

Table 1: Pharmacological activities of different extracts/compounds from different parts of *Nyctanthes arbor-tristis*

Plant part	Plant parts	Extracts/ pure compounds	<i>In vitro</i> / <i>In vivo</i> study	Geographical area of study	Studies undertaken	References
Antiviral activity	Seeds	n-Butanol fraction of 50% ethanolic extract, Arbortristoside A and Arbortristoside C	<i>In vitro</i> & <i>In vivo</i> [Swiss albino mice]	Lucknow, India	arbortristoside A [Iridoid glycoside] possesses antiviral activity against enveloped virus V]	[20]
	Leaves	Ethanolic	<i>In vivo</i> [Swiss albino Rats]	Tamilnadu, India	Both cellular and humoral immunity stimulation was reported. Elucidation of exact mechanism is in progress	[21]
Immunostimulatory activity	Leaves	Aqueous	<i>In vivo</i> [Swiss albino male mice]	South western ghats of Tirunelveli, Tamilnadu, India	Flavonol glycoside of <i>N. arbor</i> influences humoral nad cell mediated immune system of mice. Mechanism of immunomodulatory and probable use in immunocompromised individuals are to be investigated	[22]
	Leaves	Water soluble fraction	<i>In vivo</i> [Fish]	Madurai, Tamilnadu, India	Significant enhancement of immunity observed in finfish. Investigation on active compound identification and appropriate field trials need to be ascertained for prolonged use at large scale application	[23]
	Seeds	Methanolic	<i>In vivo</i> [Fish]	Chennai, India	Possess potent Immunostimulatory and disease protective properties and can be used in aquaculture but after conducting field trials on different fish spp.	[24]
Anti-inflammatory activity/ Analgesic	Whole plant	80% methanolic	<i>In vivo</i> [Albino Wistar rats]	Ahemdabad, India	Extract showed acute and sub-acute anti-inflammatory potential, Exact underlying mechanism of action and long term toxicity are need to be explored	[25]
	Leaves	β -Sitosterol isolated from Petroleum ether extract	<i>In vivo</i>	Ahmednagar, India	β -Sitosterol exhibits analgesic and anti-inflammatory role which might be due to Suppression of	[26]

					formation of prostaglandins and Bradykinins	
	Stem Bark	Methanolic	<i>In vivo</i> [adult albino rats]	Shillong, India	Extract prevent the nociceptive component which may be cause of inhibition of prostaglandins and related products. Exact mechanism of action require to be study	[3]
	Leaves	95 % ethanolic	<i>In vivo</i> [albino rats and mice]	Meerut, India	Justified its use in various inflammatory conditions as per Ayurvedic system of medicine	[27]
	Leaves	90% ethanolic	<i>In vivo</i> [Rats]	Bhubaneswar, India	Showed promising result in acute model than chronic model. Further Human trials required to prove safety and efficacy for long term use	[28]
Cognitive impairment	Leaves	90% Ethanolic	<i>In vivo</i> [Albino male wistar rats]	Warangal, India	Showed acetylcholinesterase inhibitory activity, Studies are needed to ascertain mechanism of action	[29]
Ulcerogenic activity	Leaves	Water soluble	<i>In vivo</i> [Albino rats]	Meerut, India	Mechanism of action need to be established	[27]
Antipyretic	Leaves	Water soluble	<i>In vivo</i> [Albino rats]	Meerut, India	Showed antipyretic effect in various type of fevers	[27]
	Leaves, Seed, Flower, Stem and Root	50% ethanolic	<i>In vivo</i> [Balb/c mice]	Lucknow, India	Arbor-tristosides of ethanolic extracts of Seeds showed significant activity	[30]
	Leaves	Aqueous	<i>In vivo</i> [mice]	Patiala, Punjab, India	Can be applied as an anti-immunosuppressive agent.	[31]
Immuno-modulator/ Immunorestorative activity	Seeds	Chloroform	<i>In vivo</i> [Fish]	Madurai, India	Activity shown by phytosterols and alkaloids from chloroform extract. Separation and identification of these active compounds should be conducted further	[32]
	Leaves	95% Ethanolic, 50% hydro-alcoholic	<i>In vivo</i>	Lucknow, India	Aid in the recovery of malaria. This could be a subject of further investigation for combinatorial antimalarials	[33]

