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Review on *Khadira* (*Acacia catechu* Willd.) with special reference to *Prameha* (Diabetes)

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Abstract

Prameha (Diabetes) is one amongst the refractory disease conditions recognised by medical scholars of ancient India. The prevalence of diabetes is increasing globally with a rise from about 30million in 1985 to 177 million cases in 2000 and worldwide estimates project that more than 360 million people will be suffered diabetes by the year 2030. There are many ayurvedic formulations, herbs, minerals available for treatment of *Prameha*. *Khadira* is an important medicinal plant used in ayurvedic formulation and also well documented in Indian pharmacopeia. Ayurvedic classics texts mentioned *Khadira* in treatment of *Prameha* due to its dominance of *Tikta*, *Kashayarasa*, *Katuipaka* and *Laghu*, *Rukshaguna* and *Kaphashoshan* (Absorption of Kapha), *Shophhara* (Anti-inflammatory), *Vranaropan* (Wound healing), *Medohara* (Anti-obesity) actions. Modern research shows that *Khadira* possesses Flavonoids, Saponins and Alkaloids which work against diabetes. This review gives detail information regarding importance and role of *Khadira* in treatment of *Prameha*.

Keywords: *Khadira*, *Acacia catechu*, *Prameha*, diabetes

1. Introduction

Khadira belongs to familyfabaceae which is also called pea family or legume family due to presence of single chambered legume in all species of this family. *Acacia catechu* is a small to moderate sized plant widely distributed throughout Asia^[1]. The main origin of this plant is Pakistan, India, Thailand and Bangladesh^[2]. It contains polyphenolic compounds, tannins, alkaloids, carbohydrates, flavonoids and seeds of this plants are good source of protein. Catechin present in this plant plays a vital role as anti-oxidant. *In vivo* catechins are extensively and rapidly metabolized and impart to its anti-oxidant property^[3]. *Khadira* is use in *Vatajkasa* (Dry cough), *Krumikushtha* (useful in skin diseases), *Raktapitta* (Urticaria), *Vranashodhan* (useful in wound), *Mukharoga* (useful in mouth disease), *Dantaroga* (beneficial for teeth), *Sthavarvishprativish* (useful in poisoning), *Swarbheda* (useful in horseness of voice), *Visfota* (beneficial for skin disease)^[4]. *Khadira* is used in Ayurveda in treatment of diabetes. *Khadira* has multi targeted effects on various physiological system of human body^[5]. During the intense search in classical texts of Ayurveda, it is found that *Khadira* is one the common drug has *Pramehaghna* (Anti-Diabetic) property And *Acacia catechu* showed its wide acceptance as an anti-diabetic effect. This review gives detail information about mode of action of *Acacia catechu* in *Prameha* (Diabetes), Its formulations in *Prameha chikitsa* (Treatment of Diabetes), Chemical compositions and Pharmacological actions which are works against Diabetes.

2. Prameha Samprapti (Pathophysiology)

In Ayurveda, *Prameha* is the condition caused by impairment of *Kapha Dosha* and *Jala Mahabhoota* ie. Disturbed metabolism of water compartments in body giving laxity in body tissues especially in fats, muscle tissues giving them *Abadhha* (lax or hypotonic) and *Asamhat* (not compact or loose) consistency. *Kapha Dosha* vitiation mainly hampers fat or lipid metabolism leading formation of *Kleda* (tissue waste products in liquid form dampening the body tissues). Excessive formation of *Kleda*, excessive evacuation of this *Kleda* in form of profuse, cloudy urine '*Prabhut Avil Mutrata*' is cardinal symptom described. This excess *Kleda* bring *Shaithilya* in surrounding tissues like muscles, lymph, marrow, semen, fat and in advance stage putrefy them. Therefore these tissues are considered as *Dushya* or target tissues of *Prameha*. Formation *Kleda*, disturbed lipid metabolism are key points in pathophysiology of *Prameha* although all three *Dosha* are involved in process^[6].

