individual acid. Both of crude-extract of tamarind fruits and their organic acids caused the patchy hemorrhagic swelling on the skin of ticks after dipping at 15 min. This indicates that the crude-extract of tamarind fruits by water or 10% ethanol is possibly used in practical for controlling the tropical cattle tick. The active substances are their organic acids, especially oxalic and tartaric acids.[31]

Antimicrobial activity:

The phytochemical constituents of the dried powdered plant parts were extracted using aqueous and organic solvents (acetone and ethanol). The antimicrobial activity of the concentrated extracts was evaluated by determination of the diameter of zone of inhibition against both gram negative and gram positive bacteria and fungi using the paper disc diffusion method. Results of the phytochemical studies revealed the presence of tannins, saponins, sesquiterpenes, alkaloids and phlobatannins and the extracts were active against both gram positive and gram negative bacteria. The activity of the plant extracts were not affected when treated at different temperature ranges (4^oC, 30^oC, 60^oC and 100^oC), but was reduced at alkaline pH. Studies on the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the extracts on the test organisms showed that the lowest MIC and the MBC were demonstrated against *Salmonella paratyphi, Bacillus subtilis* and *Salmonella typhi* and the highest MIC and MBC was exhibited against *Staphylococcus aureus*. *T. indica* has broad spectrum

antibacterial activity and a potential source of new classes of antibiotics that could be useful for infectious disease chemotherapy and control.[32]

For mobilization of deposited fluoride from bones:
Khadare *et al.* evaluated the effect of tamarind on ingestion and whether it provides additional beneficial effects on mobilization of fluoride from the bone after children provided defluoridated water. The main changes in urinary components (volume, pH, fluoride, calcium, copper and magnesium) after tamarind ingestion by the children in the fluoride endemic area, in the control and experimental groups were compared. The results shows that was a significant increase ($P < 0.01$) in fluoride excretion and urinary pH, and a significant decrease in urinary calcium ($P < 0.01$) and copper ($P < 0.05$) excretion, in the experimental group as compared with the control group. There was no change in urinary volume between two groups.[33] Tamarind intake appears to have an additional beneficial effect on the mobilization of deposited fluoride from bone, by enhancing urinary excretion of fluoride.

The anti-snake venom activity:
In Indian traditional medicine, various plants have been used widely as a remedy for treating snake bites. The study that the effect of *T. indica* seed extract on the pharmacological as well as the enzymatic effects induced by *V. russelli* venom. Tamarind seed extract inhibited the PLA (2), protease, hyaluronidase, l-amino acid oxidase and 5'-nucleotidase enzyme activities of venom in a dose-dependent manner. These are the major hydrolytic enzymes responsible for the early effects of envenomation, such as local tissue damage, inflammation and hypotension. Furthermore, the extract neutralized the degradation of the beta chain of human fibrinogen and indirect hemolysis caused by venom. It was also observed that the extract exerted a moderate effect on the clotting time, prolonging it only to a small extent. Edema, hemorrhage and myotoxic effects including lethality, induced by venom were neutralized significantly when different doses of the extract were preincubated with venom before the assays. On the other hand, animals that received extract 10 min after the injection of venom were protected from venom induced toxicity. Since it inhibits hydrolytic enzymes and pharmacological effects, it may be used as an alternative treatment to serum therapy and, in addition, as a rich source of potential inhibitors of PLA(2), metalloproteinases, serine proteases, hyaluronidases and 5- nucleotidases, the enzymes involved in several physiopathological human and animal diseases.[34]

***T. indica* L. leaf is a source of allelopathic substance:**
The allelopathic potential of the *T. indica* L. leaf was investigated through bioassay guided studies using several weed and edible crop species. Both radicle and hypocotyl growth of all the plant species tested was strongly inhibited by the tamarind leaf using a sandwich method.The tamarind leaf showed a high allelopathic value as expressed by the inhibition of seedling growth in all the 14 plant species tested. The highest growth inhibition was observed in barnyard grass (79% in radicle and 75% in hypocotyl), and the lowest in welsh onion (36% in radical and 33% in hypocotyl). Weed species showed higher growth inhibition than edible crop species. Tamarind leaf crude water-soluble

extracts showed a high allelopathic potentiality in terms of the radical and hypocotyl growth inhibition when the crude extracts were applied at different concentrations (w/v) study showed that both radical and hypocotyl growth in all the bioassay species decreased proportionally with increasing concentrations (w/v) of tamarind leaf water-soluble extracts. Sahid and Sugau also found similar results when aqueous extracts of lantana (*Lantana camara*) and siam weed (*Chromolaena odorata*) were applied to 5-different crop species, chilly, Chinese cabbage, cucumber, grape and spinach. Numerous works have also been carried out on the inhibitory effects of aqueous extracts of other plant species.[34] Recently, aqueous extracts of kenaf (*Hibiscus cannabinus* L.) and unicorn plant (*Proboscidea louisianica* Mill.) have been found to reduce germination in tomato and ryegrass by 30%, pigweed by 50–70% [35] and cotton and wheat by 16–43%[36, 37].

Analgesic activity:

Various extracts of *T. indica* bark was screened for analgesic activity by using suitable models as hot plate test and acetic acid induced writhing test. The petroleum ether extract showed significant result at 50 mg/kg, i.p. as compared to standard drug pentazocine (10 mg/kg, i.p.). Preliminary phytochemical tests showed presence of sterols and triterpenes in petroleum ether extract. Some sterols and triterpenes are responsible for anti-inflammatory and analgesic activity.[38] So from this study we conclude that analgesic activity observed by sterols and triterpenes of *T. indica* bark.[39]

Anti-inflammatory activity:

Aqueous, ethanol and chloroform extracts from *T. indica* were evaluated for anti-inflammatory properties in mice (ear oedema induced by arachidonic acid) and rats (subplantar oedema induced by carrageenan) after topical or i.p. administration, respectively. Results showed that the plant exhibit anti-inflammatory activity.[40]

Conclusions

T. indica is traditionally very important herb having many important pharmacological activities like analgesic, antidiabetic, anti-inflammatory wound healing, immunomodulatory, acaricidal, antimicrobial, carcinogenic and antioxidant property. Many important phytoconstituents responsible for the activity were isolated. This proves therapeutic importance of the plant. Such type of systematic information about the plant is useful for the researchers. This review of *T. indica* is hopefully induce the advance research about the benefit of this plant for human life.

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