Antiarthritic activity	Leaves, Stem	Ethanollic	<i>In vivo</i> [Male albino wistar rats]	Coimbtore, Tamilnadu, India.	Leaves showed better activity comparative to stem extract. Further, compound responsible for activity need to be isolated as a modern drug	[34]
	Fruits, Seeds and Leaves	Water soluble ethanolic extract	<i>In vivo</i> [Female Balb/c mice]	Lucknow, India	Leaves and Fruits extracts proven to be antiarthritic	[35]
	Leaves	95% ethanolic	<i>In vivo</i> [Wistar albino rats]	Mandsaur, India	Active toxicity constituents is to be isolated and underlying mechanism of action to be studied	[36]
	Leaves	Ethyl acetate	<i>In vivo</i> [Sprague Dawley rats]	Punjab, Lahore	Isolation of responsible phytoconstituents and confirmation of antiarthritic activity is required	[37]
Hepatoprotective activity	Bark	-	-	-	Hepatoprotective effect shown	[38]
	Leaves	Water soluble fraction of 70% ethanolic extract	<i>In vivo</i> [Wistar rats]	Ahmednagar, India	Leaves are found to be hepatoprotective agent. Work going on to isolate active component responsible for hepatoprotective action	[39]
	Flower	Ethanollic and Aqueous	<i>In vivo</i> [Wistar rats]	Buldhana, India	Probable mechanism of action was proposed against CCl ₄ -induced liver toxicity. Active component responsible for hepatoprotection need to be isolated and synthesized for pharmaceuticals	[40]
	Leaves	Methanollic	<i>In vivo</i> [Albino wistar rats]	Mumbai, India	Hepatoregenerative potential exhibited by protecting against membrane fragility and preventing the decline of glutathione level	[39]
Antibacterial activity	Flower	Petroleum ether, Chloroform and Ethyl acetate extracts	<i>In vitro</i>	Rajshahi district, Bangladesh	Chloroform and Ethyl acetate extracts showed effective activity	[41]
	Leaves	Methanollic	<i>In vitro</i>	Gujarat, India	Showed significant activity against <i>Staphylococcus epidermidis</i> and <i>Salmonella paratyphi A</i>	[42]
	Leaves,	Ethyl acetate and	<i>In vitro</i>	Vellore,	Both the extracts showed better	[43]

Flower, Fruits and Seeds	Chloroform extracts		Tamilnadu, India	efficacy for gram negative bacteria than gram positive.	
Leaves	Ethanollic	<i>In vitro</i>	Madurai, India	Maximum antibacterial activity exhibited and so this extract would become a part of study for bioactive drug development	[44]
Stem bark	Petroleum ether, Chloroform and Ethanol extracts	<i>In vitro</i>	Sonipat, India	Chloroform extract showed significant activity	[45]
Root barks	Aqueous, Ethanollic, Petroleum ether and Chloroform extracts	<i>In vitro</i>	Bhopal, India	Showed significant bacterial activity	[46]
Leaves and Bark	-	<i>In vitro</i>	Morang district, Nepal	Potential antimicrobial activity reported	[47]
Flower	Ethanollic extract	<i>In vitro</i>	Manipal, India	Moderate activity exhibited	[48]
Leaves	Ethanollic, Methanollic, Petroleum ether and Aqueous extracts	<i>In vitro</i>	Jaipur, India	Petroleum ether extract exhibited significant antimicrobial activity against tested pathogens	[49]
Whole plant material	Aqueous, Ethanol, Benzene, Petroleum ether and Chloroform extracts	<i>In vitro</i>	Dehradun, India	Broad spectrum antimicrobial activity against a panel of bacteria	[50]
Fruit	Petroleum ether and Methanollic extracts	<i>In vitro</i>	Nasik, India	Methanollic extract showed better antibacterial activity	[51]
Leaves	Ethanollic	<i>In vitro</i>	West Bengal, India	Showed moderate activity against <i>S. aureus</i> . Hence, active bio-active compounds need to be isolate and also checked for <i>in vitro</i> and <i>in vivo</i> toxicity	[52]
Flower	Alcoholic extract utilized for synthesis of silver nanoparticles	<i>In vitro</i>	Guwahati, Assam	Showed antibacterial and cytotoxic activities	[53]

