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ACACIA CATECHU WILLD: A PHARMACOLOGICAL REVIEW

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ABSTRACT

Over the past decade, herbal and ayurvedic drugs have become a subject of world importance, with both medicinal and economical implications. A regular and wide spread use of herbs throughout the world has increased serious concerns over their quality, safety and efficacy. *Acacia catechu willd* (AC). (Family: Fabaceae and subfamily: Mimosoideae) known as Black cutch has a diverse pharmacological and phytochemical importance. It is a potent medicinal plant in the traditional Indian medicinal systems. Thus, a proper scientific evidence or assessment has become the criteria for acceptance of herbal health claims. This review article explores the traditional knowledge or claims along with pharmacognostical, phytochemical, pharmacological and future aspects of this plant. Over many centuries humans have been mining the bounties of nature for discovering new phytoconstituent that have been used for the treatment of number of diseases; many such treatments are useful even today as modern day medicine. Emerging evidence also suggests that search is still continuing for harnessing active compounds from nature in combating human illnesses and it also leads the path to search out new active natural and novel semisynthetic or synthetic compounds.

Keywords : *Acacia catechu willd*, Herbs ,Pharmacological activity,Phytochemical activity.

INTRODUCTION

During the past decade, the indigenous or traditional system has gained importance in the field of medicine. A large number of populations depend on the traditional practitioners, who are dependent on medicinal plants to meet their primary health care needs. Although, modern medicines are available, herbal medicine retained their image for historical and cultural reasons. Since the usage of these herbal medicines has increased, issues and moto regarding their quality,
safety and efficacy in industrialized and developing countries are cropped up[1] In order to make sure the safe use of these medicines, a necessary first step is the reviewing the whole plant for its potential as a medicinal plant. *Acacia catechu willd* (AC) locally known as karungali in Tamil (English name: Black cutch) Family: Fabaceae, first described in Africa by the

Swedish botanist Carl Linnaeus in 1773. Many non-Australian species tend to be thorny, whereas the majority of Australian acacias are not. They are pod-bearing, with sap and leave typically bearing large amounts of tannins and condensed tannins that historically in many species found use as pharmaceuticals and preservatives. AC, a deciduous thorn like tree mainly found in India and also found in deciduous forests around the world. The leaves, bark, heartwood has many nutritional and medicinal uses.

The extract of Acacia catechu have been reported to have various pharmacological effects like immuno modulatory[2], anti pyretic, hypoglycaemic[3], anti diarrhoeal[4,] hepatoprotective activity[4,5]. Heartwood is used to yield concentrated aqueous extract i.e. cutch. Cutch (extract) is astringent, cooling, and digestive. It is useful in cold and cough[6,7,8,9] ulcers, boils and eruptions of the skin, bleeding piles, uterine haemorrhages,atonic dyspepsia, chronic bronchitis etc. An antibacterial mouthwash made from the extract treats gingivitis and mouth sores.

Kingdom :	Plantae – Plants
Sub kingdom	Tracheobionta – Vascular plants
	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	Rosidae
Order	Fabales
Family	Fabaceae – Pea family
Genus	Acacia Mill. – acacia
Species	Acacia catechu (L. f.) Willd. – black cutch

- *Acacia catechu* (L.f.) Willd. var. *catechuoides* (Roxb.)
- *Acacia catechuoides* (Roxb.)
- *Acacia sundra* (Roxb.)
- *Acacia wallichiana*
- *Mimosa catechu*
- *Mimosa catechuoides* Roxb

Local name: karunkali (Tamil) dant-dhavan (Hindi) Khadira (Sanskrit) Karintaali (Malayalam)
Common name: black catechu, black cutch, cashoo, catechu, cutch tree, wadalee gum

Distribution ([10]):
Acacia catechu is widely distributed throughout the greater part of India except the most humid, cold and the driest regions. It is common in the sub-Himalayan tract and outer Himalayas ascending from 900 to 1,200 m from Jammu to Assam. In India, there are 3 varities of *A. catechu* namely, *Catechu, Catechuoides* and *Sundra. Catechu*

is commercially used to obtain ***Katha*** (a concentrated filtered extract) in North India. It is found widely distributed in Jammu, Punjab, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Bihar, Andra Pradesh and Orissa. *Catechuoides* is found in terrain region of Sikkim, Assam and West Bengal, whereas *Sundra*, generally known as Lal Khair (red catechu) is found in Deccan, Gujrat, Rajasthan and southern Maharashtra .The tree can be propagated by planting its seeds, which are soaked in hot water first. After about six months in a nursery, the seedlings can be planted in the field.

