WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 12, Issue 14, 405-421. Review Article ISSN 2277–7105

ETHNOPHARMACOLOGICAL REVIEW ON PULIYATHI CHOORANAM - SIDDHA HERBAL FORMULATION

G. Tamilarasan[1*], A. Areesh Kumar[2], S. Sushma[3], V. Divya Bharathi[4] and Dr. M. D. Saravana Devi, M. D. (S)[5]

[1,2,3,4]PG Scholar, Department of Gunapadam, Government Siddha Medical College, Chennai, Tamil Nadu, India.

[5]Professor, Head of the Department, Department of PG Gunapadam, Government Siddha Medical College, Chennai Tamil Nadu, India.

Article Received on
02 July 2023,

Revised on 23 July 2023,
Accepted on 13 August 2023

DOI: 10.20959/wjpr202314-29325

***Corresponding Author**
G. Tamilarasan
PG Scholar, Department of Gunapadam, Government Siddha Medical College, Chennai, Tamil Nadu, India.

INTRODUCTION

The Siddha system of medicine is one of the traditional medical systems prominent in South India. The traditional Siddha system describes 4448 diseases caused by a disruption of three humours *(Vali, Azhal, and Aiyam*). Clinical examination and an eight-fold examination *(Envagai thervu*) are applied to diagnose these diseases, which include tools such as Naa (Tongue), Niram (Colour), Mozhi (Speech), Vizhi (Eyes), Naadi (Pulsediagnosis), Sparisam (Sensation), Malam (Stool), Moothiram (Urine), and others, and are treated with Siddha Sasthric Medicines (SSM)[1], among 4448 diseases diabetes comes under Madhumegam Diabetes is one of the most serious worldwide health crises of the twenty-first century, ranking among the top ten causes of death with cardiovascular disease (CVD), respiratory disease, and cancer.[2] [3]

According to the World Health Organisation (WHO), noncommunicable diseases (NCDs) accounted for 74% of global fatalities in 2019, with diabetes accounting for 1.6 million deaths, making it the ninth biggest cause of death worldwide.[3]

By the year 2035, nearly 592 million people are predicted to die of diabetes, the burden of diabetes can be potentially reduced if the standard of care is implemented as well as patients' compliance and participation is clinically implemented. In this mini review, we endeavor to outline the herbal medication puliyathi chooranam which is used for lowering the elevated blood glucose in T2DM.

DRUG REVIEW

Puliyathi chooranam has potent anti diabetic activity taken from the Siddha literature "*Mega nivarana bodini ennum neerizhivu maruthuvam" (*P.NO: 166)

SIDDHA ASPECT OF THE DRUG

Table No.1 Ingredients of *Puliyathi Chooranam.*

S.NO.	TAMIL NAME	BOTANICAL NAME
1.	*Puliya marapattai*	*Tamarindus indica L.,*
2.	*Puliyakottai melthol*	*Tamarindus indica L.,*
3.	*Seendhil thandu*	*Tinosporia cordifolia Willd.,*

GUNAPADAM ASPECT[4]

PULIYA MARAPATTAI

Botanical name **:** *Tamarindus indica L.,*

Other names : *Thinthruni, Aambiram, Sindhuram, Chinthagam, Egin, Sindham*

Family *: Caesalpiniaceae*

Vernacular names

English : Tamarind tree

Malayalam : Puli

Sans : Tintiri, tintrani, amlavraksha, amlikha, tintidi, tintili, ambia

Hindi : Amli, anbli, imli amlica

Kannadam : Hunasehannu, hunisay

Telugu : Chinta pandu

Part used **:** Pulp of the fruit, seeds, leaves, flowers and bark

Properties

Taste : Sour

Character : Heat

Division : Pungent

Actions

Tender Leaves **:** Refrigerant Antibilios

Unripe fruit **:** Stimulant

Fruit **:** Laxative

Seed outer shell **:** Carminative, antibilious

Seed **:** Astringent

INDICATION

SEED **:** Outer shell of seed rich in astringent is used in the treatment of venereal disease, dysentery, ulcers, dysuria, and leucorrhoea.

STEM BARK **:** Stem bark is used in the treatment of intestinal Tb, gastric ulcer, fever, indigestion, used to increase appetite.

THERAPEUTIC USES

Tamarind is useful in preventing or curing scurvy

A gargle of tamarind water is useful in healing aphthous sores and sore throats.

