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Review Article

TAMARINDUS INDICA L. (FABACEAE): EXTENT OF EXPLORED USE IN TRADITIONAL MEDICINE

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ABSTRACT

Tamarind (*Tamarindus indica* L.) belongs to the family of Fabaceae (Leguminosae), subfamily *Caesalpinioideae*, is a very important food within the tropics. Medicinal plants are the rear bone of traditional medicine (TM). TM is vital in tropical countries: Contrary to pharmaceuticals, pharmacological, and pharmacotherapy. *T. indica* is employed as TM in India, Africa, Pakistan, Bangladesh, Nigeria, and most of the tropical countries. It is used traditionally in abdominal pain, diarrhea and dysentery, helminths infections, wound healing, malaria and fever, constipation, inflammation, cell cytotoxicity, gonorrhea, and eye diseases. It is numerous chemical values and is rich in phytochemicals, and hence, the plant is reported to possess antidiabetic activity, antimicrobial activity, antivenomic activity, antioxidant activity, antimalarial activity, hepatoprotective activity, antiasthmatic activity, laxative activity, and antihyperlipidemic activity. Thus, the aim of the present review demonstrates the plant contains in leaves, seeds, roots, pulp, fruits, and flowers an excellent sort of bioactive substances that have beneficial effects on human health and therefore the possibility of application in various tropical, pharmaceutical, and industrial sectors.

Keywords: Tamarind, Antioxidant, Antidiabetic, Antimicrobial, Anti-inflammatory, hepatoprotective.

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INTRODUCTION

Tamarindus indica L. of the Fabaceae, subfamily *Caesalpinioideae*, is a crucial food within the tropics. Medicinal plants are the rear bone of traditional medicine (TM). TM is vital in tropical countries: Contrary to pharmaceuticals, pharmacological, and pharmacotherapy [1]. It is often freely and readily available multipurpose tree of which just about every part finds a minimum of some use either medicinal or nutritional. For instance, in Burkina Faso, up to 90% of the population relies to use traditional remedies [2]. Tamarind is indigenous to tropical Africa, but it is been introduced and naturalized worldwide in over 50 countries. Plants are the essential elements of TM and selected as a therapy in greater amounts. *T. indica* is employed as a standard medicine in Asian countries India, Thailand, Pakistan, Bangladesh, Sri Lanka, and most of the tropical countries. In America, Mexico and Costa Rica are the most important producers. Africa on the entire does not produce tamarind on a billboard scale, though it is widely employed by the local people. Minor producing countries in Africa are Senegal, Gambia, Kenya, Tanzania, and Zambia [3].

T. indica (Fig. 1) is of moderate to enormous in size, evergreen tree, up to 24 m in stature and 7 m in size that has light yellow and pink flowers [4]. The continued morphologic and subatomic examinations and proceeded with the study will explain the accurate situating of *Tamarindus* in connection to its putatively related genera [5-7]. It is an enormous evergreen tree with an outstandingly wonderful spreading crown and is developed during nearly the whole nation, apart from within the Himalayas and Western dry regions [8].

Practically, all parts of the tree discover some utilization or the opposite in nourishment, concoction, pharmaceutical, and textile enterprises, and as grain, timber, and fuel [9,10]. Commercial ranches are accounted for in Central American nations and in North Brazil [11]. Large fragments of human population and animals within the creating nations experience the ill effects of protein unhealthiness. *T. indica* is wealthy in supplements and assumes a big role in human nourishment, basically within the developing nations [12,13]. *T. indica* contains significant levels of rough protein. *T. indica* likewise contains a big level of protein with numerous fundamental amino acids, which help to create strong and efficient muscles. *T. indica* is additionally high in starch, which provides vitality, and is rich in minerals, such as calcium, phosphorus, potassium, calcium, and magnesium. *T. indica* can likewise give littler measures of iron and nutrient A. The whole plant of *T. indica* Linn. is employed widely for extensively for contemporary reason; subsequently, it is exceptionally gainful to the human beings [14].

