

**TAMARINDUS INDICA- A POLYHERBAL TREASURE:  
PHYTOCHEMICAL BASIS AND PHARMACOLOGICAL APPROACH  
TO INFLAMMATION CONTROL**

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**ABSTRACT**

Tamarindus indica L., commonly known as tamarind, is a tropical tree belonging to the family Fabaceae and has long been valued as both a food source and a traditional medicinal plant. The present review focuses on its phytochemical composition, pharmacological activities, and potential role in inflammation control. Tamarindus indica is widely distributed across the Indian subcontinent, Africa, and other tropical regions, where it is traditionally used to treat a variety of ailments such as abdominal pain, diarrhea, dysentery, constipation, fever, and inflammation. Phytochemical analyses reveal that the plant is rich in flavonoids, polyphenols, alkaloids, saponins, tannins, and essential amino acids, which collectively contribute to its therapeutic potential. Because of its high nutritional value and bioactivity, T. indica is also

considered a promising candidate for developing nutraceuticals and herbal formulations. Its affordability, accessibility, and wide range of health benefits make it a valuable medicinal resource for developing countries. However, despite extensive laboratory research, there is still a lack of well-structured clinical studies to standardize dosage and evaluate safety in humans. In conclusion, Tamarindus indica represents a versatile medicinal tree with significant phytochemical richness and multi-targeted pharmacological actions. Its strong anti-inflammatory and antioxidant properties position it as a potential natural alternative to synthetic drugs, meriting further exploration for future pharmaceutical and therapeutic applications.

## INTRODUCTION

The fruity plant tamarind (*Tamarindus indica*) is a member of the leguminous family.<sup>[1]</sup> It is known as "imli" in Hindi and Urdu<sup>[3]</sup> and has long been grown on the Indian subcontinent, where it is also said to be indigenous.<sup>[2]</sup> Since there is just one species in the genus *Tamarindus*—*Tamarindus indica* L., or simply "Tamarind"—it is a monotypic taxon. In Africa, it can be found growing wild in Cameroon, Sudan, Tanzania, and Nigeria. There are several types of *Tamarindus indica*, which can be divided into two categories: acidic and sweet. Since acidic tamarind is common in many nations, it grows readily in warm, sunny climates. However, sweet varieties are difficult to find.<sup>[4]</sup>

Two varieties of tamarinds have a sweeter flavor.

One of them is Manila Sweet, which is run by the US Department of Agriculture's Subtropical Horticulture Research Unit in Miami, while another is Makham-Waan from Thailand. Leaves contain the majority of essential oil. Thirteen components were found in the tamarind leaf oil, with limonene (24.4%) and benzyl benzoate (40.6%) being the most prevalent.<sup>[6]</sup>

Before 400 B.C., it was grown in Egypt. Tamarind may have been transported from India to South East Asia by Arab and Persian traders.<sup>[7]</sup> Because of the corrosive effect that fallen leaves have on clothes in wet weather, there is a superstition. Hindus may wed a tamarind tree to a mango tree before consuming the fruits. In Nyasaland, people believe that soaking tamarind bark in grain will make domestic poultry return home if they are stolen or wander. In Malaya, elephants are given fruit and bark to make them wise, and newborns are given a small amount of tamarind and coconut milk.<sup>[5-8]</sup>

Tamarind is a huge, long-lived, evergreen tree that grows to a height of 20 to 30 meters and has a thick trunk that can reach a diameter of 1.5 to 2 meters and a circumference of up to 8 meters. The trunk is multi stemmed with widely spreading branches that produce the rounded crown that droops at the ends, and it forks at a height of approximately one meter above the ground. The bark is scaly, rough, and has a brownish-grey hue. Young twigs are thin and puberulent.<sup>[9]</sup> The pinnate leaves are 3–6 inches (7.5–15 cm) long, with 10–20 pairs of feathery, oblong leaflets that are half to 1 inch (1.25–2.5 cm) long. Pale yellow or pinkish flowers are lovely. The pedicel is a thin, articulate structure that is 6–10 mm length beneath the calyx. It is 6–8 mm long, glabrous, and has concave bracts. The calyx has a length of 1.3

cm.<sup>[10]</sup>

It is thought to be the perfect tree for semiarid areas. It can withstand dry circumstances for five to six months, but it cannot withstand low temperatures.<sup>[11]</sup> The tamarind tree can withstand strong cyclones and typhoons and exhibits resistance to strong winds.<sup>[12]</sup>



**Fig. 1:** The botanical morphology of the main features of *Tamarindus indica*. (a) *Tamarindus indica* fruit (b) Leaflets leaf of *T. indica*. (c) Flower of *T. indica*. (d) *T. indica* bark.