Ashes of the burnt shells of ripe fruit are used as an alkaline substance along with other alkaline ashes in preparing medicines which is used in enlarged spleen.

Red outer covering of the seeds is also a valuable remedy in diarrhea and dysentery, About 10 grains of powdered seeds with equal quantity of cumin seeds and sugar or palmyra sugar candy are given two or three times daily.

Seeds are also used as a poultice to boils after being boiled.

Ash of bark is given internally as a digestive. Bark fried together with common salt in an earthern pot to white ash and powdered is a remedy for colic and indigestion, in one or two grain doses.

SEENTHIL

Botanical name **:** *Tinospora cardifolia Willd.,*

Other names : *Amirthavalli, somavalli, amirthai, amirtha kodi, kundali*

Family *: Menispermaceae*

Vernacular Names

English : Heart leaved moon seed, Tinospora, Gulancha tinospora

Malayalam : Amrutha

Sans : Guduchi

Hindi : Gul-bc

Kannadam : Hunasehannu, hunisay

Telugu : Tippa - tiga

Part used **:** Leaves, root, bark

Properties

Taste : Bitter

Character : Heat

Division : pungent

Actions

Alternative

Antiperiodic

Demulcent

Stimulant

Stomachic

Tonic

Mild diuretic

INDICATION

THERAPEUTIC USES

It is used to treat fever, Diabetes, 18 types of leprosy, severe kabha diseases, spleenomegaly, jaundice, cough, vomit, cystitis.

BOTANICAL ASPECT

TAMARINDUS INDICA

TAXONOMICAL CLASSIFICTION[5]

Kingdom : Plantae

Phylum : Spermatophyte

Class : Angiosperm

Sub class : Dicotyledone

Family : Leguminosae

Subfamily :Caesalpiniaceae

Genus :*Tamarindus*

Species : *indica*

Fig No: 01 *Tamarindus indica* Bark

Fig No: 02 *Tamarindus indica* Seed

DISTRIBUTION

Tropical evergreen leguminous species native to Africa and southern Asia. It grows well up to 1500 m above sea level where annual rainfall is above 1500 mm. It can grow in versatile soil conditions. It is a large evergreen tree with an exceptionally beautiful spreading crown and is cultivated throughout almost the whole country, except in the Himalayas and western dry regions.[6]

Tamarind is aboriginal to Africa and exotic to Central America and the Asian subcontinent. However 'Tamarind' word itself is a Persian word derived from 'tamar-i-hind' meaning 'date of India'. Moreover, the presence of tamarind is indicated in the historic Indian Brahma Samhita scriptures way before between 1200 and 200 BC.[7]

DESCRIPTION[8]

Tamarindus indica is of moderate to large in size, evergreen tree, grows up to 24 m in height, and 7 m in girth. Leaves are alternate, compound, with 10–18 pairs of opposite leaflets; leaflets are narrowly oblong, 12–32 × 3–11 mm, petiole and rachis finely haired, midrib and net veining more or less conspicuous on both surface. Flowers are attractive, pale yellow or pinkish, small, lax spikes about 2.5 cm in width. Flower buds are completely enclosed by two bracteoles, which fall very early; sepals 4, petals 5, the upper 3 are well developed and the lower 2 are minute. Fruit is a pod, indehiscent, subcylindrical, 10–18 × 4 cm, straight or curved, velvety, rusty-brown; the shell of the pod is brittle and the seeds are embedded in a sticky edible pulp. Seeds are 3–10, approximately 1.6 cm long, and irregularly shaped, and testa is hard, shiny, and smooth

CHEMICAL CONSTITUENTS[9]

Seed : 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.[10]

A new bufadienolide (Scilliphraside 3-O-β-D glucopyranosyl - (1-2)-L-rhamnopyranoside) and cardenolide (uzarigenin-3-O-β-Dxylopyranosyl (1-2)-α-L rhamnopyranoside) were identified from the seed extract.[11][12], Cellulose, albuminoid. amyloids, phytohemaglutinins, chitinase (XVI).[13]

Fruit : Furan derivatives (44.4%) and carboxylic acid (33.3%).13 Phlobatannine, grape acid, apple acid, tartaric acid (XI), succinic acid, citric acid, pectin and invert sugar.[14]

Tender leaves: Pulps contains invert sugar, pipecolic acid, citric acid (I), nicotinic acid, 1-malic acid, volatile oils (geranial(II), geraniol, limonene), pipecolic acid, lupanone (III), lupeol (IV), orientin (V), isoorientin(VI), vitamin B3 (VII), vitamin C (VIII), vitexin (IX), isovitexin (X).[15] [16] [17] [18] benzyl benzoate (40.6%), cinnamates, serine, betaalanine, pectin, proline, phenylalanine, leucine, potassium, 1-malic acid, tannin, glycosides, and peroxidase

BARK : Tannins, saponins, glycosides, peroxidase and lipids.