The pulp contains organic acids, such as hydroxy acid, ethanolic acid, malic acid, and carboxylic acid; amino acids; carbohydrate (25–30%) [15]; pectin; protein; fat; some pyrazines (trans-2-hexenal); and a few thiazoles (2-ethylthiazole, 2-methylthiazole) as fragrant [16]; and therefore, the seed polysaccharides are found with a main chain consisting of β-1,4-connected glucose molecules alongside xylose

Table 1: Amino acid content of *T. indica* fruit pulp and seeds

S. No.	Amino acid		Fruit pulp mg/g dw	Seeds g/100 g dw
1.	Crude protein (total protein)		116.00	17.30
2.	Aspartic acid	ASP	12.00	1.80
3.	Glutamic acid	GLU	16.70	2.82
4.	Serine	SER	6.88	0.95
5.	Glycine	GLY	5.15	1.67
6.	Histidine	HIS	3.37	0.55
7.	Arginine	ARG	8.74	1.66
8.	Threonine	THR	6.05	0.52
9.	Alanine	ALA	6.20	0.65
10.	Proline	PRO	7.61	0.85
11.	Tyrosine	TYR	4.34	0.95
12.	Valine	VAL	6.97	0.71
13.	Methionine	MET	2.48	0.14
14.	Isoleucine	ILE	5.20	0.67
15.	Leucine	LEU	8.89	1.09
16.	Phenylalanine	PHE	4.78	0.71
17.	Lysine	LYS	8.22	1.05
18.	Cysteine	CYS	1.35	0.35
19.	Tryptophan	TRP	1.04	0.18

T. indica: *Tamarindus indica*

Fig. 1: (a) Fruits, (b) leaves, (c) flowers, (d) stem bark of *Tamarindus indica*

Table 2: Mineral content of tamarind fruit pulp

S. No.	Minerals	A	B	C	D	E	F
1.	Aluminum	-	-	-	1.84	-	-
2.	Iron	8.49	6.80	14.00	3.17	2.80	1.69
3.	Sodium	76.66	11.10	-	6.21	28.00	13.95
4.	potassium	62.00	1226.90	-	0.65	628.00	790.11
5.	Magnesium	72.03	128.20	-	0.12	92.00	53.28
6.	Calcium	465.75	17.10	240.00	0.19	74.00	106.88
7.	Cobalt	-	-	-	0.01	-	0.05
8.	Cupper	21.83	-	-	0.91	0.09	0.29
9.	Barium	-	-	-	0.20	-	-
10.	Manganese	-	-	-	21.50	-	0.06
11.	Molybdenum	-	-	-	0.01	-	-
12.	Chromium	-	-	-	0.29	-	-
13.	Nickel	0.52	-	-	0.13	-	0.08
14.	Phosphorus	91.00	108.10		0.12	113.00	99.49
15.	Zinc	1.06	-	2.30	1.32	0.10	0.09
16.	Lead	-	-	-	0.01	-	-
17.	Titanium	-	-	-	0.02	-	-
18.	Strontium	1.06	-	2.30	1.32	0.10	0.09

Units are mg/100 g dw; -: Not mentioned in the original paper. Source: A: Ishola (1990); B: Saka and Msonthi (1994); C: Nordeide (1996); D: Glew (2005); E: USDA (2007, cited in Almeida, 2009); F: Almeida (2009)

Table 3: Mineral content of tamarind seeds

S. No.	Minerals	A	B	C	D	E	F
1.	Calcium	786.86	172.00	-	185.00	142.00	36.60
2.	Copper	18.97	0.47	0.73	1.16	0.26	2.10
3.	Iron	ND	6.30	13.70	2.67	9.09	45.50
4.	Potassium	610.00	1430.00	-	-	-	1308.00
5.	Magnesium	118.00	214.00	28.20	196.00	201.00	104.00
6.	Manganese	-	0.68	0.70	ND	0.70	12.10
7.	Molybdenum	-	-	-	1.39	-	-
8.	Sodium	19.17	21.30	-	ND	-	8.90
9.	Nickel	ND	-	-	-	-	-
10.	Phosphorous	165.00	312.00	-	228.00	220.00	-
11.	Zinc	3.00	7.100	1.22	2.63	3.12	7.00