Antidiabetic activity	Bark	Ethanollic	<i>In vivo</i> [Male Wistar Albino rats]	Namakkal, Tamilnadu, India	Showed Safe and strong activity	[54]
	Leaves	50% Ethanollic	<i>In vivo</i> [Sprague-Dawley rats]	Tamilnadu, India	Antidiabetic effect is possibly due to the antioxidant compounds present in the extracts which neutralizes the oxidative stress in diabetic condition	[55]
Antidiarrheal activity	Bark	80% methanollic	<i>In vitro</i>	Odisha, India	Cure of dysentery	[56]
Antifilarial activity	Leaves	Ursolic acid	<i>In vitro</i>	West Bengal, India	May serve as a promising agent in the treatment of <i>Bancroftian filariae</i>	[57]
Antimalarial activity	Leaves, Fruits	99% ethanollic	<i>In vitro</i>	Thiruvanthapuram, India	Leaves extract showed effective activity against malaria	[58]
	Flower	[Ethanollic] Rengyolone 1 and its acetate derivative	<i>In vitro</i>	Nakorn Pathom, Thailand	Possessed antiplasmodial activity. This compound further need to be studied <i>in vivo</i> for its pharmaceutical approach	[59]
	Stem bark, Leaves, Root, Seed, Flower	50% ethanollic	<i>In vitro</i> and <i>In vivo</i> [Mouse]	Lucknow, India	Leaves extract showed both <i>in vitro</i> and <i>in vivo</i> activity whereas root and seed extracts showed only <i>in vitro</i> but not <i>in vivo</i>	[60]
	Leaves	Herbal Formulation preparation [250mg powder/5 ml suspension]	<i>In vivo</i> [Human trial]	Maharashtra, India	Excellent improvement in the vital signs of malaria within first week of treatment. This may prove beneficial in the long run	[61]
	Leaves	Fresh paste of leaves	<i>In vivo</i> [Human trial]	Mumbai, India	Showed significant activity against malaria and good tolerability. A standardized formulation need to be prepared	[62]

	Leaves	Ethanollic	<i>In vitro</i>	New Delhi, India	Hypothetically leaves of this plant possess the said activity because of iridoid glycosides present in leaves. Further continuous investigation to be done for new anti-malarial drug discovery	[63]
	Seed-kernel	Iridoid glucosides	<i>In vitro</i>	Guwahati, India	Showed adverse effect on parasite redox homeostatic	[64]
	Leaves	Fresh preparation of leaves paste	<i>In vivo</i> [Human trial]	Mumbai, India	Formulated paste showed potential effect in patients. Further in depth studies required to develop standardized pharmaceutical	[65]
Anti-leishmanicidal activity	Seeds	Iridoid glucosides	<i>In vivo</i> [Male golden hamsters] and <i>In vitro</i>	Lucknow, India	Proved to be leishmanicidal agents	[66]
Anti-trypanosomal activity	Leaves	50% ethanolic	<i>In vitro</i> and <i>In vivo</i> [Swiss mice]	Howrah, India	Significant activity observed	[67]
Larvicidal activity	Leaves, bark, roots and seeds	Petroleum ether, Chloroform and Methanolic	-	Pondicherry	Not much effective activity reported	[68]
	Leaves, Roots	Chloroform, Dichloromethane and Methanolic	-	Jalgaon, India	Methanolic extract showed more effective than other extracts against mosquitos vector species. Could be a safe botanical insecticide	[69]
Anti-fungal activity	Leaves	β -sitosterole and Calceolarioside compounds from 50% ethanolic extract	<i>In vitro</i>	Allahabad, India	Showed effective anti-Malassezia activity. Could be a plant based antifungal formulation.	[70]
	Flower	Zinc oxide nanoparticles synthesized using aqueous extract	<i>In vitro</i>	Murthal, India	Could be commercialize as an antifungal agent for agriculture purpous	[71]

