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SHORT REVIEW

A Scientific Evidence-based Review of Tamarind usage in Indian Folklore Medicine

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Abstract

Currently, the paradigm shift of folklore medicine is obvious among the public and researchers. Study based on traditional medicine around the world has become prominent with the addition of pharmacological studies to scientifically prove the effectiveness of the concerned medicine. Tamarind (*Tamarindus indica* L. of family Fabaceae) alone or with a combination of other herbs has been proved to be effective for treating many ailments such as arthritis, dysuria, dental diseases, ulcer, sexual dysfunction, etc. It also exhibits pharmacological actions such as anti-microbial, anti-dysentery, anti-coagulant, hepatoprotective, anti-asthmatic, and anti-diabetic. The pharmacological effect of the fruit or the pulp, leaves, flowers, kernel, and inner bark has been studied. Furthermore, different species of tamarind have also been studied. Numerous studies such as chemical, analytical and biological were conducted to confirm the same. The clinical studies of tamarind match with folklore practices with respect to pharmacological actions, still some are yet to be explored. This study focuses on reviewing the chemical composition, pharmacological effects, and nutritional effects of tamarind. Hence it can be concluded that the folklore practice and modern medicinal practice interact with each other. Thus, the folklore practices without being neglected can be extended for the support of scientific evidence through detailed researches.

Keywords: Herbal Formulation, Pharmacological Effect, *Tamarindus indica*, Traditional Medicine, Traditional Practices

1. Introduction

Human beings and plants share an age-old relationship[1]. The use of plants as medicine goes back to the period of early man. India has an ancient heritage of traditional medicine and a rich tradition of plant-based knowledge in healthcare. Plants have formed the basis of sophisticated traditional medicinal practices that have been used for thousands of years by people in China, India, and the rest of the other countries[2–4]. The earliest record of the use of plants for the treatment of various ailments can be found in the oldest Hindu scripture, the Rig Veda which dates back from 3500 B.C. to 1800 B.C[5]. Practices of traditional medicine vary greatly from country to country, and from region to region, as they are influenced by factors

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Figure 1. Different morphological parts of *Tamarindus indica L.*

like culture, history, personal attitudes, and philosophy. In many cases, their theories and applications are quite different from those of conventional medicine. Long historical use of many practices of traditional medicine, including experience passed on from generation to generation, has demonstrated the safety and efficacy of traditional medicine[6]. One such plant commonly used in folklore and traditional medicinal practice is tamarind[7]. *Tamarindus indica* L. of the family Fabaceae (Figure 1) is a medicinal plant that has been utilized in Indian medicine for centuries. In many regions of the world, tamarind has been utilized in a variety of remedies[8]. This review is an attempt to document certain significant folk healing practices that existed in India and the respective clinical trials conducted.

Binomial Name *Tamarindus indica* L.
Family Fabaceae
Subfamily Detarioideae
Tribe Amherstieae
Synonyms *Cavaraea elegans* Speg.
Tamarindus erythraeus Mattei
Tamarindus occidentalis Gaertn.
Tamarindus officinalis Hook.
Tamarindus somalensis Matteqi
Tamarindus umbrosa Salisb.

Vernacular names: *Ttali* (Assamese), *Tentul* (Bengali), *Ambla, Amli* (Gujarati), *Imli* (Hindi), *Hunashe*, *Hannu*, *Hunasemara* (Kannada), *Chinch* (Konkani), *Puli* (Malayalam), *Chicha*, *Chinch*, *Chincha* (Marathi), *Telul*, *Tentuli* (Oriya), *Imbli*, *Imlii* (Punjabi), *Puli* (Tamil), *Chintapandu* (Telugu)[9].

English name: Indian date, Indian tamarind, Kily tree

2. Morphology/Botany

It grows up to a height of 25–30 meters. Tamarind tree is evergreen, dome-shaped, much branched and it looks similar to an *Amla* tree (Indian gooseberry) with respect to leaves, like small pinnate compound leaves. But the main difference between them is, *Amla* (Phyllanthus) bears longer leaves which are light green in color and the leaflets are a little narrower than tamarind. Whereas in tamarind, leaves are smaller leaflets, broader and dark green in color[10].

Flowers are small, 3 cm in length, aromatic, and yellow in color. Fruits are sub-cylindrical, straight or slightly curved. Pods are swollen, with rounded ends and are brown or greyish-brown in color. The sapwood of the tamarind tree is pale yellow in color and the heartwood is very hard, dark purplish-brown color, heavy, strong, durable and resistant to bugs and insects[11].

2.1 Origin of Tamarind Tree/Distribution

Tamarind is native to Eastern Africa. In India, tamarind tree is grown in Madhya Pradesh (central part), Andhra Pradesh, Tamil Nadu and Karnataka (southern parts).

2.2 Propagation

Tamarind seeds remain in good condition for months and germinate a week after planting. Young trees are usually grown in nurseries. Vegetative propagation of the selected

varieties is also carried out due commercial prospective of tamarind products. Tamarind trees can also be grown from stem cuttings, grafting, or air-layering.

2.3 Edible Morphological Parts

Edible morphological parts of tamarind are the fruit pulp, leaves, flowers, and seeds.

Fruit pulp: It is available in the market as a pod form or as a paste. The tamarind fruit pulp is eaten raw as a spice in various Indian food dishes like gravy dishes, cooked with vegetables or pulses with tamarind sauce. Tamarind is an important ingredient in chutneys (pickles) and is also added to some sea fish recipes called Tamarind Fish. Tamarind is a staple in the South Indian diet, where it is used to prepare *Rasam*, *Sambar*, *Puliyogare* (South Indian rice preparation with tamarind), *Pulikuzhambu* (sour soup of tamarind, with chili and salt) which are popular in Tamil Nadu. The tamarind fruit pulp is acidic in taste and has been used for centuries as a skin scrubbing material to promote smoother and lighter skin.

L*eaves and flowers:* The fresh sour leaves and flowers are mixed with vegetables, cooked, and eaten in India. In South India, flowers are used to prepare tangy pickles.

Seeds: Seeds are rich in essential minerals and proteins. Tamarind seeds are roasted, fried, boiled, and consumed as snacks. Seeds contain high starch content which is used in food, paper, and jute industries. Tamarind gum, obtained from the seed kernels forms a stiff gel and is used as a thickening, stabilizing, and gelling agent in the food industries. Seed kernel powder is used as a stabilizer during ice cream preparation. Seeds contain chemical constituent polyose which is used in the preservation of fruits.

3. Chemical Composition of Tamarind

The chemical composition of tamarind varies with respect to different parts of tamarind (Table 1). The tamarind fruit (dried and riped) consists of pulp and seed. The pulp constitutes 30–50 % of the ripe fruit and 11-30% of shell and fiber and 25-40% of seed[12].

L*eaves and flowers*

Tamarind leaves consists of essential oils, free and conjugated fatty acids and flavonoids. The presence of significant levels of selenium and other micro-elements also were identified[13]. The leaf oil is rich in 25% of limonene and 41% benzyl benzoate[14]. They also contain triterpenes, lupanone, and lupeol. Leaves are also a rich source of protein, lipid, fiber, and vitamins such as thiamine, riboflavin, niacin, ascorbic acid, and β-carotene. Leaves are composed of 13 essential oils, of which limonene and benzyl benzoate are the most important compounds, followed by pentadecanol and hexadecanol[15].

Stem bark

The root bark was found to contain n-hexacosane, eicosanoic acid, b-sitosterol, octacosanyl ferulate, 21-oxobehenic acid, and (+)-pinitol[16]. They also consist of flavonoids, cardiac glycosides, alkaloids, saponins, and tannins[17].