Climate:

In the natural habitat of khair, the absolute maximum shade temperature varies from 40^{o}C to 50^{o}C and the absolute minimum from 2.5^{o}C to 7.5^{o}C. The mean daily maximum temperature in May which is generally the hottest month in the hot weather varies from 37.5^{o}C to 43.5^{o}C. The mean daily minimum temperature in January which is the coldest month of the year varies from 1.0^{o}C to 2.1^{o}C.*Acacia catechu* is essentially a tree of comparatively dry regions though in its alluvial form, it extends into regions of heavy rainfall as in the Eastern sub-Himalayan tract, where it is found in places with rainfall as high as 3,800 mm. Away from riverain tracts it occurs in localities where the normal rainfall varies from 500 to 2160 mm. Khair develops to its maximum size in localities with heavy rainfall but it is decidedly xerophilous and grows in dry situations where few other species survive.

Botanical description: [11]

AC is a moderate sized tree, not reaching more than 9-12 meters high and often smaller, with a short, somewhat crooked trunk.. The bark is dark grey and rough. The leaves numerous, alternate, stalked, often armed with a few prickles, bipinnately compound, leaflets 30-50 pairs. The rachis branching from the mid-rib has 4 to 5 round prickles. The rachis is nearly 10 to 20 cm long and bears 20 to 60 pinnae each about 3 to 4 cm long. The flowering occurs in May and June. Its inflorescence is pale yellow to cream colored .The foliage is softly textured; light green and oval-shaped. The branches are thin and spike like because tiny thorns grow around the exterior. The fruit, pod, 5-12 cm long, brown, acute, shining, with 3-10 seeds.AC typically reaches heights of up to 50 feet .The sap wood of AC is large and yellowish white and heart wood is small and red in colour

Fig .1 :*Acacia catechu Willd*-Branch with Inflorescence & pod

Fig .2 :*Acacia catechu Willd*-Heart wood .

Macroscopic Characters *Acacia catechu Willd.(*Table: 1)

1.	Height	Plant 5- 15 m tall
2.	Stem	Straight and grayish brown
3.	Bark	Bark is dark grayish brown, exfoliating in narrow strips brown and red in side
4.	Leaves	Leaf: bipinnate having 10-30 pairs of pinnae each with 20-50 pairs of leaflets
5.	Spines	Short and hooked shaped
6.	Inflorescence	Axillary pedunculate spike
7.	Flower	scented Flowers, Creamy whitish
8.	Pods	flat brown and 3-10 seeded

Microscopic features of *Acacia catechu willd.*

The anatomical features of heartwood are shown in the Figure-3.

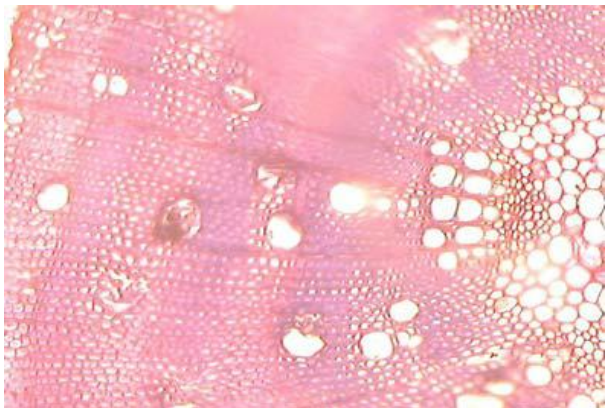

Fig. 3: TS of heartwood enlarged

The biochemical analysis revealed that the deposition of lipid and
lignin was high in the vascular region compared to the deposition of
starch and protein. (Figures 4-7).