Units are mg/100 g dw; ND: not detected; -: Not mentioned in the original paper. Source: A: Ishola (1990); B: Siddhuraju (1995); C: Smith (1996); D: Glew (1997); E: Lockett (2000); F: Ajayi (2006)

(alpha-1,6) and galactose [17,18]; total protein; lipids with fatty oils; and a few keto acids [19]. Within the leaves of the plant, two triterpenes, lupanone and lupeol, were found [20].

The aerial parts of this plant have exhibited the appearance of tartaric acid, ethanolic acid, and succinic acid, gum, pectin, sugar, tannins, alkaloid, flavonoids, sesquiterpenes, and glycosides [21,22]. *T. indica* pericarp and seeds contain phenolic antioxidants to stop cancer. The leaf oil contains 13 components among which limonene and benzyl benzoate were most predominant [23]. Phytochemical screening of the basis bark of *T. indica* demonstrated the presence of n-hexacosane, eicosanoic acid, octacosanylferulate, 21-oxobehenic acid, and (+)-pinitol. The appearance of the bioactive compound (+)-pinitol during this plant is being accounted for the primary time [24]. The unpredictable constituents of the fruit pulp were furan derivatives (44.4%) and acid (33.3%) of the entire volatiles [25]. The many unsaturated fats of seeds were hexadecanoic acid, monounsaturated fatty acid, linoleic acid, and eicosanoic acid. The unsaponifiable issue from the seed oil of *T. indica* indicated the presence of β-amyrin, compesterol, β-sitosterol, and 7-hydrocarbons [26].

Table 4: Medicinal and pharmacologic properties

S. No.	Disorder category	Medicinal use	Plant part	Activity	References
1.	Infestations/infections	Microbial infections	Leaf, flower	Antibacterial activity	[35-37]
2.		Cold	Fruit pulp		[38]
3.		Fever	Fruit		[39]
4.		Laxative	Fruit, bark	Constipation	[38,40]
5.	Circulatory system	Chest complaints Heart diseases	Fruits	Atherosclerotic activity	[38]
6.		Hypotension	Leaf		[41]
7.		Jaundice	Bark and leaf		[42]
8.		Antidiabetic	Seeds	Immunomodulatory	[43]
9.	Pain	Dysuria	Bark		[44]
10.		Pain	Bark and leaf	Immunostimulant	[45]
11.		Scurvy	Fruit pulp		[46]
12.	Injuries	Wound healing	Bark/leaves		[47,48]
13.		Malaria	Fruits, leaves, and bark		[49-51]
14.	Eye	Eye drops	Seed	Corneal wound healing	[52]
15.		Analgesic and anti-inflammatory	Bark, leaves, and seeds	Pain	[53,54]
16.	Gastrointestinal	Peptic ulcer	Seeds	Protective effect	[55]
17.	Mental	Sleep	Fruit pulp		[38]
18.	Respiratory system	Respiratory	Leaf		[46]
19.	Nervous system	Epilepsy	Root		[56]
20.		Chew sticks	Wood		[57]
21.	Digestive system	Abdominal pain	Bark	Protective activity	[38]
22.	Microbial infections	Cancer	Seed	Antioxidant property	[58]
23.		Hyperlipidemia	Fruit pulp	Antioxidant property	[59]
24.	Endocrine system	Diabetes	Seed	Antidiabetic	[60]
25.		Asthma	Leaves	Antiasthmatic	[61]
26.		Helminth infections (parasitic worms)	Fruit/leaf/bark seed	Anthelmintic	[48,62,63]
27.		Microbial infections	Fruit		[64]
28.		Sleeping sickness	Leaf, fruit		[65]
29.		Mumps	Leaf		[38]
30.		Blackleg	Root/stem bark		[66]
31.	Sensory system	Earache	Leaf		[67]
32.		Vertigo	Fruit pulp		[37]
33.		Fortifiant	Bark and leaf		[45]
34.		Dysentery	Green stem bark		[46]
35.		Snakebite	Seed	Antivenom	[68]
36.	Cellular system	Cytotoxicity	Fruit, seed coat	Immunomodulatory	[69-71]
37.	Genitourinary system	Aphrodisiac	Flower/twigs and bark		[72,73]
38.		Infertility	All aerial parts		[74]
39.		Vomiting	Fruit		[75]
40.		Hepatitis A	Leaf		[76]
41.	Skin	Skin	Bark and leaf		[77]