Bark

Tamarind bark is rich in tannins and polyphenols such as N-hexacosane, eicosanoic acid, b-sitosterol, octacosanyl ferulate, 21-oxobehenic acid, (+) - pinitol and phenolic antioxidant proanthocyanidins (catechin, procyanidin B2, epicatechin, procyanidin trimer, procyanidin tetramer, procyanidin pentamer, procyanidin hexamer along with taxifolin, apigenin, eriodictyol, luteolin and naringenin)[18-20].

Pulp

The dried pulp consists of 8–18 % tartaric acid and 25–45% reducing sugars (70 % is glucose and 30 % fructose)[21,22]. The tender fruits contain around 16% free form of tartaric acid. The sweetness of ripe tamarind fruit is balanced by tartaric acid which has an intense acid taste. The fruit contains tartaric acid, reducing sugars, pectin, tannin, fiber, and cellulose. Tamarind contains organic acids like oxalic acid, succinic acid, citric acid, quinic acid, and a low level of ascorbic acid[23]. Pulp was also identified with free amino acids namely proline, serine, β-alanine, phenylalanine, and leucine[24]. These are a rich source of minerals like potassium, phosphorus, calcium, and iron. They are high in magnesium, and sodium but low in copper and zinc. They excel in riboflavin, thiamine, and niacin whereas poor in vitamin A and C[25]. The volatile constituents were identified in pulp such as 2-phenyl acetaldehyde with a fruity and honey-like odor, 2-furfuryl with a caramel-like flavor, and hexadecanoic acid and limonene having a citrus flavour[26]. TI (Trypsin inhibitor) is higher in the pulp than any other parts of tamarind.

Seed

The seed contains 20–30% seed coat (testa) and 70-75% kernel (endosperm). (70–75 %). The seed contains 13-20% protein and 5-16 % oil. Testa is also rich in 20 %

Table 1. Chemical constituents of various morphological parts of tamarind[29–31]

Morphological part	Chemical constituent
Leaves and flowers	Essential oils, free and conjugated fatty acids, flavonoids, selenium with other micro-elements, limonene, benzyl benzoate, pentadecanol, hexadecanol[14]triterpenes, lupanone, lupeol, protein, lipid, fibre, vitamins such as thiamine, riboflavin, niacin, ascorbic acid, β-carotene
Stem bark	n-hexacosane, eicosanoic acid, b-sitosterol, octacosanyl ferulate, 21-oxobehenic acid, and (+)-pinitol, flavonoids, cardiac glycosides, alkaloids, saponins, tannins
Bark	Tannins, polyphenols like N-Hexacosane, eicosanoic acid, b-sitosterol, octacosanyl ferulate, 21-oxobehenic acid, and (+) - pinitol and phenolic antioxidants, catechin, procyanidin B2, epicatechin, procyanidin trimer, procyanidin tetramer, procyanidin pentamer, procyanidin hexamer, taxifolin, apigenin, eriodictyol, luteolin and naringenin.
Pulp	Tartaric acid, reducing sugars, pectin, tannin, fibre, cellulose, organic acids like oxalic acid, succinic acid, citric acid, quinic acid, ascorbic acid, free amino acids namely proline, serine, β-alanine, phenylalanine and leucine, minerals like potassium, phosphorus, calcium, iron, magnesium, sodium, copper and zinc, vitamins like riboflavin, thiamine and niacin, volatile constituents such as 2-phenyl acetaldehyde and TI (trypsin inhibitor).
Seed	Protein, fibre, tannins, crude protein, crude fibre, crude fat, tannins, TI, carbohydrate, starch, phytic acid and albuminoid tannins.

fibre and 20% tannins. Whole tamarind seed consists of crude protein, crude fibre, crude fat, tannins and TI. Seeds contain 63 % starch and 5–6% of semi-drying oil[27]. It also contains phytic acid and albuminoid tannins[28].

4. Folklore Medical Practices[32] (Figure 2)

4.1 For Hand, Leg and Joint Pain

Matured tamarind leaves and castor oil are used to relieve pain. Castor oil is slightly warmed and applied to the parts where pain exists. After applying the castor oil, tamarind leaves are patched. The leaves are left in the pain areas for about three hours, after which the area is washed with hot water. The same procedure is repeated both in the morning and in the evening for three days continuously. Pain is relieved, especially in the joints. On these three days of treatment, pepper, dried ginger, garlic, and asafoetida are finely ground and the same mixture is used for preparing curry. This curry has to be consumed with freshly boiled rice.

4.2 For Inflammation

The tamarind leaves are separated and sauted (fried) in a mud pot with a spoonful of neem (*Azadirachta indica*) oil. These leaves are applied to the inflammated areas when it is hot.

4.3 For Bronchial Asthma

Two handfuls of tamarind leaves are mixed with the fresh decanted rice water (starch) from cooked rice. This mixture is mixed thoroughly so that the leaves are spread evenly throughout the rice water. The mixture is kept overnight. The next day, leaves are separated from the mixture and

the leaves are ground in a stone grinder with 3g of *Alpinia officinarum*. The grounded leaves are squeezed to get the extract (juice). To the above extract, a half tumbler lemon juice (without seeds) is mixed. Freshly prepared above mixture is given to the patients with bronchial asthma only in the morning for five continuous days.

4.4 For Wounds

Tamarind leaves are boiled with three glasses of water. Water is decanted while hot. This water is used to wash the wounds before the application of any medicine.

4.5 For Eye Diseases

The tender leaves of tamarind are cooked with pigeon pea (toor dal) and eaten with rice to get rid of eye diseases. The tamarind leaves are ground and applied around the eyes for the treatment of irritation and redness in the eyes and are also used in other eye diseases.

4.6 To Reduce pitham

Pickle (chutney) is prepared by grinding a mixture of a handful of tamarind flowers, stone salt (*sendha namak*), tamarind fruit pulp, ginger, and coriander leaves in a stone grinder. This chutney when consumed with fresh rice in the morning will gradually reduce *pitham*. The above procedure is also followed with tender fruits of tamarind instead of tamarind flowers.

4.7 For Cold

A handful of tamarind leaves are boiled with water in a mud pot, cooled and filtered. Half a tumbler of this mixture with sugar is consumed early morning and evening to cure cold.

4.8 For Arthritis

Equal quantities of tamarind leaves and flowers sauted (fried) with castor oil. This mixture is applied to the areas of pain which gradually reduces all kinds of arthritis.

4.9 For Painful Urination (Dysuria)

A handful of cleaned tamarind flowers are boiled in one tumblerful of water in a mud pot, cooled, and filtered. To a half tumbler of the above filtrate, one spoonful of palm sugar is added and consumed both in the morning and in the evening. Gradually the painful urination gets cured. For painful urination due to an overheated body, the seeds of the tamarind fruit are taken two in numbers and chewed along with the outercoat of the seed.

4.10 For Blood Clots

Curry is prepared with the thick ripe fruit pulp of tamarind. This curry is taken in an iron spoon and salt is added in a ratio of 1:4 and heated. This hot mixture is applied to the blood clot area as treatment.

4.11 For Poisoning due to Scorpion Bite

Ripe pulp of tamarind fruit is mixed with an equal quantity of slaked lime in the palm. In this process, heat is generated. This mixture, while hot is applied to the scorpion biten area. The mixture gets patched up on the applied area which absorbs the poison.

4.12 For Dysentery

The outer covering is removed from the seeds of the tamarind fruit. The removed covers of seeds are sauted and ground in a stone grinder into a fine powder. The measured quantity of the above powder is mixed with a spoonful of honey and consumed both in the morning and evening which cures dysentery.