ACTIONS : Stimulant, Laxative, Carminative, antibilious, Astringent[19]

MEDICINAL USES

T. indica fruit is used as a laxative in traditional medicine, inspite of high malic acid, tartaric acid and potassium content.[20]

T. indica leaves used for diarrhea, *t. indica* fruit used for constipation, soft parts of bark and root can be used for abdominal pain.

T. indica seed extract has tannins which prevents the ulcer development via causing protein accumulation and vasoconstriction.[21]

Tamarind fruit acts as a calcium channel blocker hence used in smooth muscle relaxation.[22]

PHARMACOLOGICAL ACTIVITIES

Indica L., seed shows antioxidant effect via its flavonoid, tannin, polyphenol, anthocyanin and oligomeric proanthocyanidin content. Polysaccharides isolated from *T. indica* seed show the immunomodulatory effect via increasing phagocytosis, inhibiting leukocyte migration and decreases cell proliferation.[26]

Triglyceride decreasing effect is associated with epicatechin content of the extract. This compound increases total fatty acid, neutral and acidic sterols excreted via feces and shows its hypolipidemic effect in this way.[26] Tamarind seed and fruit are suggested as a nutritional support in patients with high blood cholesterol levels.[23-26]

Liver protective effect Alcohol and other chemicals, environmental, biologic toxins and many other factors are related with liver diseases. Apoptosis (programmed cell death) is the main mechanism in most of the liver diseases. In acute alcohol induced liver toxicity *T. indica* leaves showed anti-apoptotic and liver protective effect. It causes membrane stabilization and decreases glutathione consumption. Additionally, it prevents CASP-3 activation and DNA fragmentation and causes histopathologic amelioration.[27]

Ameliorative effect of *T. indica* seed extract has been shown in chemical induced acute nephrotoxicity and renal cell carcinoma. This effect can be explained by antioxidant effect. Although oxidative damage is strongly associated with cancer; polyphenol compounds [2-hydroxydihydroxyacetophenone, methyl 3,4-dihydroxybenzoate, 3,4-dihydroxyphenylacetate, (-)-epicatechin, tannin, anthocyanidine and oligomeric proantocyanidins] in *T. indica* seed extract has antioxidant enzyme induction properties and cancer related signal pathway blockage effect.[28]

Sandesh P, Velu V, Singh RP Studied that MeOH extract, of *T. indica* seed coat were evaluated by various *in-vitro* and *in vivo* techniques and indicate the presence of compounds responsible for exhibiting antioxidant activities. The difference in activities of various extracts may indicate the differential extraction of the compounds in various solvents responsible for these properties. MeoH extract has also been shown to provide hepatoprotective effect against CCl_4 toxicity.[29]

SEENDHIL

Kingdom : Plantae
Class : Magnoliophyta
Order : Rananculalus
Family : Menispermacea
Genus : *Tinospora*
Species : *cordifolia*

Fig No: 03 *Tinospora cordifolia.*

DISTRIBUTION

The plant of Tinospora cordifolia (Willd.) Miers. ex. Hook F. and Thomas (family Menispermaceae), is a large spreading, deciduous, succulent climber, widely distributed in almost the entire country1 from the Himalayas to the southern part of peninsular India. The plant is also found in South East Asian countries such as Borneo, the Philip pines, Malaysia, Indonesia, Thailand, Vietnam and China; as well as in North, West and South Africa. Its robust and wide distribution in the country has reportedly not been linked to any anthropogenic activities, despite its economic importance.[30] [31]

It is a large deciduous, extensively spreading climbing shrub with several coiled branches with a different type of morphology. The stem of the plant is filiform, fleshy and climbing in nature; bark is white to gray.[32] Powder of the stem is creamish brown or dark brown, characteristic odor, bitter taste and is used in dyspepsia, fever, and urinary diseases.[33] The starch obtained from the stem known as "Guduchi-satva." It is highly nutritive and digestive. Leaves of this plant are simple, alternate, long-petioled (approximately 15 cm); round, pulvinate, heart-shaped, twisted partially and halfway around. Lamina is ovate, 10–20 cm long, seven nerved and deeply cordate at the base and membranous.[34] Flowers are unisexual, axillary position, 2–9 cm long leaflet branches and greenish-yellow in colour, male flowers are clustered, female usually solitary.[35] Its fruits are single-seeded, fruits during the winter and flowers grow during the summer.[36] The root is thread-like, aerial, squairshin, sometimes continuously lengthening touch the ground[37] aerial roots are characterized by tetra to penta arch primary structure[38] The seeds are curved shape[39] and endocarp is variously ornamented.