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3. Rasapanchaka of Khadira ^[7]

Rasa: Kashaya, Tikta

Vipaka: Katu

Veerya- Sheet

Guna: Laghu, Ruksha

Prabhav- Kushdhaghana (Useful in skin diseases).

Doshghnata- Kaphapittshamak

Karma – Vranaropak, Shophahar, medoghna, Pramehaghna.

4. Botanical Description of Khadira

Acacia catechu willd. Is also known as black catechu. Word acacia came from Greek word 'thrones' meaning 'point or a barb'. The species name is derived from word 'cutch' which is tanning extract obtained from heartwood of acacia catechu ^[8].

5. Khadira in Pramehachikitsa

The formulations of Khadira are described in ayurvedic classics as following

5.1 Charaka Samhita: Khadira described in *Kushtagna mahakashaya* and *Kashayskandha* ^[9].

Table 1: Table showing formulation of Khadira in Charaka Samhita.

Preparation	Diseases	Reference
1. khadira kwatha	Kaphaja Prameha	Charak Samhita Chikitsastana 6/28
2. Trikantkadi Sneha	Vataja Prameha	Charak Samhita Chikitsastana 6/38
3. Sarodaka	Prameha	Charak Samhita Chikitsastana 6/46

5.2 Sushruta samhita: Arjuna described in *Salsaradigana* ^[10].

Table 2: Table showing formulation of Khadira in Sushruta Samhita.

Preparation	Diseases	Reference
1. Khadira kwatha	Shanaimeha	Sushruta Samhita Chititsastana-11/8
2. Khadira kwatha	Kshodrameha	Sushruta Samhita Chititsastana -11/9
3. Salsaradileha	Prameha	Sushruta Samhita Chititsastana -13/10
4. Loharishta	Prameha	Sushruta Samhita Chititsastana -13/12

5.7 Bhaisajyaratnavali: Khadira described as below ^[15].

Table 7: Table showing formulation of Khadira in Bhaisajyaratnavali.

Preparation	Diseases	Reference
Khadira kwatha	Kaphaja Prameha	Bhaishajya Ratnawali-Pramehadhikara/20
Khadira kwatha	Shanaimeha	Bhaishajya Ratnawali- Pramehadhikara /27
Kadaradikwatha	Kshodrameha	Bhaishajya Ratnawali- Pramehadhikara /32

5.8 Yogratnakara: In this, Khadira is mentioned as *Pramehagha dravya* ^[16].

5.9 Nighantu

Bhavprakash Nighantu- Khadirais described as a *Medoghna (anti-obesity)* and *Mehaghna (anti-diabetic) dravya* ^[17].

Raj Nighantu – Khadirais described as *Kaphghna, Shophhara (anti-inflammatory)* and *Vranashodhana (wound healing) dravya* ^[18].

Kaidev Nighantu - Khadirais mentioned as *Kaphaghna, Shophghna (anti-inflammatory), Meahar (anti-diabetic)* and *medohar (anti-obesity) dravya* ^[19].

Shodhal Nighantu – Khadirais explained as *Medoghna (anti-obesity)* and *Mehaghna (anti-diabetic)*.

5.3 Ashatanghridayam: Acharya Vagbhata described *Khadira* in *Salsaradi gana* ^[11].

Table 3: Table showing formulation of Khadira in Ashtanghridayam.

Preparation	Diseases	Reference
1. Khadira kwatha	Kaphaja Prameha	Ashtang Hridaya Chikitsastana 12/7
2. Khadira kwatha	Prameha	Ashtang Hridaya Chikitsastana 12/18
3. Khadira churna	Prameha	Ashtang Hridaya Chikitsastana 12/42
4. Khadira kwatha	Prameha	Ashtang Hridaya Chikitsastana 12/31

5.4 HaritaSamhita ^[12]

Table 4: Table showing formulation of Khadira in Harita Samhita.