### Phytoconstituents

Phytochemicals	Compound structure	Pharmacological target(s)	Overall effect (s)
<b>Procyanidins</b>	 Procyanidins.cdx	NF-κB pathways; inhibiting iNOS and COX-2 expressions.	Down regulation of inflammation and body pain <sup>[15]</sup>
<b>Catechin</b>	 CATECHIN.cdx	NF-κB mitogen activated protein kinases.	Down regulation of inflammation and body pain <sup>[16]</sup>
<b>Taxifolin</b>	 TAXIFOLIN.cdx	Inhibition of LPS-induced tumor necrosis factor-α.NF-κB mitogen activated protein kinases.	Down regulation of inflammation and body pain <sup>[17,18]</sup>

<b>Apigenin</b>	 Apigenin.cdx	Inhibition of NO production and iNOS, and COX-2 expression	Down regulation of inflammation and body pain <sup>[19,20]</sup>
<b>Luteolin</b>	 LUTEOLIN.cdx	Down regulation of inflammatory mediators and cytokines	Down regulation of inflammation and body pain <sup>[21]</sup>
<b>Naringenin</b>	 NARINGENIN.cdx	Inhibition of the pro-inflammatory cytokines. Modulate transient receptor potential channels	Down regulation of inflammation and body pain <sup>[22,23]</sup>

### PHARMACOLOGICAL ACTIVITY

Body Organs [parts]	Activities
GIT [Stomach]	Constipation, Diarrhoea, Dysentery, Laxatives, Carminatives, Indigestion, Nausea, Vomiting and Other GIT related disease
Respiratory Tract	Asthma, Cough and other related disease
Liver	Jaundice, Hepatic damage, Cholesterol metabolism disorder, Liver disease
Eye	Conjunctivitis, Dry eye, Eye inflammation, Keratitis
Nervous system [Brain]	Alzheimer, Depression and Paralysis
Cardiovascular system	Antioxidant, hypo-cholesterolemic and other heart related disease.
Other	Antimicrobial, Antiviral, antiseptic, Ant inflammatory, Anticancer, ligament injury, Expectorant, Malaria, Typhoid and antivenom
Supplementary	Vitamin B, Vitamin C, Calcium Potassium and Other

### Docking studies

PDB: 7R8U

The compounds were docked to the target LOX1 to check their binding profiles. The docking studies have been done by using PyRx.

PyRx is a Virtual Screening software for Computational Drug Discovery that can be used to screen libraries of compounds against potential drug targets. PyRx enables Medicinal Chemists to run Virtual Screening from any Platform and helps users in every step of this process- from data preparation to job submission and analysis of the results.

PyRx includes a docking wizard with an easy-to-use user interface which makes it a valuable tool for Computer-Aided Drug Design. PyRx also includes a chemical spreadsheet-like

functionality and powerful visualization engine that are essential for structure-based drug design.

### 1. Preparation the input Structures

Click on File - Load molecule, then browse the desired PDB

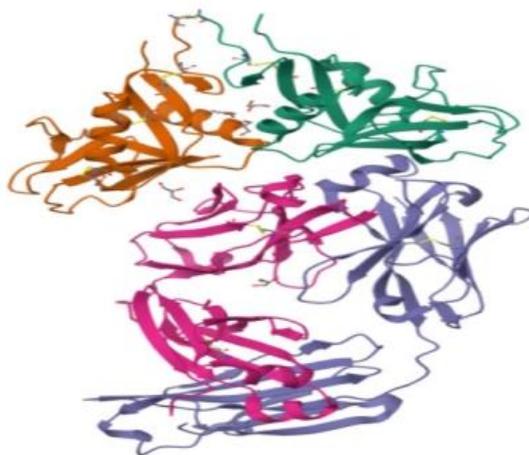
Right -Click on the selected PDB in the Molecules tab, and select AutoDock - Make Macromolecule.