CHEMICAL CONSTITUENTS

Phytochemistry Tinospora cordifolia have different classes of chemical constituents such as alkaloids diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides.

Stem & Root : Alkaloids Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine,

Stem : Glycosides 18-norclerodane glucoside, Furanoid diterpene glucoside, Tinocordiside, Tinocordifolioside, Cordioside, Cordifolioside Syringin, Syringin-apiosylglycoside, Pregnane glycoside, Palmatosides, Cordifolioside A, B, C, D and E.

Stem & Aerial plant: Steroids β–sitosterol, δ-sitosterol, 20β-hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol5.

MEDICINAL USES[40]

Tinospora cordifolia Willd., has an importance in traditional Siddha medicine used for ages in the treatment of fever, jaundice, chronic diarrhea, cancer, dysentery, bone fracture, pain, asthuma, skin disease, poisonous insect, snake bite, eye disorders.

Tinospora cordifolia extracts are extensively used in various herbal preparations for the treatment of different ailments for its anti-periodic, anti-spasmodic, anti-microbial, anti-osteoporotic, anti-inflammatory, anti-arthritic, anti-allergic, and anti-diabetic properties.[41]

Mehra et al., prepared the formulation and evaluated its antioxidant activity by DPPH (1-diphenyl-2-picrylhydrazyl) free radical scavenging method. They estimated the total flavonol and total phenolic content. Using the result of the formulation showed potent antioxidant activity and inhibitory concentration (IC50) at 5 µg/ml as compared to standard drug ascorbic acid.[42]

George et al., reported the methanolic, ethanolic, and water extracts of T. cordifolia for their antioxidant activity, in which the stemic ethanol extract increased the erythrocytes membrane lipid peroxide, catalase activity and decrease the superoxide dismutase, glutathione peroxidase in alloxan-induced diabetic rats.[43]

Antimicrobial activity Antimicrobial activity of the T. cordifolia with different solvents on different micro-organism, showed good antifungal and antibacterial activity.[44]

Jeyachandran et al., reported the antimicrobial activity of stem extracts by in-vitro analysis against both gram-positive and gram-negative bacteria and showed good therapeutic activity on the infectious disease. It has taken a methanolic extract of T. cordifolia against both bacteria group.[45]

Allemailem et al., have reported the antifungal activity of T. cordifolia, which was determined using the agar well plate diffusion method. The aqueous extract of T. cordifolia showed potent activity against A. fumigatus, Aspergillus flavus, and Aspergilles nigar (fungus) in the study.[46]

Antidiabetic activity

The anti-diabetic activities is due to alkaloids (Magnoflorine, Palmetine, Jatrorrhizine), tannins, cardiac glycosides, flavonoids, saponins, etc.[47]

The crude extract of the stem in ethyl acetate, dichloromethane (CDM), chloroform and hexane was studied for inhibition of the alpha-glucosidase enzyme. The activity of the enzyme inhibited hypoglysomic action in diabetic animal and normal animals. The aqueous extract was studied in the rats, without the addition of Tinospora cordifolia extract increase in glucose by 21.3%, insulin by 51.5%, triglycerides by 54.12%, and glucose-insulin index by 59.8 when plant containing extract was given. The fructose-induced abnormalities in the liver involving lipid peroxidation, protein carbonyl groups, GSH levels, and enzymatic antioxidants decreased.[48]

Methew et al., have reported invivo studies of different extracts of the plants on a diabetic patient. Sedimental extract of Tinospora on the subject was studied at 30 d ay. Different doses (200and 400 mg/kg b. w) of Ethanolic extract of T. cordifolia leaves were prepared. The doses were administered orally for ten days and 30 days in streptozotocin-diabetic albino rats. T. cordifolia showed the antidiabetic activity in diabetic animals an efficacy an 50%–70% compared to insulin.[49]