Preparation	Diseases	Reference
khadirakwatha	Prameha pidaka	Harita Samhita Tritiyasthana -28/26
khadirakwatha	Prameha	Harita Samhita Tritiyasthana 28/33
Khadira kwatha	Prameha	Harita Samhita Tritiyasthana 28/44

5.5 Chakradatta: Khadira has been described in different formulation to treat various disorders. Reference of Khadira in *Prameha* are mentioned below ^[13].

Table 5: Table showing formulation of Khadira in Chakradatta.

Preparation	Diseases	Reference
Khadira kwatha	Madhumeha	Chakra Datta-33/13
Khadira kwatha	Pramehapidaka	Chakra Datta-33/49

5.6 Bhavprakash: Khadira has been described in the form of various preparations which are indicated for *Prameha* treatment ^[14].

Table 6: Table showing formulation of Khadira in Bhavprakash.

Preparation	Diseases	Reference
Khadira kwatha	Prameha	Bhavprakash Madhyam Khand.-38/44
Khadira kwatha	Prameha	Bhavprakash Madhyam Khand-38/46
Khadira kwatha	Prameha	Bhavprakash MadhyamKhand -38/108

Dhanvantari Nighantu: Khadirais described as a *Kaphaghnadravya* ^[20].

6. Chemical constituents ^[21]

Bark- Glycosides: Poriferasterol, poriferasterol acylglucosides, Tannins: Gallic acid, d-rhamnose, Sugars: D-galactose, and l-arabinose, phlobatannins., Triterpenoids, Bitter principle.

Heartwood: Flavanoids- Epigallocatechin, epicatechingallate, Catechin (-) epicatechin, epigallocatechingallate, rocatechin, phloroglucinol, procatechuic acid, catecutannic acid, quercetin.

Leaves -Alkaloids: Kaempferol, dihydrokaempferol, taxifolin, (+)-afzelchin gum.

Fruit- Fruit a strap-shaped pod, 5-8.5 cm x 1-1.5 cm, flat, tapering at both ends, shiny, brown, dehiscent, 3-10 seeded; seeds broadly.

7. Mode of Action of *Khadira* In *Prameha*

The diseases *Prameha* defined in classics as the *Kaphavata* predominance. Even though all three *Dosha* are involved in the *Prameha* manifestation, the *Vata* predominance is understood with hypo functioning of *Agni (Mand)* or *Vishmagni* [22]. This improper *Agni* influence the *Kapha* and *Aam* production into the body. Further, due to unwholesome diet and regimen (*Apathyaaharavihara*) *Kapha*, *Mamsa*, *Meda* get aggravated and cause the obstruction. (*Margavarodha*) *Khadira* with *Kashayarasa* clears the channels due to *kaphashoshan* (Absorption of *kapha*) as well as decreases the *Kleda*. *Katuvipaka* helps to increase the digestion. Thus it stimulates the *Jatharagni* and regularizes the *Mandagni* which is the main cause of *Prameha*. *Laghu* and *Ruksha* guna clears the *Mala*, *Kleda* from *strotas* and alleviates. So the *Khadira* is capable of correcting the *Dhatuvitiatisation (Saithilyata)*. Due to *Kashaya* rasa, sheet *Veerya* and *Ruksha* guna, it acts as *sthambhaka* hence performs *Mutrasangrahanikarma* ie. Reduces the amount of *Mutra* thus restore the normal *Ambu*. *Khadira* has '*Tikta*' rasa in addition to *Kashayarasa*. *Tiktarasa* has predominance of *Akasha* and *Vayumahabhoota*. So it has ability of permeate to *sushmastrotas*. Due to this drug can reach at cellular level and help to reduce *meda* and *Kleda*. Thus, helps in breakdown of *Pramehasampranti* and reduces related symptoms [23]. Many times diabetes existed along with obesity and diabetic wound. Properties of *Khadira* like *Pramehaghna* (Anti-diabetic), *Mehaghna* (Anti-obesity) and *Vrana ropan* (wound healing) properties are well explained in ayurvedic classics.