Antispermato-genic effect	Bark	70% Methanolic	<i>In vivo</i> [Adult male albino rats]	Jaipur, India	Showed suppression of the spermatogenesis	[72]
Antistress activity	Fruit	Water soluble fraction of 50% ethanolic extract	<i>In vivo</i> [Adult albino rats]	Lucknow, India	It reversed the stress induced biochemical changes	[73]
Anti-ulcerogenic activity/ Ulcer healing property	Seeds	Arbortristiside-A and 7-O-trans-cinnamoyl-6 β -hydroxyloganin	<i>In vivo</i> [Rats]	Lucknow, India	Showed prevention of ulcer and ulcer healing property	[74]
Anxiolytic activity	Leaves	50% Ethanolic	<i>In vivo</i> [Adult albino rats]	Amethi, India	Significant dose related anxiolysis caused by extract	[75]
Bronchodilatory effect	Leaves	80% Ethanolic	<i>In vivo</i> [Guinea Pigs]	Dhaka, Bangladesh	Showed direct relaxant effect. Development of new drug [bioactive molecule] for the treatment of asthma need to be study from ethanolic extract	[76]
Hypoglycemic and and hypolipidemic activity	Flower	Aqueous	<i>In vivo</i> [Adult male mice]	Srilanka	Proven to be safe for oral consumption that elicits promising hypoglycemic and hypolipidemic activity. Active principle requires in future investigation	[1]
Wound healing activity	Leaves	Methanolic	<i>In vivo</i> [Wistar albino rats]	Vidisha, India	Folklore claim of wound healing property was justified.	[77]
Tumor necrosis factor Depleting activity	Leaves	Ethanolic	<i>In vivo</i> [Male Balb/c mice]	Lucknow, India	It could be useful in inflammatory rheumatic disease, inflammatory bowel disease, improvement in cardiac function in patient with septic shock, might help in problem associated with exogenous TNF administration in different carcinomas.	[78]
Membrane stabilizing activity	Tubular calyx of flowers	Croctin [A carotenoid aglycone]	<i>In vitro</i>	Thane, India	Represented good membrane stabilizing activity	[79]
Commercial application	Flower corolla	Aqueous	-	Amravati, India	Eco-friendly, dyeing and painting agent on silk and cotton	[80]

Other biological activities						
1. Prevention of initial Lung injury	Leaves	Water soluble fraction of ethanolic extract	<i>In vivo</i> [Male Swiss mice]	Lucknow, India	Showed bypassing of silica induced initial lung injury	[81]
2. Tranquilizing, antihistaminic and Purgative activity	Leaves	Water soluble portion of alcoholic extract	<i>In vivo</i> [Albino rabbits]	Meerut	Showed the presence of activity	[82]
3. Therapeutic efficacy against Caecal amoebiasis	Leaves, Stem, Flowers, Seeds and Roots	Ethanolic extracts and fractions	<i>In vitro</i> and <i>In vivo</i> [Rats]	Lucknow and Dehradun	Efficacy against <i>In vivo</i> but lack of amoebicidal activity <i>in vitro</i>	[83]
4. Stimulation of Acetylcholinesterase activity	Leaves, Flowers	Aqueous	<i>In vivo</i> [Swiss albino mice]	Patiala, India	Adverse effect of malathion on Acetylcholinesterase enzyme activity could be antagonized	[84]
5. Mast cell stabilizing and bronchodilatory activity	Bark	Petroleum ether, chloroform, ethylacetate and ethanolic extracts	<i>In vivo</i> [Male Swiss mice]	Ahmednagar. India	Petroleum ether extract of bark showed mast cell stabilizing and potent bronchodilatory effects. Further investigation on active molecule and its toxicity should be conducted before developing into proper drug.	[85]
6. Bio-medical application	Flower	Ethanolic extract used in synthesis of gold nanoparticles	<i>In vitro</i>	Guwahati, [Assam] India	Potential source of reducing agent as gold nanoparticles synthesized successfully which may have application in Contrasting agent in bio-imaging, may cross the cytotoxicity barrier	[86]
	Seeds	Aqueous	-	Howrah, West Bengal	Low cost and abundance makes seed extract a potential source of nano- materials to explore its various catalytic and biomedical application	[87]
7. Inhibition of mild steel corrosion	Leaves	Acid extract	-	Tamilnadu, India	Leaves are good corrosion inhibitors	[88]