4.13 For Nervous Weakness (Sexual Dysfunction)

The outer covering of the seeds of the tamarind fruit is removed and the white inner part (kernel) of the seed is fried to redness. This fried inner part of the seed is ground into powder and stored in a wide-mouthed glass bottle. One teaspoonful of this powder is mixed with a tumblerful of boiled cow's milk and a spoonful of rock sugar is consumed before going to bed for continuous 40 days. It is strictly advised that there should not be any sexual intercourse during this treatment period.

4.14 For Hot Wounds

This treatment is for the boil wounds due to hot water, hot oil, or boils due to fire. The bark of tamarind is dried, ground in a stone grinder, and sieved. The above mixture is stored in a wide-mouthed container. Coconut oil is applied to the boil wound and the prepared powder is sprinkled on the coconut oil and again a layer of coconut oil is applied. This way of application for continuous 7 days heals the boil wounds.

4.15 For Inflammation in Uvula (Tonsils)

An equal quantity of old fruit pulp of tamarind and salt is ground into a fine paste in a stone grinder. This paste is applied to the uvula to reduce inflammation.

4.16 For Dental Diseases

The outer covering of the seeds of the tamarind fruit is removed by grinding in the stone grinder with an iron rod. The outer covering of the seed is collected and the same quantity of bark of *Prosopis juliflora* (*Karuvelam pattai*) is ground in a stone grinder into fine powder. To this, salt is added in the ratio of 1:8 and mixed well. This mixture is stored in a wide-mouthed glass container and is used to brush the teeth in the morning. This practice will gradually prevent and cure all kinds of tooth diseases.

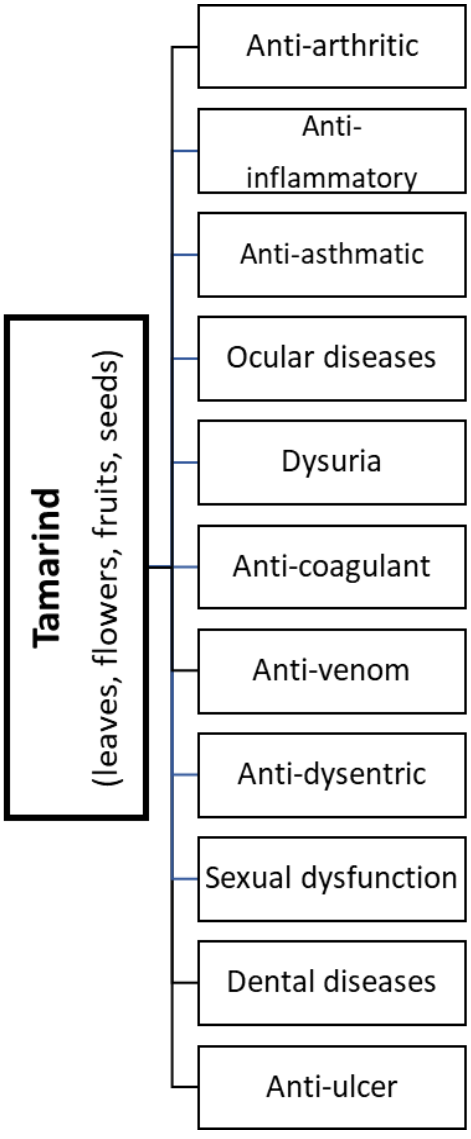

Figure 2. Folklore medicinal practices of tamarind in India.

4.17 For Peptic Ulcer

The inner bark of the tamarind tree is dried in sun, ground into powder in a stone grinder, and sieved. This powder is stored in a container and consumed on daily basis to get rid of peptic ulcers and also other stomach disorders.

5. Nutritional/Chemical, Analytical and Biological Studies

5.1 General

Researches have showed that tamarind pulp, seed, leaves and stem bark have pharmacological activities such as antimicrobial, antioxidant, antiinflammatory, molluscidal, hypoglycaemic, antihypercholesterolemic activity, antidiabetogenic, antivenom, and antiemetic, immunomodulatory, retarding fluorosis, antiplatelet, analgesic, UVB protection and corneal healing.

5.2 Antioxidant Activity

Tamarind fruit was found to contain high levels of phenolics and showed high antioxidant activity. High antioxidant activity could provide protection against certain human degenerative conditions related with oxygen free radical damage. Tamarind fruit or foodstuffs from tamarind fruit pulp may act as functional foods, providing beneficial effects on human health[33]. *T. indica* seeds are important sources of antioxidant activity as it contains 2-hydroxy3',4'-dihydroxyacetophenone, metdihydroxybenzoate, (-)-epicatechinand 3,4 dihydroxyphenylacetate, in addition to oligomeric proanthocyanidins (OPC). OPCs are potent antioxidant, anti-inflammatory, antihistaminic agent and ultraviolet protection. OPCs also stabilize elastin, collagen and ground substances[34]. A detailed study on the composition of *T. indica* seeds were done to evaluate its antioxidant potential, fatty acid profile and content of tocopherols. The findings led to the interest in using the extract derived from the seeds of tamarind for cosmetics[35].

5.3 Hypoglycemic Activity

Aqueous extract of the tamarind seeds had potent anti-diabetic activity that reduced blood sugar levels in streptozotocin (STZ) induced diabetic male rat[36]. The tamarind seeds are included in a lower percentage in diet (4% and 8%) and were found to reduce the blood glucose level and serum cholesterol in rats[37]. Administration of seed pectin also reduced blood glucose concentration by 30% after 24 hours[38]. Another study was done on human volunteers for preventing and/or treating type 2 diabetes[39].

5.4 Anti-Hypercholesterolemic/Anti-Hyperlipidemic Activity

Treatment of obese rats with the *T. indica* pulp extract showed decrease in the levels of plasma total cholesterol, low-density lipoprotein cholesterol and triglyceride and increased high density lipoprotein cholesterol level[17].

5.5 Antimicrobial Activity

Phytochemical studies of the leaf extracts showed the presence of saponins, alkaloids and glycosides. The extracts were active against both gram positive and gram negative bacteria[40]. Tamarind consisted of a broad-spectrum of antimicrobial action which could be considered as highly active against infectious disease and also for chemotherapy[41]. *T. indica* leaf extracts showed anti-*Burkholderia pseudomallei* (a life-threatening infection common among paddy cultivators) inhibitory potentials under *invitro* conditions[42]. Also, a study showed aqueous and fluid extracts of fresh and dried tamarind leaves were found to contain phenols and flavonoids. The phenols were found to be active against *Bacillus subtilis* cultures, but not against other microorganisms[43]. The antimicrobial activity of the ethanolic extract of the stem bark of *T. indica* was notable, however, the tamarind fruit extracts exhibited comparatively better action[44].

5.6 Antivenom Activity

Tamarind seed extract showed to reduce and neutralize the effects of envenomation such as local tissue damage, inflammation and hypotension caused by the venom of *Vipera russelli*[45].

5.7 Analgesic Activity

Phytochemical test showed the presence of sterols and triterpenes in the extract, hence Tamarind plant parts might be responsible for the analgesic activity[46].

5.8 Spasmogenic and Spasmolytic Activity

The aqueous extract of *T. indica* was found to induce spasm[47]. Another study showed that, the methanolic extract of tamarind fruits have spasmolytic activity[48].

5.9 Anti-aging Activity

Extracts of *T. indica* were found to exhibit antioxidant effect, and also showed antiglycation effect which could be further developed for use in anti-aging cosmetics[49].

5.10 Sialagogue Activity

Tamarind has been reported to increase the flow of saliva[50].

5.11 For Preventing Pregnancy

In Tamil Nadu, India, tribals of the *Anaikkatty* hills drink the ground root bark powder infusion for abortion and to prevent pregnancies[51].