8. Relation between chemical compositions and *Prameha*

Flavonoids: It is important antioxidant and promotes several health effects. Flavonoids in Diabetes usually alternate the diabetes treatment by reducing the aldose reductase, regenerating the pancreatic cells, enhancing insulin release and increasing calcium ion uptake [24]. The role flavonoids are quite important in fighting with complications of diabetes mellitus than any other method of treatment [25]. Also, Flavonoids stimulated glycogen synthesis in rats soleus muscle through mechanisms well known to insulin signal transduction [26].

Saponins- Saponins have been found having Pharmaceutical properties of anti-inflammatory, anti-fungal, anti-bacterial, antiviral and anti-diabetes. In the aspect of anti-diabetes, saponins activates AMPK in a calcium-dependent manner, thus regulating gluconeogenesis and glucose uptake. Saponins effectively alleviated hyperglycemia in diabetic rats by up-regulating the expression of glucose transporter type 4 (GLUT4) while down-regulated the expression of G6P in insulin signal pathway [27].

Triterpenoids- The therapeutic approach of Triterpenoids to treating DM is to decrease postprandial glucose levels. It can be achieved through the inhibition of α -glucosidases and α -amylases which delay the absorbance of carbohydrates in postprandial insulin level [28].

Bitter principle- Compound stimulate peripheral and skeletal muscle glucose utilization and inhibites intestinal glucose

uptake and shows hypoglycemic effect [29].

9. Research on Pharmacological Actions of *Khadira*

9.1 Anti-oxidant activity

As the *Khadira* contain many potent flavonoids such as catechin present in this plant plays a vital role as anti-oxidant. Catechins and rutin are most importance constituents which are free radical scavengers. Anti-oxidant principles of *Acacia catechu* Willd were analysed by Dot-blot assay and quantitative analysis by DPPH radical scavenging assay which ascorbic acid as standard [30, 31].

9.2 Anti-diabetic activity

In type 2 diabetes, insulin is secreted in lesser amounts than required, thus causing much of the sugars to remain in the blood stream. *Acacia* also increase the level of beta cells, thus encouraging them to secrete more insulin. This is helpful for type 2 diabetes mellitus. It is also help to lose body weight. Its adrenergic amine content stimulates beta-receptors to break down the lipids in the body. This, in turn, enhances the rate of metabolism as cholesterol is broken down and hunger is curbed [32].

9.3 Anti-hyperlipidemic activity

In eastern traditional medicine *Acacia catechu* Willd is extensively used in management of diabetes in combinations with other medicinal plants. Polar as well as non-polar components of *Acacia catechu* Willd shown hypoglycaemic activity. Hypoglycemic activity of extract of *Khadira* (*Acacia catechu* Willd) is assumed to be due to the presence of flavonoids which also show inhibition of cyclooxygenase and regenerate β cells. In an experiment, ethyl acetate extract of *Acacia catechu* Willd at a concentration of 500mg/kg/day used for 7 days, significantly decreases blood glucose level of normal as well as alloxan induced diabetic albino rats but it was not effective as that of standard drug. Studies show that myricetin, quercetin and catechin-gallate inhibit insulin stimulated glucose transporters in cells [33].

9.4 Anti-obesity activity

The bark of *Acacia catechu* Willd family Fabaceae, maintains healthy fat metabolism and reduces the conversion of carbohydrates to fats. In studies of rats fed on a diet containing cholesteryloleate, betel nut extracts significantly lowered cholesterol and triglycerides [34].

Diabetic wound healing property

9.5 Wound healing property

Crushed bark of *acacia catechu* is used topical on wounds as it is very potent wound healing medicinal plant. It has astringent effect and also cause precipitation of skin which makes it very good wound healing plant. Furthermore it also exhibits antimicrobial property which prevent growth of microbes on wounds. This property is due to presence of tannins, flavonoids and other active ingredients [35].