AMINO ACID PROFILE

The fruit pulp is comparatively poor in protein though the fruit is rich in several amino acids [27]. Glew *et al*. reported the aminoalkanoic acid composition of tamarind fruit pulp [28] consistent with Ishola *et al*. (1990), tamarind seeds are an honest source of protein. Aminoalkanoic acid profiles of tamarind reveal that the proteins contain fairly balanced essential aminoalkanoic acid levels [29]. In terms of protein content and WHO standards, tamarind seeds score well for three of the eight essential amino acids. Tamarind seeds could, therefore, be used as a less costly source of protein to assist alleviates protein malnutrition found so widespread in many developing countries (Table 1).

MINERAL COMPOSITION

The fruit pulp may be a rich source of several macro- and microelements (Table 2), including relatively high amounts of copper, manganese, and zinc. Fruit pulp is additionally an honest source of calcium and phosphorus [3], but is, unfortunately, extraordinarily low in iron [29]. Almeida indicated that tamarind may be a rich source of all minerals available, especially magnesium, copper, and potassium, additionally to being an honest source of calcium, phosphorous, iron, and selenium. The consumption of 100 g tamarind fruit pulp by an adult will cover 10.69% of the recommended daily intake of calcium, 20.49% of magnesium, 14.21% of phosphorous, 12.07% of iron, 2.61% of manganese, 1.29% of zinc, 32.22% of copper, and 9.21% of selenium, respectively [30].

MINERAL COMPOSITION TAMARIND SEEDS

Mineral composition tamarind seeds appear to be a good source of different mineral elements [31-34], such as calcium, phosphorus, magnesium, and potassium (Table 3). Calcium content of tamarind seeds is quite high compared to that of some of the cultivated pulse crops of all the minerals studied. K is that the element in highest concentration, with the values for the trace mineral copper also relatively high is shown in Table 3. The high concentration of potassium is nutritionally significant considering the fact that potassium plays a principal role in neuromuscular function.

MEDICINAL AND PHARMACOLOGIC PROPERTIES

One of the most known health benefits of tamarind is its use as medicine since the ancient times. *T. indica* is used as traditional medicine in India, Africa, Pakistan, Bangladesh, Nigeria, and most of the tropical countries.

CONCLUSION

T. indica L. is an important source of food in tropical regions, but currently waste products such as seed, bark, and peel are little used. The plant contains in leaves, seeds, roots, pulp, fruits, and flowers a great variety of bioactive substances that have beneficial effects on human health and the possibility of application in various industrial sectors. Tamarind showed that there is great variation in amino acids, mineral, and elemental composition in fruit and seed. Tamarind leaves

are reported for antioxidant and antimicrobial activity, but it has not been possible to establish a relationship with the chemical composition due to scanty information availed. Many parts of the tamarind are utilized in TMs to treat diseases additionally as symptoms. Considering the overall benefits of the plant, it can be advocated as a safe, highly important, medicinal plant for humankind.

AUTHORS' CONTRIBUTIONS

All the authors contributed equally.

CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

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