From Guduchi Prasant et al., isolated alkaloids, cardiac glycosides, saponins, flavonoids, tannins, and steroids that contains anti-diabetic property. Alkaloids from this plants showed insulin-mediated actions due to insulin hormone.[50]

Gestational diabetes can increase the GSH content and other reactive species that can act as a threat to the mother as well as the fetus. The study based upon the pregnant rat using T.

cordifolia was incorporated in the daily diet to a diabetic-pregnant rat (streptozocin-induced diabetes), which showed a protective effect by reducing the oxidative load thereby preventing the relative incidence of diseases and any birth defect.[51]

In a diabetic rat model, T. cordifolia root extracts of Guduchi attenuated the brain mediated lipid level and down-regulated the blood glucose and urinary glucose level emphasizing its anti-diabetic and lipid-lowering activity.[52]

The root extract of Guduchi showed an antihyperglycemic effect in the alloxan-induced diabetic model by decreasing its excess glucose level in urine as well as in normal.[53]

Certain herbal preparation, including Guduchi like Ilogen-Excel, Hyponidd, and Dihar have been tested in diabetic rat models, the anti-diabetic activity of T. cordifolia was observed. The effects by Ilogen Excel down the level of excess glucose in the blood and enhance the insulin efficiency by increasing its amount in the systemic circulation. Hyponidd is reported, and it maintained the oxidative load by decreasing reactive species and reduced the glucose-mediated hemoglobin count. when the tested of 'Dihar' for one and a half month in streptozotocin-induced diabetic model decreased the urea as well as creatinine amount in the blood with an increase in enzyme activities.[54,55,56]

Hypolipidemic effect

Stanely et al., studied the hypolipidemic effect of an aqueous extract of the root on the rats weighing 2.5 and 5.0 g/kg body weight on sixth weeks, that resulted in decrease tissue cholesterol, reduction in serum, phospholipids, and free fatty acid in alloxan diabetic rats. The dose of root extract 5.0 g/kg body weight showed the highest hypolipidaemic effect. When the level of serum lipids in diabetes increased, they represented coronary heart disease, lower the serum lipids level decreased the risk of vascular disease. The ability of T. cordifolia root extract to reduce the level of serum or tissue lipids in diabetics animals have never been studied before till then.[57]

2.3.7. Hepatic disorder Protective Effects of Tinospora cordifolia water extract (TCE) on Hepatic and Gastrointestinal Toxicity was reported by Sharma et al., a significant increase in the levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, Triglyceride, Cholesterol, HDL and LDL ($P < 0.05$) in alcoholic sample whereas their level get downregulated after TCE intervention, patients showed the normalized liver function of

T. cordifolia stand to relieve the symptoms.[86] 2.3.8. Anticancer activity Ali et al., studied the anticancer activity of T. cordifolia palmatine extract in animal models, alkaloid using response surface methodology (RSM). The extract indicates the anticancer potential in 7,12-dimethylbenz(a)anthracene DMBA induced skin cancer model in mice.[87] Rahul et al., prepared the extract of 200, 400, 600 mg/kg dry weight in a dose depend upon manners. 50% methanolic extract of cordifolia to C57 BI mice for 30 days at a dose of 750 mg/kg body weight the tumor size reduced life span.[58]

Mishra et al., showed the anti-brain cancer potential, 50% ethanolic extract of T. cordifolia (TCE) using C6 glioma cells significantly induced differentiation in C6 glioma cells, and reduced cell proliferation.[59]

CONCLUSION

Plants discussed in this review is a cheap and easily available. It is a rich source of essential amino acids, phytochemicals and vitamins. In traditional medicine, it has so many well known health benefits. With the aid of modern techniques it could be used in evidence based medicine in so many health conditions. There is a need of further investigation about these plants and clinical trial have to be done to evaluate its therapeutic efficacy that can help in many of the diseases.

REFERENCES

1. Shanmugavelu M., Natarajan K., Anandan Anaivaari R. 1st ed. Department of Indian Medicine & Homeopathy; Chennai: 2009. Principles of diagnosis in Siddha, p. 406. 306.
2. International Diabetes Federation. IDF Diabetes Atlas. 9th ed. Brussels, Belgium: International Diabetes Federation, 2019.
3. World Health Organization. The top 10 causes of death. [Last accessed on 2021 Jun 04]. Available from: http://www.who.int/en/news-room/fact-sheets/detail/the-top-10-causes-of-death.
4. GUNAPADAM BOOK.
5. Bhadoriya SS, Ganeshpurkar A, Narwaria J, Rai G, Jain AP. Tamarindus indica: Extent of explored potential. Pharmacogn Rev, 2011 Jan; 5(9): 73-81. doi: 10.4103/0973-7847.79102. PMID: 22096321; PMCID: PMC3210002.
6. G. A. Nayik, A. Gull (eds.), Tamarind (Tamarindus indica), Antioxidants in Fruits: Properties and Health Benefits, https://doi.org/10.1007/978-981-15-7285-2_16.