9.6 Antibacterial activity

Khadira (*Acacia catechu* Willd) heartwood extract is found to be an effective antibacterial agent. A study conducted in ethanolic and aqueous heartwood extract of *Khadira*, proved its efficacy as a potent anti-bacterial agent. Taxifolin present in heartwood of *Khadira* is found to be responsible for its antibacterial effect. *In vitro*, *Acacia catechu* Willd is reported to have broad spectrum antimicrobial and antifungal activity. Phytochemical studies of *Khadira* leaves shows the presence

of alkaloids, carbohydrates, flavones, glycosides, phenolic compounds, saponins, steroids and tannins which may be responsible for its antimicrobial activity. Its Methanolic extract having antimicrobial activity against pathogenic as well as non-pathogenic bacteria e.g. *Bacillus subtilis*, *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*. It is effective against gram positive as well as gram negative bacteria [36].

9.7 Antifungal activity

Ethanol extract of Heartwood of *Acacia catechu* Willd was tested for antifungal (antimycotic) activity against *Candida albicans*, *Aspergillus Niger*, *Aspergillus fumigates*, *Mucor* spp and *Penicillium marneffei*. Disc diffusion technique was followed for screening antifungal activity. The discs were loaded with 50µl of ethanolic extracts at different concentrations [25ug/disc, 250ug/disc and 500ug/disc]. Positive controls used were fluconazole (10mcg/disc) and amphotericin B (100 units/disc). After incubation at 28 °C for 48 hours, the zone of inhibition was measured. The extract at different concentrations showed varying degree of antifungal activity against the micro-organisms tested compared to standard. Assay was conducted to check antifungal activity of the aqueous and methanol extract of *Acacia catechu* Willd against fourteen human pathogenic fungi using agar disc diffusion method. The methanol extract of *Acacia catechu* Willd was established most promising, and found active against *Candida*, *Dermatophytes* and *Aspergillus* species therefore stressing the need to locate the active principle [37].

9.8 Anti-microbial activity

In vitro *Khadira* (*Acacia catechu* Willd) is reported to have broad spectrum anti-microbial and antifungal activity. Phytochemical studies of *Acacia catechu* Willd leaves shows the presence of alkaloids, carbohydrates, flavones, glycosides, phenolic compounds, saponins, steroids and tannins which may be responsible for its anti-microbial activity. Its Methanolic extract of has Anti-microbial activity against pathogenic as well as non-pathogenic bacteria e.g *Bacillus subtilis*, *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*. It was found to be most effective against *Staphylococcus aureus* with about 20mm zone of inhibition at minimum bactericidal concentration (MBC) of the crude extract 1,000 lg/ml. Experiments shows that anti-microbial activity of *Khadira* (*Acacia catechu* Willd) depends on nature of solvent used for extraction, thus organic solvents used in extraction of leaves are most effective than any other [38].

9.9 Anti-inflammatory properties

The chief major active chemical components of *Khadira* (*Acacia catechu* Willd) are flavonoids which inhibit Cyclooxygenase and 5-Lipoxygenase and hence decrease inflammation. Mixed extract of *Scutellaria baicalensis* and *Acacia catechu* inhibit Prostaglandin E2 generation in human osteosarcoma cells which express COX-2, and leukotriene production is also inhibited in human cell lines, immortalized THP-1 monocyte and HT-29 colorectal adenocarcinoma. Baicalin from *Scutellaria baicalensis* and catechin from *Acacia catechu* Willd are responsible for dual inhibition of Cyclooxygenase and 5-Lipoxygenase. Baicalin and catechin are found to inhibit COX1, COX2 and 5-LOX. Baicalin also down regulates the expression of cytokines and PGE2, nitric oxide formation, and neutrophil invasion in a carrageenan-induced paw edema model [39].