Click on the Open Babel tab under the Controls page. Click on the Gest loon on de toolbar, and open the ligand structure. Right-Click on the selected entry inside the Open Babel sadget, and select. Minimize all. Right click on the selected entry and select Convert All to AutoDock Ligand (pdbqt) This opens a progress dialog box and shows the pdbut files created in the Ligands folder Now that we have the input pdbqt structures, we are ready to use the Vina Wizard.

### 2. Using the Vina Wizard

Click on the Vina Wizard tab under the Controls panel. The first page for the VinaWizard is similar to the AutoDock Wizard, except that there are 2 execution modes. instead of 3 (je..there are currently no remote web services for Vina). Also, since Vinabinaries are distributed within PyRx, the Local execution mode is enabled by default. Click on the Start button to begin. On the Select Molecules page click Forward. A grid box will appear on the working screen. Adjust the grid box in a way that it includes all the atoms from the target. Click on Forward to perform the docking.

## PROTEIN



**Fig. 2: The 7R8U {LOX 1} 3D representation.**

## LIGAND

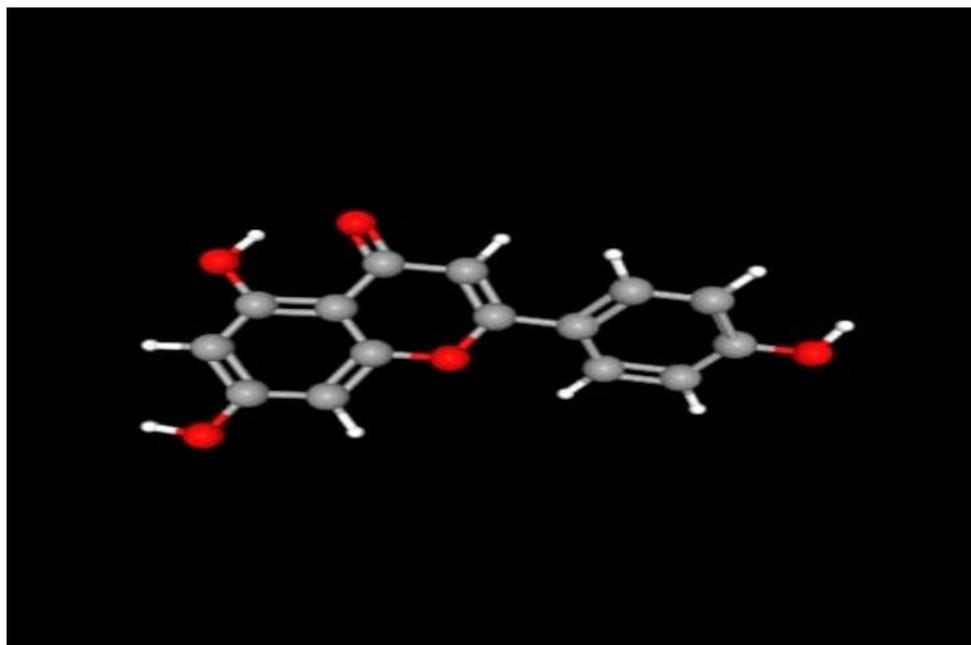


Fig. 3: CID 5280443 {Apigenin} in 3D.