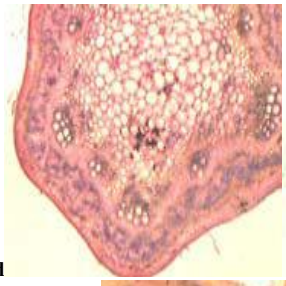

Fig. 4: Lipid

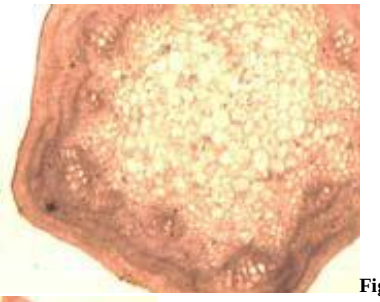

Fig. 5: Lignin

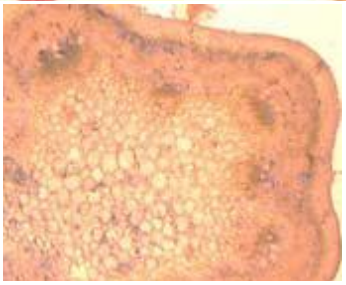

Fig. 6: Protein

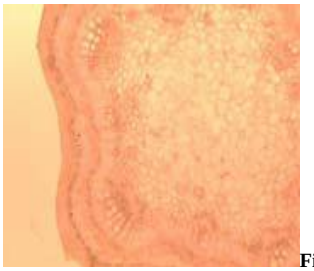

Fig. 7: Starch

Physico-chemical Analysis: [6,7,14]

The physico-chemical parameters are given in Table 1. These values are in agreement with the earlier reports[12]. The ash obtained from the drug was tested for inorganic radicals and the tests for CO3 2-,PO43-, SO42-, Al3+, Ca2+,Mg2+ and K+ were found to be positive by standard methods [13,14] The preliminary phytochemical studies showed the presence of catechins, flavones, tannins and sugars. The total sugar content and reducing sugar content are given in Table 2.

Table 2: Analysis of physicochemical parameters of *Acacia catechu*

S.No	Tests	**Results % (range)**
1.	Loss on drying at 105˚C	9.00-11.00 %
2.	Total ash	1.16-2.00 %
3.	Acid insoluble ash	0.20-0.4.00 %
4.	Water soluble ash	0.09-0.25 %
5.	Water soluble extractives	23.00-25.00 %
6.	Alcohol soluble extractives	19.00-21.00%
7.	pH of water extract	6.02-6.04
8.	Volatile oil	Nil
9.	Fibre content	49.00-53.00 %
10.	Swelling index	4.00-5.00 ml/gm
11.	Foaming index	<100
12.	Total sugar	1.20-1.90 %
13.	Reducing sugar	0.70-1.50 %

CHEMICAL CONSTITUENTS

Main chemical constituents of *Acacia catechu Willd* are catechin, (-) epicatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallete rocatechin, phloroglucin, protocatechuic acid, quercetin, poriferasterol glucosides, poriferasterol, acyglucosides, lupenone, lupeol, procyanidin AC, kaempferol, dihydrokaemferol , L-arabinose, D-galactose, D-rhamnose andaldobiuronic acid [27], afzelchin gum and mineral ([15 ,16-22]) Another important constituent is taxifolin .Catechin is biologically highly active. It is used as a haemostatic. Taxifolin has antibacterial[23], anti-fungal[24], antiviral, anti-inflammatory, and antioxidant activity[25,26]. The medicinal properties of Acacia catechu is due to the antioxidant properties of these constituents.

Phytochemical Analysis

Preliminary phytochemical screening of the leaves extracts of AC was performed as per standard procedure ([28, 29]) which revealed that the presence of carbohydrates, steroids, alkaloids, glycosides, tannins, saponins, flavones, and phenolic compounds.

ETHNOPHARMACOLOGY

Acacia Catechu is an herb. The leaves, shoots, and wood are used to make medicine. The two types of catechu, black catechu and pale catechu, contain slightly different chemicals, but they are used for the same purposes and at the same dose. Catechu is used for diarrhea, swelling of the nose and throat, dysentery, swelling of the colon (colitis), bleeding, indigestion, osteoarthritis, and cancer. People apply catechu directly to the skin for skin diseases, hemorrhoids, and traumatic injuries; to stop bleeding; and for dressing wounds. Catechu is included in mouthwashes and gargles used for gum disease (gingivitis), pain and swelling inside the mouth (stomatitis), sore throat, and mouth ulcers, hoarseness of voice. Cyanidanol, an active principle of *Acacia catechu*, is claimed to be effective in treating liver diseases.[30]In foods and beverages, catechu is used as a flavoring agent. It is used in the diseases like worms, wounds, fever, edema, pruritis, diabetes,

obesity, blood disorders, cough, asthma and anemia etc. The bark, wood extracts, fruits, Gum and flowering tops of AC are used for medicinal purpose. The plant is useful, internally as well as externally. It possess anti-helmentic anti dysenteric and antipyretic and hypotensive [31] properties. It is also used in melancholia, conjunctivitis, haemoptysis, chest pain, asthma, colicky pain, gravel, bronchitis etc.[32], it was reported that both t he natural dyes [33] and bark [34] and whole plant [35]has microbicidal activity.