10. Conclusion

Due to *Kashayarasa*, *Katuvipaka*, it shows *kaphashoshan* property (Absorption of kapha), Clears the channels by reducing obstructions, and improves the hypo functioning of *Agni*. Due to *tikta rasa* *Khadira* shows *Aampachan*, *Angnideepana* and *Srotoshodhana* properties. So it is useful in *Prameha*. Main chemical constituents of *Acacia catechu* are Flavonoids, Tannins, Saponins, Alkaloids, Glycosides which shows anti-diabetic activity. *Khadira* has been shown to possess multifarious medicinal properties such as Anti-oxidant, Anti- hyperlipidemic, Anti-diabetic, Anti-obesity, Wound healing property, Analgesic activity, Antifungal activity, Anti-inflammation activities which are help against Diabetes. With anti- diabetic activity, *Khadira* also screened for effective in diabetes associated with obesity and diabetes Wound. We hope this review article will help the scientists working of *Khadira* in the area of traditional medicines against Diabetes.

11. References

1. Karnam Chandra Shekhar. Essentials of Dravyaguna. Chaukhamba publication, Varanasi, 2016, 187.
2. Brijlal. Notes on Traditional uses of khair (*Acacia catechu*) by inhabitants of shivalik range in western Himalaya, Ethnobotanical leaflets. 2010; 1(1):109-112.
3. Theodore cooke, Flora of the Presidency of Bombay Vol-II. Chaukhamba Bharatipublication, Varanasi, 1902,541.
4. Priyavratasharma. Medicinal plants. Chaukhambha Bharati publication, Varanasi, 1995, 143.
5. Shrikanth N. Diabetes mellitus (Madhumeha) and Ayurvedic management: An evidence-based approach, World journal of pharmacy and pharmaceutical science, volume 4(8):881-892.
6. Shrutiphatak, Prameha hetu and sampraptivicharin today's context, international ayurvedic medical journal volume 5(11):4140-4147.
7. Gangasahay Pandey, Krushnachandra Chuneekar. Bhavprakasha Nighantu (Hindi translation). Chaukhamba Bharati Academy, Varanasi, 2010, 875.
8. VMGogate. Ayurvedic Pharmacopia and Therapeutic Uses of Medicinal Plants. Chaukhambha Bharati publication, 2010, 231.
9. Vidyadhar Shukla, Ravidatta Tripathi. Charaka Samhita (Hindi Translation). Chaukhambha Sanskrit Pratishthan, Delhi, 2005. 231.
10. Anant Ram Sharma. Sushrut Samhita (Hindi Translation). Chaukhambha subharti Prakashana, Varanasi, 2012, 543.
11. KavirajAtrideva Gupta. Ashtang Hridayam (Hindi Translation). Chaukhamba Prakashana, Varanasi, 2009, 231.
12. Rama valamba Shastri. Harit Samhita. Prachya Prakashana, Varanasi, 1985, 256.
13. Indradev Tripathi. Chakradatta Vidyotini. Chaukamba Sanskrit sanstana, Varanasi, 1994, 127.
14. Vidhyotini. Bhavprakash of shri Bhavmishra part II. Chaukamba Prakashana, Varanasi. 2011, 546.
15. Shastri RD. Bhaishajya Ratnavali. Chaukhambha Sanskrit sanstana, Varasani, 1993, 108.
16. Shree lakshmi patishashri. Yogratnakar. Chaukhambha Bharati Prakashan, Varanasi, 1986, 243.
17. Gangasahay Pandey, Krushna chandra Chuneekar. Bhavprakasha Nighantu (Hindi translation). Chaukhamba Bharati Academy, Varanasi, 1986, 210.
18. Bapalal G. Vaidya. Nighantu Aadarsh. Chaukhamba