7. Devi, Barsha & Boruah, Tridip. (2020). Tamarind (Tamarindus indica). 10.1007/978-981-15-7285-2_16.
8. Salim Azad, Tamarindo—Tamarindus indica, Exotic Fruits Reference Guide, 2018; Pages 403-412.
9. Dhasade, V.V, Nirmal, S.A, Dighe, N.S, & Pattan, S.R (2009). an overview of tamarindus indica linn.: chemistry and pharmacological profile. Pharmacologyonline, 2009; 3: 809-820.
10. Ibrahim E and Abbas SAE. Chemical and biological evaluation of Tamarindus indica L. growing in Sudan. Acta Ho, 1995; 390: 51-57.
11. Yadara RN and Yadav SV. A new bufadienolide from the seeds of Tamarindus indica L. Res of Chem Environ, 1999a; 3(2): 55-56.
12. Yadara RN and Yadav SV. A new cardenolide uzarigenin-3-O-β-D-Xylopyranosyl (1→2)-αLrhamnopyranoside. J Asian Nat Prod Res, 1999b; 1(4): 245-249.
13. Patil DN, Datta M, Chaudhary A, et al. Isolation, purification, crystallization and preliminary crystallographic studies of chitinase from tamarind (Tamarindus indica) seeds. Acta Crystallogr Sect F Struct Biol Cryst Commun, 2009(1); 65(Pt 4): 343-5.
14. Shankaracharya NB. Tamarind-chemistry, technology and uses a critical appraisal. J Food Sci Technol, 1998; 35(3): 193-208
15. Pino JA, Escalora JC and Licea P. Leaf oil of Tamarindus indica L. Jr. of Essential Oil Research, 2002; 14(3): 187-188.
16. Iman S, Azhar I, Hasan MM, et al. Two Terpentenes Lupanone and Lupeol isolated and Identified from Tamarindus indica Linn., Pak J Pharm Sci, 2007; 20(2): 125 –127.
17. Koeppen, B.H., D.G.Roux, C-glycosylflavonoids: The Chemistry of Orientin and Iso-orientin. Biochem J, 1965; 97(2): 444 – 448.
18. Bhatia VK, Gupta SR and Seshadri TR. C-Glycosides of Tamarind leaves. Phytochemistry, 1966; 5(1): 177-181.
19. Komakech R, Kim YG, Matsabisa GM, Kang Y. Anti-inflammatory and analgesic potential of Tamarindus indica Linn. (Fabaceae): a narrative review. Integr Med Res, 2019 Sep; 8(3): 181-186. doi: 10.1016/j.imr.2019.07.002. Epub 2019 Jul 23. PMID: 31453087; PMCID: PMC6704379.
20. RM Havinga, A Hartl, J Putscher, S Prehsler, C Buchmann, CR Vogl Tamarindus indica L. (Fabaceae): patterns of use in traditional African medicine J Ethnopharmacol, 2010; 127(3): pp. 573-588.