5.12 Other Uses

In West Africa, tamarind bark is used to treat diarrhoea, also in East Africa, the leaves are used for similar purpose[52]. In the Philippines and Eastern Sudan, the bark is used as astringent and is also used as a tonic and in lotions or poultices to treat the sores, ulcers, boils and rashes[53]. In Kenya, bark decoction is used to treat cough and as a gargle to treat sore throat. In Uganda, decoction of the bark is used for treating uterine fibroids and root decoction is used to treat syphilis[54]. In the Philippines, tamarind flower extract is used as a remedy for eye diseases and conjunctivitis[55].

6. Clinical Studies on *Tamarindus indica*

The various parts of tamarind either alone or as formulation were tested for their clinical efficacy. The clinical efficacy of tamarind evaluated are discussed below and also shown in Table 2.

Patients with premature ejaculation were given tamarind seed powder for four weeks in a randomised, double-blind, controlled clinical experiment. When tamarind seed powder was used instead of placebo, the intra-vaginal ejaculatory latency period was considerably longer[56]. *Unani* formulations containing tamarind were found to reduce low backache and lower stomach

discomfort in women with abnormal vaginal discharge in a single blind randomised controlled trial[57]. The intra-vaginal tamarind seed powder tampons used for 3 months was effective in restoring vaginal prolapsed in 1/3rd patients and remaining patients showed symptomatic relief[58].

In a double-blind randomised clinical trial, women aged 18–50 years with bacterial vaginosis were treated with a traditional *unani* polyherbal formulation using tamarind as one of the ingredients, along with fennel, *gokshur*, and myrtle. The odour, pH, and quantity of vaginal discharge, as well as pelvic pain and cervical irritation, were dramatically reduced after 14 days of treatment. In addition, the treatment reduced the presence of clue cells and Gram-positive bacteria in the vaginal area[59]. In a three-month interventional clinical investigation, 30 women who had missed their menstruation for three months or more were given 6 gm of powdered tamarind. Menstrual bleeding and stomach pain improved significantly as a result of treatment; however menstrual cycle regularisation was unaffected[60].

Tamarind leaves powder administered for 8 weeks enhanced haemoglobin levels in anaemic individuals in a quasi-experimental research. Patients' symptoms such as weariness, weakness, dyspnoea, palpitation, and pallor improved[61]. In a double-blind clinical investigation, a combination of tamarind and turmeric reduced physical activity-induced knee discomfort and restored joint activity in non-arthritic people[62]. A recent double-blind placebo-controlled clinical trial found that combining *T. indicus* seed extract with turmeric and garcinia enhanced knee joint function and reduced discomfort in osteoarthritic patients. The herbal formulations inhibited the pro-inflammatory markers IL-6, TNF-α, C-reactive protein, matrix metalloproteinase 3, and cartilage degradation product in the blood, showing anti-inflammatory activity[63]. When compared to hot compress and topical NSAID application in myofascial pain syndrome patients, applying a hot herbal compress containing tamarind and other herbs once every three days for two weeks lowered pain intensity and enhanced pain pressure threshold[64]. When given with aspirin pills, tamarind increased their bioavailability in healthy individuals. Aspirin's C_{max}, AUC, and half-life increased considerably[65]. In another investigation, *T. indica* fruit extract increased the bioavailability of ibuprofen pills in 6 healthy volunteers. Ibuprofen and its metabolites were found in higher concentrations in the blood when administered along with tamarind extract[66].

Tamarind pulp, cumin, and corn silk added to cooked rice significantly lowered postprandial insulinemic responses in healthy young people in a randomised cross-over trial. This research shows that a dietary matrix rich in polyphenol compounds found in tamarind, cumin, and corn silk affects postprandial glycemia and insulin levels[67]. Previous study demonstrated that *T. indica* fruit pulp consumption for 4 weeks twice a day reduced total cholesterol and low density lipoprotein (LDL) in healthy subjects[68]. In obese and overweight subjects, tamarind fruit eating for 6 weeks significantly lowered body mass index, blood pressure, LDL, and waist circumference when compared to their baseline levels[69].

Interestingly, a recent case study showed that anticancer drug-induced hepatotoxicity can be effectively treated using *unani* medicine, which includes tamarind and other herbals. The drug reduced the liver enzymes SGOT and SGPT as an adjunct treatment for 15 days[70]. Patients with *Amlapitta* were given *Chincha* (tamarind) *kshara* three times a day for one month to alleviate indigestion, heartburn, acid eructation, nausea, vomiting, stomach discomfort, weariness, and anorexia. When compared to the placebo group, the symptoms of indigestion, heartburn, acid eructation, nausea, flatulence, weariness, and anorexia were reduced in the treatment group[71]. Postoperative bowel function recovery is disrupted following abdominal surgery, resulting in a longer hospital stay. Tamarind lozenges given to abdominal postoperative patients in conjunction with regular postoperative treatment had no effect on bowel function[72].

In a multicenter open label randomised clinical trial, xyloglucan, a polysaccharide derived from tamarind seeds, was found to be effective in treating acute diarrhoea. Treatment with xyloglucan reduced the amount of faeces, nausea, and abdominal pain without causing any side effects[73,74]. In addition, xyloglucan improved diarrhoeal symptoms, nausea, vomiting, and flatulence in children with acute gastroenteritis without creating any negative side effects[75]. The xyloglucan formulation APT036 significantly reduced stomach distension and flatulence in patients with functional bloating in a randomised multicenter double-blind study[76].

In women volunteers, a cleansing lotion containing tamarind fruit extract (10 % w/w) applied twice daily for 8 weeks resulted in lower melanin values after 4 weeks

Table 2. Clinical studies on tamarind

Sl. No	Medicinal use	Plant part used	Type of study	Study finding	References
1.	Genitourinary system	Seed powder	Randomised, double-blind, controlled	Improved premature ejaculation	56
		Fruit pulp	Single blind randomised controlled trial	Reduced low backache and lower stomach discomfort in women with abnormal vaginal discharge	57
		Seed powder tampons	Single blind randomised controlled trial	Restored uterine prolapse and showed symptomatic relief	58
		Seed powder	Double-blind randomised clinical trial	Reduced vaginal discharge, pelvic pain and cervical irritation in bacterial vaginosis	59
		Pulp powder	Interventional clinical study	Menstrual bleeding and stomach pain improved in women who missed their menstruation	60
2.	Cardiovascular system	Leaves powder	Quasi-experimental research	Enhanced haemoglobin levels in anaemic subjects	61
3.	Skeletal system	Seed extract	Double blind clinical investigation	Reduced physical activity-induced knee discomfort and restored joint activity in non-arthritic people	62
		Seed extract	Double-blind placebo-controlled clinical trial	Enhanced knee joint function and reduced discomfort in osteoarthritic patients	63
		Leaves	Single-blind randomized controlled trial	Hot herbal compress containing tamarind & other herbs lowered pain intensity and enhanced pain pressure threshold in myofascial pain syndrome patients	64
4.	Anti-inflammatory system	Seed extract	Double-blind placebo-controlled clinical trial	inhibited the pro-inflammatory markers IL-6, TNF-α, C-reactive protein, matrix metalloproteinase 3, and cartilage degradation product in the blood in osteoarthritic patients	65
5.	Drug facilitation	Fruit extract	Pharmacokinetic study	Increased bioavailability of aspirin & ibuprofen in healthy volunteers	66, 67
6.	Endocrine system	Pulp with other herbs	Randomised cross-over study	Significantly lowered postprandial insulinemic responses in healthy young people	68
		Fruit pulp	Randomized trial	Reduced total cholesterol and low-density lipoprotein (LDL) in healthy subjects	69