- Bharati Academy, Varanasi, 2007, 234.
19. Priya Vrat Sharma. Kaiyadeva Nighantu (Hindi translation). Chaukhamba Bharati Academy, Varanasi, 1979, 654.
 20. Priya Vrat Sharma. Dhanvantari Nighantu (Hindi translation). Chaukhamba Orientalia, Varanasi, 1998, 234.
 21. Indradeo Tripathi. Raj Nighantu (Hindi translation). Chaukhamba Bharati Academy, Varanasi, 2003, 344.
 22. Veni Madhava Shastri Joshi. Ayurvediya shabdhakosha, *RajyaSahitya*, Sanskriti Mandal, Mumbai, 1968, 123.
 23. Theodore cooke, Flora of the Presidency of Bombay Vol-II. Chaukhamba Bharati publication, Varanasi, 1902, 541.
 24. Mohan S, Nandhakumar L. Role of various flavonoids Hypothesis on novel approach to treat diabetes, Iranian Journal of medicinal hypothesis and Ideas. 2014; 8(1):1-6
 25. Hussain SA. Flavonoids as alternative in treatment of type2 diabetes mellitus. 2013; 1(1):31-36
 26. Cazarolli LH. stimulatory effect of apigenin-6-C-beta-L-fucopyranoside on insulin secretion and glycogen synthesis, European Journal of Medicinal Chemistry. 2009; 44(11):4668-4673
 27. Lu JM. Antidiabetic effect of total Saponins from Polygonatum kingianum in streptozotocin-induced diabetic rats., Journal of Ethnopharmacology. 2015; 9(17):291-300
 28. Nazaruk J. the role of triterpenes in the management of diabetes mellitus and its complications, Phytochemistry reviews. 2015; 14(4):675-690
 29. Ming-junchen, phytochemicals for non-insulin diabetes mellitus: a minireview on plant-derived compounds hypoglycemic activity, Journal of food and nutrition sciences 2017; 5(2):23-27.
 30. Gayathri DV, Lanitha J, Devi R, Sreekala Prabhakaran VA. Pharmacognostical studies on Acacia catechu willd and identification of antioxidant principles. Int J of Pharmacy and Pharmaceutical Sci., 2011; 3(2): 108-11.
 31. Guleria S, Tiku A, Singh G, Vyas D, Bhardwaj A. Antioxidant Activity and Protective Effect Against Plasmid DNA Strand Scission of Leaf, Bark, and Heartwood Extracts from Acacia catechu. J of Food Science, 2011; 76(7):959-64. <http://www.diethealthclub.com/herbs-and-naturalcures/acacia.html>
 32. Edwin J, Siddheshwar BJ, Dharam JC. Biochemical study on the hypoglycaemic effects of extract and fraction of Acacia catechu willd in alloxan-induced diabetic rats. Int J Diabetes & Metabolism, 2009; 17(1):63-69.
 33. Pingale SS. Heptoprotection by Acacia catechu in CCL4 Induced Liver Dysfunction Int. J of Pharmaceutical Sciences Rev. and Res, 2010; 5(1): 150-154.
 34. Muhammad anis Hashmat. A review on Acacia catechu willd, Interdisciplinary journal of contemporary research in business, 2015;(1):593-59
 35. Lakshmi T, Anitha R. Geetha RV Acacia catechu willd - A gift from ayurveda to mankind – A Review. T. Ph. Res, 2011; 5(2): 273-93.
 36. TG N, Sarang S, Jambhale D. Evaluation of anti-mycotic activity of Acacia catechu willd. (Mimosaceae). J of Biopesticides. 2008; 1(2):197-198.
 37. Lakshmi T, Geetha RV, Roy Anitha. *In vitro* evaluation of antibacterial activity of heartwood extract of acacia catechu willd. International Journal of Pharma & Bio Sciences. 2010; 2(2):188.
 38. Burnett B, Jia Q, Zhao Y & Levy R. A medicinal extract of Scutellaria baicalensis and Acacia catechu acts as a dual inhibitor of cyclooxygenase and 5-lipoxygenase to reduce inflammation. Journal of medicinal food, 2015; 10(3):442-51.