21. P Kalra, S Sharma, Suman, S Kumar Antiulcer effect of the methanolic extract of Tamarindus indica seeds in different experimental models, J Pharm Bioallied Sci, 2011; 3(2): 236-241.
22. N Ali, S Shah Spasmolytic activity of fruits of Tamarindus indica L, J Young Pharm, 2010; 2(3): pp. 261.
23. CY Lim, SM Junit, MA Abdulla, AA Aziz, In vivo biochemical and gene expression analyses of the antioxidant activities and hypocholesterolaemic properties of Tamarindus indica fruit pulp extract, PloS One, (2013), 10.1371/journal.pone.0070058.
24. F Martinello, SM Soares, JJ Franco, AC Santos, A Sugohara, SB Garcia, et al. Hypolipemic and antioxidant activities from Tamarindus indica L. pulp fruit extract in hypercholesterolemic hamsters, Food Chem Toxicol, 2006; 44(6): 810-818.
25. URW Chong, PS Abdul-Rahman, AA Abdul-Aziz, OH Hashim, SM Junit, Tamarindus indica extract alters release of alpha enolase, apolipoprotein A-I, transthyretin and rab GDP dissociation inhibitor beta from HepG2 cells, PloS One, 2012; 10.1371/journal.pone.0039476.
26. AP Landi Librandi, TN Chrysóstomo, AE Azzolini, CG Recchia, SA Uyemura, AI de Assis-Pandochi, Effect of the extract of the tamarind (Tamarindus indica) fruit on the complement system: Studies in vitro and in hamsters submitted to a cholesterol-enriched diet, Food Chem Toxicol, 2007; 45(8): 1487-1495.
27. SS Bhadoriya, A Ganeshpurkar, J Narwaria, G Rai, AP Jain, Tamarindus indica: extent of explored potential, Pharmacogn Rev, 2011; 5(9): 73-81.
28. CY Vargas-Olvera, DJ Sanchez-Gonzalez, JD Solano, FA Aguilar-Alonso, F Montalvo-Munoz, CM Martinez-Martinez, et al. Characterization of N-diethylnitrosamine-initiated and ferric nitrilotriacetate-promoted renal cell carcinoma experimental model and effect of a tamarind seed extract against acute nephrotoxicity and carcinogenesis, Mol Cell Biochem, 2012; 369(1–2): 105-117.
29. Sandesh P, Velu V, Singh RP. Antioxidant activities of tamarind (Tamarindus Indica) seed coat extracts using in vitro and in vivo models. J Food Sci Technol. 2014 Sep; 51(9): 1965-73. doi: 10.1007/s13197-013-1210-9. Epub 2014 Feb 2. PMID: 25190852; PMCID: PMC4152496.
30. Lade S, Sikarwar PS, Ansari MA, Khatoon S, Kumar N, Yadav HK, Ranade SA. Diversity in a widely distributed dioecious medicinal plant, Tinospora cordifolia (Willd.) Miers. ex. Hook F. and Thomas. Current Science, 2018 Apr 10: 1520-6.

31. Panchabhai TS, Kulkarni UP, Rege NN, Pharmacognostic description Validation of therapeutic claims of Tinospora cordifolia: a review. Phytother Res, 2008 Apr; 22(4): 425-41. doi: 10.1002/ptr.2347. PMID: 18167043.
32. Upadhyay A.K., Kumar K., Kumar A., Mishra H.S. Tinospora cordifolia (Wild.) Hook. f. and Thoms. (Guduchi)–Validation of the ayurvedic pharmacology through experimental and clinical studies. Int. J. Ayurveda Res, 2010; 1: 112–121.
33. Tiwari P., Nayak P., Prusty S.K., Sahu P.K. Phytochemistry and pharmacology of Tinospora cordifolia. Syst. Rev. Pharm, 2018; 9: 70–78.
34. Gupta A.K. 1st ed. Vol. 1. 2003. pp. 212–218. (Anonymous:Quality Standards of Indian Medicinal Plants, NewDelhi).
35. Arul V., Miyazaki S., Dhananjayan R. Studies on the anti-inflammatory, antipyretic and analgesic properties of the leaves of Aegle marmelos Corr. J. Ethnopharmacol, 2005; 96: 159–163.
36. Spandana U., Liakhat Ali S.L., Nirmala T., Santhi M., Babu S.D. A review on Tinospora cordifolia. IJCPR, 2013; 4: 61–68.
37. Sinha A., Sharma H.P. A medicinal plant: micropropagation and phytochemical screening of Tinospora cordifolia (Wild.) Miers ex Hook F & Thoms. IJAPBC, 2015; 4: 114–121.
38. Singh S.S., Pandey S.C., Srivastava S., Gupta V.S., Patro B., Ghosh A.C. Chemistry moreover, medicinal properties of Tinospora cordifolia (Guduchi) Indian J. Pharmacol, 2003; 35: 83–91.
39. Misra B., Prakash B. Vol. 1. 1969. p. 26. (Study of Medicinal Plant and Drug, Bhava Prakash Nighantu).
40. Parthipan M, Aravindhan V, Rajendran A. Medico-botanical study of Yercaud hills in the eastern Ghats of Tamil Nadu, India. Anc Sci Life, 2011; 30: 104–9.
41. Sharma U, Bala M, Kumar N, Singh B, Munshi RK, Bhalerao S. Immunomodulatory active compounds from Tinospora cordifolia. J Ethnopharmacol, 2012; 141: 918–26.
42. R. Mehra, T. Naved, M. Arora, S. Madan, Standardization and evaluation of formulation parameters of Tinospora cordifolia tablet, J. Adv. Pharm. Educ. Res, 2013; 3: 440–449.
43. George, L. Josepha, M. Mathew, A research on screening of learning and memory enhancing the activity of whole plant extract of Tinospora cordifolia (Willd), Pharma Innovation, 2016; 5: 104–107.
44. Duraipandiyan, S. Ignacimuthu, K. Balakrishna, N.A. Aaharbi, Antimicrobial activity of Tinospora cordifolia: an ethnomedicinal plant, Asean J. Trad. Knowledge, 2012; 7: 59–65.