## BINDING AFFINITY

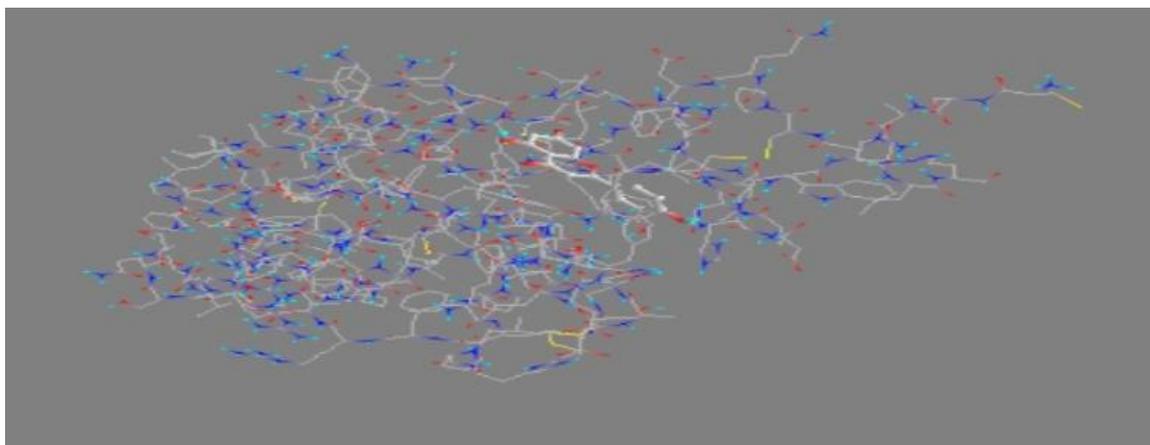


Fig 4: The 3D depiction of 7R8U {LOX 1} with CID 5280443 {Apigenin}.

## Marketed Formulations and Products

Binding Affinity (kcal/mol)	Mode	RMSD lower bound	RMSD upper bound
-8.3	0	0.0	0.0
-8.2	1	3.593	7.89
-7.9	2	4.317	7.247
-7.6	3	29.434	31.18
-7.1	4	11.44	14.0
-6.9	5	7.281	10.98
-6.7	6	20.189	22.642
-6.6	7	30.132	32.237
-6.6	8	30.188	31.473

### **Food and Culinary Products**

The most common and widely marketed formulations are food-related, leveraging the pulp's unique sweet and sour flavor profile.

### **Tamarind Paste/Concentrate**

This is a concentrated, shelf-stable form of the fruit pulp used as a souring agent in global cuisines (Indian, Thai, Mexican, etc.) and as an ingredient in commercial sauces like Worcestershire, barbecue, and ketchups.

### **Tamarind Pulp Powder**

Dehydrated and milled pulp used as an acidulant in dry instant pre-mixes and various food products.

### **Beverages and Confectioneries**

The pulp is the base for commercially available refreshing drinks ("Ade"), juices, syrups, jams, candies, and fruit bars.

### **Spice Mixes**

Tamarind powder is an ingredient in formulated spice mixes for traditional dishes like Puliogare and Sambar.

Industrial and Pharmaceutical Applications

(Useful for interdisciplinary journals)

### **Tamarind seed polysaccharide as**

Drug release retardant

Binder and stabilizer in tablets

Use in ophthalmic and controlled drug delivery systems

Application in cosmeceuticals (anti-aging, skin hydration)

### **ANTI INFLAMMATORY**

A complex biological process, inflammation occurs when vascular tissues are exposed to harmful stimuli brought on by infections, damaged cells, or irritants. The body uses inflammation as a defensive mechanism to get rid of harmful stimuli and start the healing process<sup>[53]</sup>, but swelling, tightness, joint pain, and irritation are some of the symptoms that make patients uncomfortable. In addition to reducing pain, fighting inflammation can increase circulation and promote recovery. Conventional medicines such as steroids and non-

steroidal anti-inflammatory drugs (NSAIDs) have shown only limited achievement against all forms of inflammatory circumstances. Furthermore, the unpleasant side effects associated with these drugs such as bleeding and mucosal damage and other gastrointestinal disturbances make the treatment difficult.<sup>[54]</sup> Considering the probable adverse effects of these drugs, as well as their limited ability to provide long-term remission, there is a need of a new, effective and safe anti-inflammatory agent which can reduce pain and other associated symptoms.<sup>[55]</sup> Plant-based remedies are used extensively in traditional medical systems and have become significant in modern medicine to address these issues.

**Acute inflammation** = short-term, protective

Example: swelling after an injury → brings immune cells to repair tissue.

**Chronic inflammation** = long-term, destructive

Example: low-grade inflammation lasting months or years → damages tissues silently

## CONCLUSION

Tamarindus indica is a valuable medicinal plant enriched with diverse phytochemicals exhibiting strong antioxidant, anti-inflammatory, and therapeutic properties. Its traditional uses are well-supported by modern pharmacological evidence, including docking studies that highlight its potential against inflammatory targets. With its wide biological applications and minimal side effects, T. indica represents a promising source for developing safe, natural, and effective herbal formulations. However, further clinical and pharmacokinetic studies are essential to validate its therapeutic efficacy and ensure standardized medicinal use.

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