PHARMACOLOGICAL ACTIVITIES:

Anti microbial Activity: [24,36]

Study showed *Acacia catechu Willd* leaves Extract is found to possess broad-spectrum antimicrobial activity

Results showed AC has antimicrobial activity by inhibiting common human pathogenic organisms like *Staphylococcus aureus* (Gram positive), *Escherichiacoli, Pseudomonas aeruginosa, Klebsiella pneumoniae*, and *Salmonellatyphi* (Gram negative) and fungi like *Candida albicans*, *Aspergillus niger* supporting its use in traditional medicine. *Acacia catechu Willd* leaves, Bark, root extract also possess Anti mycotic activity . The bark extract showed an inhibitory effect on the growth of fungi such as Piricularia oryzae and Colletotrichum falcatum.

AntiOxidant Activity:[25,37]

Study of 70% methanol extract of heartwood extract of Acacia catechu showed significant antioxidant activity , iron chelating and DNA protective activity which is partly due to the phenolic and flavonoid compounds present in it Standard methods like The dot-blot assay, TLC study and the DPPH assay showed that the AC extract is a highly effective antioxidant. Catechin, rutin and isorhamnetin are reported as free radical scavengers and these compounds largely contribute to the bio-potency of *Acacia catechu.*

Antidiarrheal activity:[4,38]

Antidiarrhoeal activity was evaluated in albino rats after inducing diarrhea with castor oil.1

The antidiarrhoeal property of the ethyl acetate extract of *Acacia catechu* appears to be due to its

tannin[38] content, which has astringent property.

Antipyretic activity: [39-41]

The antipyretic effect of *Acaciacatechu* is due to presence of flavonoid compounds, as some flavonoids are predominant inhibitors of cyclooxygenase or lipooxygenase.[39], [40],[41]

Hypoglycaemic activity: [42-46]

Acacia catechu possess hypoglycaemic activity. The hypoglycaemic effect of *A. catechu* may be due to presence of flavonoids which acts as insulin secretagogues.[42] Epicatechin, a flavonoid compound, is reported to promote regeneration of β cells of the Islets of Langerhans .[43],[44],[45],[46]

Hepatoprotective activity: [30,46,47]

Acacia Catechu also possesses hepatoprotective property found in the heartwood. During trials, an ethyl acetate extract in male rats decreased CCI4-induced elevated enzyme levels in acute and chronic models of liver damage. The results indicated some form of repair of the structural integrity of the hepatocyte cell membrane or regeneration of damaged liver cells. Decreased levels of serum bilirubin after treatment with the extract in both acute and chronic liver damage indicated the efficacy of the extract in restoring normal functional status of the liver and the protective action of the extract was further substantiated by histopathological observations The hepatoprotective activity of *A. catechu* could be due to the presence of bioflavonoids which have hepatoprotective and antioxidant properties.[30],[46],[47]

Immuno modulatory activity: [48-53]
Study on Wistar albino rats shows that the aqueous extract of *Acacia catechu*
have significant effect on both the cell mediated and the humoral immunity The exact constituent(s)responsible for the immunomodulatory effect
is not known. However, the catechins, by virtue of their antimicrobial [48, 49], antiinflammatory [50], antiviral [51, 52]and antioxidant [53] effect may be the
main constituents responsible for their activity.

Anti inflammatory activity:([54-57]
Study shows [57] extract containing both baicalin and (_)-catechin directly inhibits the production
Of inflammatory fatty acids by acting on the COX and LOX enzymes. Since elevated AA metabolism is part of the etiology of arthritis, [54,55] inhibition of the production of these inflammatory mediators via dual inhibition of the COX and LOX pathways may provide a way to manage OA safely while providing acceptable efficacy. Toxicological safety studies in animals and humans have shown the combination of *S. baicalensis* and *A. catechu* extracts to be safe.[56]

CONCLUSION

In the present review we have made an attempt to explore and provide the
maximum information of botanical, pharmacognostical with history and cultivation, Ethnopharmacological, phytochemical, nutritional, pharmacological information on *Acacia catechu willd*, a medicinal herb used in the Indian system of medicine. Various chemical constituent present in this plant are catechin and catechutannic acid. epicatechin, Atzelchin, catechin tetramer, dicatechin, gallochin, gossypetin, phlobatannin, kaempferol, quercitrin, quercitin ,taxifolin found to possess diverse pharmacological activities. This data provides that. *Acacia catechu willd as a* potential medicinal herb.