45. Jeyachandran, T.F. Xavier, S.P. Anand, Antibacterial activity of stem extracts of Tinospora cordifolia (willd) hook, Anc. Sci. Life. Res, 2003; 25: 40–43.
46. Allemailem, A. Almatroudi, M.A. Alsahli, A. Khan, M.A. Khan, Tinospora cordifolia aqueous extract alleviates cyclophosphamide-induced immune suppression, toxicity and systemic candidiasis in immunosuppressed mice: in vivo study in comparison to antifungal drug fluconazole, Curr. Pharmaceut. Biotechnol, 2019; 20: 1–5.
47. Anonymous, the Ayurvedic Pharmacopoeia of India. Part I. first ed.. Vol. 1, Department of AYUSH, Ministry of Health and FW, New Delhi, 2001; 53-55.
48. P. Sudha, S. Zinjarde, S.Y. Bhargava, A.R. Kumar, Potent α-amylase inhibitory activity of Indian ayurvedic medicinal plants, BMC Complement Altern. Med, 2011; 11: 1–10.
49. A.D. Chougale, V.A. Ghadyale, S.N. Panaskar, A.U. Arvindekar, Alpha-glucosidase inhibition by stem extract of Tinospora cordifolia, J. Enzym. Inhib. Med. Chem, 2009; 24: 998–1001.
50. M.B. Patel, S. Mishra, Hypoglycemic activity of alkaloidal fraction of Tinospora cordifolia, Pharma Innovation, 2016; 5: 104.
51. M.B. Patel, S.M. Mishra, Magnoflorine from Tinospora cordifolia stem inhibits α-glucosidase and its antiglycemic in rats, J. Funct. Foods, 2012; 4: 79–86.
52. M.M. Shivananjappa, M. Muralidhara, Abrogation of maternal and fetal oxidative stress in the streptozotocin-induced diabetic rat by dietary supplements of Tinospora cordifolia, Phytomedicine, 2011; 18: 1045–1052.
53. D. Singh, P.K. Chaudhuri, Chemistry and pharmacology of Tinospora cordifolia, Nat. Prod. Commun, 2017; 12: 299–308.
54. Umamaheswari, S.P. P Mainzen, Antihyperglycemic effect of 'Ilogen-Excel,' an ayurvedic herbal formulation in streptozotocin-induced diabetes mellitus, Acta Pol. Pharm, 2007; 64: 53–61.
55. S. Babu, P.P.M. Stanely, Antihyperglycaemic and antioxidant effect of hyponid, an ayurvedic herbo mineral formulation in streptozotocin induced diabetic rats, J. Pharm. Pharmacol, 2004; 56: 1435–1442.
56. S.S. Patel, R.S. Shah, R.K. Goyal, Antihyperglycemic, antihyperlipidemic, and antioxidant effects of Dihar, a polyherbal ayurvedic formulation in streptozotocininduced diabetic rats, Indian J. Exp. Biol, 2009; 47: 564–570
57. P.P.M. Stanely, V.P. Menon, G. Gunasekharam, Hypolipidaemic action of Tinospora cordifolia roots in alloxan-induced diabetic rats, J. Ethnopharmacol, 1999; 64: 53–57.

58. R. Verma, H.S. Chaudhary, R.C. Agrawal, Evaluation of antcarcinogenic and antmutagenic effect of Tinospora cordifolia in experimental animals, J. Chem. Pharm. Res, 2011; 3: 877–881.
59. R. Mishra, G. Kaur, Aqueous ethanolic extract of Tinospora cordifolia as a potential candidate for differentiation based therapy of glioblastomas, PLoS One, 2013; 8: e78764.