		Fruit pulp		Significantly lowered body mass index, blood pressure, LDL, and waist circumference in obese and overweight subjects	70
7.	Metabolism	Fruit pulp	Case report	Reduced the liver enzymes SGOT and SGPT as an adjunct treatment in anticancer drug-induced hepatotoxicity	71
8.	Digestive system	Bark and leaves	Comparative clinical trial	Indigestion, heartburn, acid eructation, nausea, flatulence, weariness, and anorexia were reduced	72
		Xyloglucan from seeds	Multicenter open label randomised clinical trial	Treatment of acute diarrhoea, improved diarrhoeal symptoms, nausea, vomiting, and flatulence in children with acute gastroenteritis	73, 74, 75
		Xyloglucan formulation	Randomised multicenter double-blind study	Reduced stomach distension and flatulence in patients with functional bloating	76
9.	Skin	Fruit extract lotion	Double- blind, randomized side of face and placebo-controlled trial	Melanin value reduced in facial skin	77
		Fruit extract lotion	Single-blinded, randomized side of arm, and controlled study	Did not produce erythema or transdermal water loss indicating safety profile	78
		Polyherbal gel of tamarind	Placebo controlled clinical trials	Reduced the stiffness, thickness, pigmentation, and irregularity of post-surgical scar development in patients who had bilaterally symmetric procedures	79, 80
10.	Eye	Tamarind seed polysaccharide	Open-label, randomised, single-centre clinical study and randomized, double-masked study	Ocular surface disease index (OSDI) score improved when compared to baseline and control values. Decreased tear breakdown time, corneal and conjunctival damage	81, 82
		Tamarind seed polysaccharide eye drops	Prospective, multicenter study	Reduced hyperaemia in conjunctiva, pain, burning and stinging sensation in glaucoma patients. Corneal and conjunctival sensitivity improved in glaucoma patients	83, 86
		Tamarind seed polysaccharide eye drops	Interventional, prospective, contralateral eye trial	Enhanced tear production and tear stability	84
		Tamarind seed polysaccharide eye drops	Prospective, randomized, controlled study	Keratoconjunctivitis patients benefited from dry eye with improved ocular surface protection	85

11.	Antioxidant activity	Dietary supplement of tamarind	Prospective, single arm design study	Increased antioxidant status by lowering the oxidative stress marker 8-hydroxy-2-deoxyguanosine and enhancing antioxidant capacity in glaucoma patients	87
12.	Unspecified	Fruit pulp	Randomised diet-controlled clinical trials	Increased fluoride excretion in urine in school children. Reduced zinc, magnesium, and creatinine elimination but had no effect on calcium or phosphorous elimination	88, 89

Table 3. The scientific confirmation of folklore practice through clinical studies

Folklore practice	**Clinical studies**
Joint pain	Joint pain
Anti-inflammatory	Anti-inflammatory
Bronchial asthma	NA
Wound healing	NA
For hot wounds	NA
Ocular diseases	Ocular diseases
For *pitham*	For *pitham*
For cold	For cold
For arthritis	For arthritis
For dysuria	NA
For blood clot	NA
Anti-venom	NA
Diarrhea, dysentery	Diarrhea, dysentery
For tonsils	NA
Dental diseases	Dental diseases
Peptic ulcer	NA

NA-not available

when compared to the other side of the face. Also, there was no erythema or transdermal water loss, showing that the product was safe[77,78]. Previous research has shown that applying a polyherbal gel containing tamarind extract for 12 weeks reduced the stiffness, thickness, pigmentation, and irregularity of post-surgical scar development in patients who had bilaterally symmetric procedures[79,80].

Tamarind has been shown to have ocular benefits in numerous trials. As dry eye disease patients were given tamarind polysaccharide with hyaluronic acid for three months (4 times a day), their ocular surface disease index (OSDI) score improved when compared to baseline and control values. Additionally, the combination decreased tear breakdown time as well as corneal and conjunctival

damage[81,82]. Tamarind seed polysaccharide containing eye drops application for 3 months reduced hyperaemia in conjunctiva, pain, burning and stinging sensation in glaucoma patients[83]. In an interventional, prospective, contralateral eye trial, Nozari and Ramin (2021) found that treating dry eyes with tamarind seed polysaccharide-containing lubricating eye drops for two weeks significantly enhanced tear production and tear stability[84]. After 3 months of treatment, keratoconjunctivitis patients benefited from dry eye with improved ocular surface protection[85]. The corneal and conjunctival sensitivity of 20 glaucoma patients who received artificial tears derived from tamarind seed polysaccharide improved[86]. In glaucoma patients, a dietary supplement containing tamarind, hesperidin, and crocetin increased antioxidant status by lowering the oxidative stress marker 8-hydroxy-2-deoxyguanosine and enhancing antioxidant capacity[87].

Fluoride level in natural waters is extremely high, and excessive ingestion causes fluorosis, a serious health problem. In a randomised diet-controlled clinical trial, school children who consumed tamarind pulp daily for 18 days had considerably higher fluoride excretion in urine. Tamarind reduced zinc, magnesium, and creatinine elimination but had no effect on calcium or phosphorous elimination[88,89].

Based on the folklore practices and the clinical studies discussed above, the Table 3 summarizes and provides a comparison of both. From the Table 3, it is clear that there are still a number of therapeutic activities that are yet to be explored.

7. Conclusion

Scientific research is widely accepted due to the confirmation of its claim. Though various parts of tamarind plants were claimed for their medicinal properties for centuries, still those are not being utilized to the fullest. Thus, the folklore practice of tamarind is challenged for its scientific evidence resulting in the neglect of valuable medicine. Hence, the folklore practices were compared with the claimed clinical efficacy to understand the significance of folklore medicinal practices. From this review, we can understand that most of the folklore practices are evaluated for their clinical efficacy a few decades later. And still, many more claimed medicinal uses are yet to be evaluated (Figure 3).

We support the scientific evidence for the safety and efficacy of their therapeutic action, at the same time not to lose the valuable, economical and easily available source of medicines. This review will provide information to correlate the clinical efficacy of tamarind with folklore medicinal practices.

8. References

1. Das S, Choudhury MD. Ethnomedicinal uses of some traditional medicinal plants found in Tripura, India. J Med Plant Res. 2012; 6(35):4908–14. https://doi.org/10.5897/JMPR10.539
2. Sneader W. Drug Discovery: A History. Chichester, UK: Wiley; 2005. https://doi.org/10.1002/0470015535
3. Mukherjee PK. Evaluation of Indian traditional medicine. Drug Inf. 2001; 35(2):623–2. https://doi.org/10.1177/009286150103500235
4. Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing-Exploring medicinal plants of India. J Ethnopharmacol. 2007; 114(2):103–13. https://doi.org/10.1016/j.jep.2007.08.010. PMid:17884316
5. Shantabi L, Jagetia GC, Vabeiryureilai M, Lalrinzuali K Phytochemical screening of certain medicinal plants of Mizoram, India and their folklore use. J Biodivers Biopros Dev. 2014; 1:136. https://doi.org/10.4172/2376-0214.1000136
6. WHO. General guidelines for methodologies on research and evaluation of traditional medicine. World Health Organization, Geneva, Switzerland; 2000. WHO/EDM/TRM/2000.1.
7. Havinga RM, Hartl A, Putscher J, Prehsler S, Buchmann C, Vogl CR. *Tamarindus indica* L. (Fabaceae): Patterns of use in traditional African medicine. J Ethnopharmacol. 2010; 127(3):573–88. https://doi.org/10.1016/j.jep.2009.11.028. PMid:19963055
8. Havinga RM, Hartl A, Putscher J, Prehsler S, Buchmann C, Vogl CR. *Tamarindus indica* L. (Fabaceae): Patterns of use in traditional African medicine. J Ethnopharmacol. 2010; 127(3):573–88. https://doi.org/10.1016/j.jep.2009.11.028. PMid:19963055
9. Lim TK. Edible medicinal and non-medicinal plants. Fruits. 2022; 2. https://doi.org/10.1007/978-94-007-4053-2
10. Available from: https://www.quora.com/Can-I-distinguish-aonla-and-tamarind-by-looking-at-leaves

11. Available from: https://hort.purdue.edu/newcrop/morton/tamarind.html
12. Shankaracharya NB. Tamarind – chemistry, technology and uses: a critical appraisal. J Food Sci Technol. 1998; 35(3):193–208.
13. Escalona-Arranz JC, Pérez-Rosés R, Jiménez IL, Rodríguez-Amado J, Argota-Coello H, Cañizares-Lay J, *et al*. Chemical constituents of *Tamarindus* L. Leaves. Revista Quibana de Quimica. 2010; 12(3):65–71.
14. Pino JA, Escalona JC, Licea K, Perez R, Aguero J. Leaf oil of *Tamarindus indica* L. Essent. Oil Res. 2002; 14:187–8. https://doi.org/10.1080/10412905.2002.9699819
15. Arranz JCE, Roses RP, Laffita IU, Pozo MIC, Amado JR and Jiménez IL. Antimicrobial activity of extracts from *Tamarindus indica* L. leaves. Pharmacogn Mag. 2010; 6(23):242–7. https://doi.org/10.4103/0973-1296.66944. PMid:20931087. PMCid:PMC2950390
16. Jain R, Jain S, Sharma A, Hideyuki I, Hatano T. Isolation of (+)-pinitol and other constituents from the root bark of *Tamarindus indica Linn*. J Nat Med. 2007; 6:355–6. https://doi.org/10.1007/s11418-007-0144-9
17. Jindal V, Dhingra D, Sharma S, Parle M, Harna RK. Hypolipidemic and weight reducing activity of the ethanolic extract of *Tamarindus indica* fruit pulp in cafeteria diet - and sulpiride - induced obese rats. Pharmacol Pharmacother. 2011; 2(2):80–4. https://doi.org/10.4103/0976-500X.81896. PMid:21772765. PMCid:PMC3127355
18. Sudjaroen Y, Haubner R, Würtele G, Hull WE, Erben G, Spiegelhalder B *et al*. Isolation and structure elucidation of phenolic antioxidants from Tamarind (*Tamarindus indica* L.) seeds and pericarp. Food Chem Toxicol. 2005; 43(11):1673–82. https://doi.org/10.1016/j.fct.2005.05.013. PMid:16000233
19. Kuru P. *Tamarindus indica* and its health related effects. Asian Pac J Trop Biomed. 2014; 4(9):676–81. https://doi.org/10.12980/APJTB.4.2014APJTB-2014-0173
20. Nakchat O, Nalinratanan N, Meksuriyen D, and Pongsamart S. Tamarind seed coat extract restores reactive oxygen species through attenuation of glutathione level and antioxidant enzyme expression in human skin fibroblasts in response to oxidative stress. Asian Pac J Trop Biomed. 2014; 4(5):379–85. https://doi.org/10.12980/APJTB.4.2014C806. PMid:25182723. PMCid:PMC3985053
21. Meillon S. Process for making drinks, syrups, juice and liquor and solid extracts based on tamarind products thus obtained; 1974.
22. Anon. Tamarind, in The Wealth of India, Vol. X. CSIR, New Delhi; 1976. p. 114–22.
23. Lewis YS, Neelakantan S. The chemistry, biochemistry and technology of tamarind. J Sci Ind Res. 1964; 23:204–6. https://doi.org/10.1038/204023b0
24. Rao MVL, Subramanian N, Srinivasan N. Free amino acids in tamarind pulp. J Sci Ind Res. 1954; 13B:377.
25. Leung WT, Flores M. Food composition tables for use in Latin America. National Institute of Health, Bethesda, MD; 1961.
26. Askar A, Ei-nemr SE, Siliha H. Aroma constituents of Egyptian tamarind pulp. Déutsch. Lebensmitt Rundsch. 1987; 83:108–10.
27. Purseglove JW. Tropical crops dicotyledons. Longman Science and Technology, London. 1987; 204–6.
28. Ishola MM, Agbaji EB, Agbaji AS. A chemical study on *Tamarindus indica* (Tsamiya) fruits grown in Nigeria. J Sci Food Agric. 1990; 51(1):141–3. https://doi.org/10.1002/jsfa.2740510113
29. Bhattacharya S, Bal S, Mukherjee RK, Bhattacharya S. Functional and nutritional properties of tamarind (*Tamarindus indica*) kernel protein. Food Chem. 1994; 49(1):1–9 https://doi.org/10.1016/0308-8146(94)90224-0
30. Ishola MM, Agbaji EB, Agbaji AS. A chemicalstudy of *Tamarindus indica* (Tsamiya) fruits grown in Nigeria. J Sci Food Agric. 1990; 51(1):141–3. https://doi.org/10.1002/jsfa.2740510113
31. De Caluwé E, Halamová K, Van Damme P. Tamarind (*Tamarindus indica* L.): A review of traditional uses, phytochemistry and pharmacology. In: Juliani HR, Simon J, Ho CT (eds.) African natural plant products: new discoveries and challenges in chemistry and quality. ACS Symp Ser Am Chem Soc. 2009; Chapter 5:85–110. https://doi.org/10.1021/bk-2009-1021.ch005
32. Vaidhyar NK. Mooligaigal thanmaiyum payanum. Kannappan padhipagam; 2000. p. 230–40.
33. Parvez SS, Parvez MM, Fujii Y, Gemma H. Analysis of chemical components and oxygen radical absorbance capacity of *Tamarindus indica* L. Jap J. Trop Agric. 2003; 47(4):243–9.
34. Waqas MK, Khan BA, Akhtar N, Chowdhry F, Khan H, Bakhsh S, *et al.* Fabrication of *Tamarindus indica* seeds extract loaded-cream for photo-aged skin: Visioscan® studies. Postepy Dermatol Alergol. 2017; 34(4):339–45. https://doi.org/10.5114/ada.2017.69314. PMid:28951709. PMCid:PMC5560182
35. Luzia DMM, Jorge N. Antioxidant activity, fatty acid profile and tocopherols of *Tamarindus indica* L. seeds. Food

Sci Technol. (Campinas) 2011; 31(2):497–501. https://doi.org/10.1590/S0101-20612011000200034
36. Maiti R, Jana D, Das UK, Ghosh D. Antidiabetic effect of aqueous extract of seed of *Tamarindus indica* in streptozotocin-induced diabetic rats. J Ethnopharmacol. 2004; 92(1):85–91. https://doi.org/10.1016/j.jep.2004.02.002. PMid:15099853
37. Uchenna UE, Shori AB, Baba AS. *Tamarindus indica* seeds improve carbohydrate and lipid metabolism: An in vivo study. J Ayurveda Integr Med. 2018; 9(4):258–65. https://doi.org/10.1016/j.jaim.2017.06.004. PMid:29203351. PMCid:PMC6318079
38. Ibrahim NA, El Gengaihi S, El Hamidi A, Bashandy SAE. Chemical and biological evaluation of *Tamarindus indica* L. growing in Sudan. Acta Hortic. 1995; 390:51–7. https://doi.org/10.17660/ActaHortic.1995.390.6
39. Parvin A, ALam M, Haque M, Bhowmik A, Liaquat L, Rokeya B. Studies on the antidiabetic effects of *Tamarindus indica* (Tamarind) Linn. seeds on Nondiabetic, Type 1 and Type 2 diabetic model rats. Br J Pharm Res. 2013; 3(4):1094–105. https://doi.org/10.9734/BJPR/2013/4865
40. Abukakar MG, Ukwuani AN, Shehu RA. Phytochemical screening and antibacterial activity of *Tamarindus indica* pulp extract. Asian J Biochem. 2008; 3:134–8. https://doi.org/10.3923/ajb.2008.134.138
41. Doughari JH. Antimicrobial activity of *Tamarindus indica* L*inn*. Trop J Pharm Res. 2006; 5(2): 597–603. https://doi.org/10.4314/tjpr.v5i2.14637
42. Muthu SE, Nandakumar S, Rao UA. The effect of methanolic extract of *Tamarindus indica* Linn. on the growth of clinical isolates of *Burkho*L*deri apseudoma*LL*ei*. Indian J Med Res. 2005; 122:525–8.
43. Escalona-Arranz JC, Péres-Roses R, Urdaneta-Laffita I, Camacho-Pozo MI, Rodríguez-Amado J, Licea-Jiménez I. Antimicrobial activity of extracts from *Tamarindus indica* L. leaves. Pharmacogn Mag. 2010; 6(23):242-7. https://doi.org/10.4103/0973-1296.66944. PMid:20931087. PMCid:PMC2950390
44. Nwodo UU, Obiiyeke GE, Chigor VN and Okoh AI. Assessment of *Tamarindus indica* extracts for antibacterial activity. Int J Mol Sci. 2011; 12(10):6385–96. https://doi.org/10.3390/ijms12106385. PMid:22072893. PMCid:PMC3210984
45. Ushanandini S, Nagaraju S, Kumar KH, Vedavathi M, Machiah DK, Kemparaju K, *et al.* The anti-snake venom properties of *Tamarindus indica* (leguminosae) seed extract. Phytother Res. 2006; 20(10):851–8. https://doi.org/10.1002/ptr.1951. PMid:16847999
46. Dighe NS, Pattan SR, Nirmal SA, Kalkotwar RS, Gaware VM, Hole MB. Analgesic activity of *Tamarindus indica*. Res J Pharmacogn Phytochem. 2009; 1(1):69–71.
47. Souza A, Aka KJ. Spasmogenic effect of the aqueous extract of *Tamarindus indica* L. (Caesalpiniaceae) on the contractile activity of guinea-pig taenia coli. Afr J Tradit Complement Altern Med. 2007; 4(3):261–6. https://doi.org/10.4314/ajtcam.v4i3.31217. PMid:20161887. PMCid:PMC2816490
48. Ali N, Shah SS. Spasmolytic activity of fruits of *Tamarindus indica* L. J Young Pharm. 2010; 2:261–4. https://doi.org/10.4103/0975-1483.66805. PMid:21042482. PMCid:PMC2964778
49. Povichit N, Phrutivorapongkul A, Suttajit M, Chaiyasut CC, Leelapornpisid P. Phenolic content andin vitro inhibitory effects on oxidation and protein glycation of some Thai medicinal plants. Pak J Pharm Sci. 2010; 23(4):403–8.
50. Veena T. Tamarind as a sialogogue. Indian J Physiol Pharmacol. 1999; 43(3):401–2.
51. Lakshmanan KK, Narayanan ASS. Antifertility herbals used by the tribals in Anaikkatty hills. J Econ Taxon Bot. 1994; 14(1):171–3.
52. Dalziel JM. The useful plants of West Tropical Africa (Reprint of 1937 edn). Crown Agents for Overseas Governments and Administrations, London; 1955. p. 612.
53. Kokwaro JO. Medicinal plants of East Africa. East African Literature Bureau, Kampala; 1976. p. 368.
54. Tabuti JRS, Lye KA, Dhillion SS. Traditional herbal drugs of Bulamogi, Uganda: plants, use and administration. J Ethnopharmacol 2003; 88:19–44. https://doi.org/10.1016/S0378-8741(03)00161-2
55. de Padua LS, Lugod GC and Pancho JV. Handbook on Philippine medicinal plants, 4 vols. Documentation and Information Section, Office of the Director of Research, University of the Philippines at Los Banos, The Philippines; 1997–1983.
56. Homayuonfar A, Aminsharifi A, Salehi A, Sahraian A, Dehshari S and Bahrami M. A randomized double-blind placebo controlled trial to assess the effect of tamarind seed in premature ejaculation. Adv Biomed Res. 2018; 7:59. https://doi.org/10.4103/abr.abr_16_17. PMid:29862208. PMCid:PMC5952527
57. Bhat TA, Begum W. Efficacy of *Tamarindus indicus*, *Melia azadirach* and *Santalum album* in syndromic management of abnormal vaginal discharge: A single-blind randomised controlled trial. J Complement Integr Med.

2017; 15(2):1–8. https://doi.org/10.1515/jcim-2015-0023. PMid:29257757

58. Ahmad A, Ahmad W, Sajid M, Hasan A, Zeenat F. Clinical evaluation of *Tamarindus indica* Linn seeds in uterine prolapsed. Int J Unani and Int Med. 2018; 2(4):35–7.
59. Baery N, Nejad AG, Amin M, Mahroozade S, Mokaberinejad R, Bioos S, *et al.* Effect of vaginal suppository on bacterial vaginitis based on Persian medicine (Iranian traditional medicine): A randomised double blind clinical study. J Obstet Gynaecol. 2018; 38(8):1110–14. https://doi.org/10.1080/01443615.2018.1445706. PMid:30084707
60. Resny AR, Jayasree P. Clinical evaluation on effect of root of amleeka (*Tamarindus indica* Linn.) in nastarthava (amenorrhoea) - A case series study. Int J Ayurveda and Pharma Research. 2017; 5(8):83–6.
61. Paheerathan V, Piratheepkumar R, Kokilan K. Efficacy of *Tamarindus indica* in the management of pandu noei. Siddha Papers. 2018; 13:1.
62. Rao PS, Ramanjaneyulu YS, Prisk VR and Schurgers LJ. A Combination of *Tamarindus indica* seeds and *Curcuma longa* rhizome extracts improves knee joint function and alleviates pain in non-arthritic adults following physical activity. Int J Med Sci. 2019; 16(6):845–53. https://doi.org/10.7150/ijms.32505. PMid:31337958. PMCid:PMC6643110
63. Kare SK, Vinay V, Maresz K, Prisk V and Vik H. *Tamarindus indica* seed extract-based botanical compositions alleviate knee pain and improve joint function in mild-to-moderate osteoarthritis: A randomized, double-blind, placebo-controlled clinical study. Evid Based Complement Alternat Med. 2022; 2022. https://doi.org/10.1155/2022/2226139. PMid:35096104. PMCid:PMC8791717
64. Boonruab J, Nimpitakpong N, Damjuti W. The distinction of hot herbal compress, hot compress, and topical diclofenac as myofascial pain syndrome treatment. J Evid Based Integr Med. 2018; 23. https://doi.org/10.1177/2156587217753451. PMid:29405762. PMCid:PMC5871049
65. Mustapha A, Yakasai IA, Aguye IA. Effect of *Tamarindus indica* L. on the bioavailability of aspirin in healthy human volunteers. Eur J Drug Metab Pharmacokinet. 1996; 21(3):223–6. https://doi.org/10.1007/BF03189717. PMid:8980919
66. Garba M, Yakasai IA, Bakare MT, Munir HY. Effect of *Tamarindus indica*. L on the bioavailability of Ibuprofen in healthy human volunteers . Eur J Drug Metab Pharmacokinet. 2003; 28(3):179–84. https://doi.org/10.1007/BF03190483. PMid:14527090
67. Haldar S, Gan L, Tay SL, Ponnalagu S, Henry CJ. Postprandial glycemic and insulinemic effects of the addition of aqueous extracts of dried corn silk, cumin seed powder or tamarind pulp, in two forms, consumed with high glycemic index rice. Foods. 2019; 8(10):437. https://doi.org/10.3390/foods8100437. PMid: 31554322. PMCid:PMC6835365
68. Iftekhar AS, Rayhan I, Quadir MA, Akhteruzzaman S, Hasnat A. Effect of *Tamarindus indica* fruits on blood pressure and lipid-profile in human model: An in vivo approach. Pak J Pharm Sci. 2006; 19(2):125–9.
69. Asgary S, Soltani R, Barzegar N, Sarrafzadegan N. Evaluation on the effects of *Tamarindus indica* L. fruit on body weight and several cardiometabolic risk factors in obese and overweight adult patients: A randomized controlled clinical trial. Int J Prev Med. 2020; 11:24.
70. Jaladat AM, Zareifar S, Daneshfard B, Shahriarirad R. Management of drug-induced liver injury with Persian medicine: Case report. Integr Med Rep. 2022; 1(1):3–6. https://doi.org/10.1089/imr.2021.0006
71. Acharya S, Panda PK, Acharya G, Mohanty N, Nathsharma PK, Dash SC. A comparative clinical trial of Chinchakshara and Kadali kshara on Amlapitta. Ayu. 2011; 32(4):494–9. https://doi.org/10.4103/0974-8520.96122. PMid:22661843. PMCid:PMC3361924
72. Lertbannaphong S, Suwanthanma W, Kongdan Y, Euanorasetr C. Randomized controlled trial study for evaluation of herbal lozenge compared with standard postoperative care to enhance postoperative bowel function recovery following elective open abdominal surgery. J Med Assoc Thai. 2018; 101:78–83.
73. Gnessi L, Bacarea V, Marusteri M, Piqué N. Xyloglucan for the treatment of acute diarrhea: Results of a randomized, controlled, open-label, parallel group, multicentre, national clinical trial. BMC Gastroenterol. 2015; 15:153. https://doi.org/10.1186/s12876-015-0386-z. PMid:26518158. PMCid:PMC4628347
74. Santos J, Musta V, Luca CM, Belei OA, Cambrea SC. Randomized, placebo-controlled trial of xyloglucan and gelose for the treatment of acute diarrhea in children. Expert Rev Gastroenterol Hepatol. 2021; 15(3):325–31. https://doi.org/10.1080/17474124.2021.1833715. PMid:33028102
75. Condratovici CP, Bacarea V, Piqué N. Xyloglucan for the treatment of acute gastroenteritis in children: Results of a randomized, controlled, clinical trial. Gastroenterol Res

Pract. 2016; 2016. https://doi.org/10.1155/2016/6874207. PMid:27212943. PMCid:PMC4861777

76. Burta O, Iacobescu C, Mateescu RB, Nicolaie T, Tiuca N, Pop CS. Efficacy and safety of APT036 versus simethicone in the treatment of functional bloating: a multicentre, randomised, double-blind, parallel group, clinical study. Transl Gastroenterol Hepatol. 2018; 3:72. https://doi.org/10.21037/tgh.2018.09.11. PMid:30511026. PMCid:PMC6256934
77. Maenthaisong R, Chaiyakunapruk N, Warnnissorn P, Viyoch J. Cleansing lotion containing tamarind fruit pulp extract. III. Study of lightening efficacy and skin irritation on Asian skin type. Science Asia. 2009; 35(1):24–30. https://doi.org/10.2306/scienceasia1513-1874.2009.35.024
78. Maenthaisong R, Viyoch J, Chaiyakunapruk N, Warnnissorn P. Cleansing lotion containing tamarind fruit pulp extract. II. Study of cumulative irritation effects in human. J Cosmet Dermatol. 2007; 6(3):78–182. https://doi.org/10.1111/j.1473-2165.2007.00328.x. PMid:17760696
79. Muangman P, Aramwit P, Palapinyo S, Opasanon S, Chuangsuwanich A. Efficacy of the combination of herbal extracts and a silicone derivative in the treatment of hypertrophic scar formation after burn injury. Afr J Pharm Pharmacol. 2011; 5(3):442–6. https://doi.org/10.5897/AJPP10.282
80. Chuangsuwanich A, Jongjamfa K. The efficacy of combined herbal extracts gel preparation in the prevention of postsurgical hypertrophic scar formation. Dermatol Ther (Heidelb). 2014; 4(2):187–95. https://doi.org/10.1007/s13555-014-0055-0. PMid:24962057. PMCid:PMC4257949
81. Rolando M, Valente C. Establishing the tolerability and performance of Tamarind Seed Polysaccharide (TSP) in treating dry eye syndrome: Results of a clinical study. BMC Ophthalmol. 2007; 7:5. https://doi.org/10.1186/1471-2415-7-5. PMid:17394642. PMCid:PMC1859988
82. Barabino S, Rolando M, Nardi M, Bonini S, Aragona P, Traverso CE. The effect of an artificial tear combining hyaluronic acid and tamarind seeds polysaccharide in patients with moderate dry eye syndrome: A new treatment for dry eye. Eur J Ophthalmol. 2014; 24(2):173–8. https://doi.org/10.5301/ejo.5000355. PMid:24030535
83. Iester M, Oddone F, Fogagnolo P, Frezzotti P, Figus M. Confocal microscopy study group. Changes in the morphological and functional patterns of the ocular surface in patients treated with prostaglandin analogues after the use of TSP 0.5%® preservative-free eyedrops: a prospective, multicenter study. Ophthalmic Res. 2014; 51(3):146–52. https://doi.org/10.1159/000357100. PMid:24557328
84. Nozari N, Ramin S. The effect of tamarind seed polysaccharide containing eye drop in dry eye syndrome: Results of an interventional, comparative, clinical study. Med. Hypothesis Discov Innov Optom. 2021; 2(2):71–6. https://doi.org/10.51329/mehdioptometry128
85. Jacobi C, Kruse FE, Cursiefen C. Prospective, randomized, controlled comparison of SYSTANE UD eye drops versus VISINE INTENSIV 1% EDO eye drops for the treatment of moderate dry eye. J Ocul Pharmacol Ther. 2012; 28(6):598–603. https://doi.org/10.1089/jop.2012.0066. PMid:22813209
86. Vagge A, Bonino M, Rolando M, Macrì A, Traverso CE, Iester M. The utility of an artificial substitute to improve corneal sensitivity in glaucomatous patients on chronic therapy with prostaglandin analogs. J Ocul Pharmacol Ther. 2015; 31(5):286–90. https://doi.org/10.1089/jop.2014.0131. PMid:25974240
87. Himori N, Inoue Yanagimachi M, Omodaka K, Shiga Y, Tsuda S, Kunikata H, Nakazawa T. The effect of dietary antioxidant supplementation in patients with glaucoma. Clin Ophthalmol. 2021; 15:2293–300. https://doi.org/10.2147/OPTH.S314288. PMid:34113073. PMCid:PMC8183457
88. Khandare AL, Kumar P U, Shanker RG, Venkaiah K, Lakshmaiah N. Additional beneficial effect of tamarind ingestion over defluoridated water supply to adolescent boys in a fluorotic area. Nutrition. 2004; 20(5):433–6. https://doi.org/10.1016/j.nut.2004.01.007. PMid:15105030
89. Khandare AG, Lakshmaiah N. Effect of tamarind ingestion on fluoride excretion in humans. Eur J Clin Nutr. 2002; 56:82–5. https://doi.org/10.1038/sj.ejcn.1601287. PMid:11840184