REFERENCES

1. WHO, 1999. WHO Monographs on Selected Medicinal Plants. Vol. 1, World Health Organization,Geneva.

2. SyedIsmail and Mohammed Asad Immunomodulatory activity of *acacia catechu* Indian Journal of Pharmacology 2009; 53 (1): 25–33
3. Singh KN, Mittal RK, Barthwal KC, Hypoglycaemic activity of *Acacia catechu*, *Acacia suma*, And *Albizzia odoratissima* seed diets in normal albino rats, Indian Journal of Medical research, 64(5), 1976, 754-757.
4. Ray D, Sharatchandra KH, Thokchom IS, Antipyretic, antidiarrhoeal, hypoglycaemic and Hepatoprotective activities of ethyl acetate extract of *Acacia catechu Willd.* In albino rats, Indian Journal of Pharmacology, 38(6), 2006, 408-413
5. Jayasekhar P, Mohanan PV, Hepatoprotective activity of ethyl acetate extract of *Acacia catechu*, Indian Journal of Pharmacology, 29(6), 1997, 426-428
6. Anonymous, Indian Herbal Pharmacopoeia, Revised new edition 2002, Indian Drug Manufacturer's Association, Mumbai, 2002, 1-11.
7. Anonymous, The Wealth of India, Raw Material, Vol 1, CSIR, New Delhi, 2004, 11
8. Qadry JS, Shah's and Qadry's Pharmacognosy, 12th edition, B.S Shah Prakashan, Ahmedabad, 2008, 302-303
9. Wallis TE, Textbook of Pharmacognosy, 5th Edition, CBS Publishers and Distributors, New Delhi, 2005, 461-463
10. Anonymous., *The Wealth of India, Raw materials*, CSIR, New Delhi, Vol. I-A (Rev.), 24-30, 1985.

11. Comparative pharmacognostical and antimicrobial studies of *acacia* species (Mimosaceae) Saini et al. Journal of Medicinal Plants Research Vol. 2(12), pp. 378-386, December, 2008
12. Anonymous., *The Ayurvedic Pharmacopoeia of India*, Ministry of Health & Family Family Welfare, Dept. of Ayush, Govt. of India, Part I, Vol.1, 70, 1989
13. Anonymous., Pharmacopoeial Standards for Ayurvedic Formulations, CCRAS, New Delhi, 1987.
14. Anonymous., Quality Control Methods for Medicinal Plant Materials, World Health Organization (WHO), Geneva, 1998
15. Anonymous, The Wealth of India, Raw Material, Vol 1, CSIR, New Delhi, 2004, 11(8-14)
16. Singh KN, Mittal RK, Barthwal KC, Hypoglycaemic activity of *Acacia catechu, Acacia suma*,and *Albizzia odoratissima* seed diets in normal albino rats, Indian Journal of Medical research,64(5), 1976, 754-757.
17. Naik GH, Priyadarsini KI, Satav JG, Banavalikar MM, Sohoni DP, Biyani MK, Mohan H, Comparative antioxidant activity of individual herbal components used in Ayurvedic medicine, 63(1), 2003, 97-104.
18. Bimla, Meera, Chander, Jagdish, Kalidhar SB, A Review on the chemistry and bioactivity of Acacia Spp., Journal of Medicinal and Aromatic Plants Science, 27, 2005, 51-90.
19. Sharma P, Dayal R, Ayyer KS, Chemical constituents of *Acacia catechu* leaves, Indian Journal of Chemical Society, Page No. 60, 1997.
20. Sharma P, Dayal R, Ayyer KS, Acylglucosterole from *Acacia catechu* , Journal of Medicinal and Aromatic Plants Science, 21(4), 1999, 1002-1005.
21. Rao PR, Seshadri TR, L-Epi-catechin from *Acacia catechu*, Journal Scientist Indian Research, 7B, 1948, 59.
22. Jain R, Patni V, Arora DK, Isolation and identification of flavonoid "quercetin" from *Acaciacatechu (L.F.) Willd*- A katha yielding plant, Journal of Phytological Research, 20(1), 2007, 43-45.
23. Anonymous, Indian Herbal Pharmacopoeia, Revised new edition 2002, Indian Drug Manufacturer's Association, Mumbai, 2002, 1-11. (13-16)
24. Nagaraja T.G *, S.V. Sarang and D. C. Jambhale Evaluation of anti-mycotic activity of Acacia catechu Willd.(Mimosaceae) Anti-mycotic activity of *Acacia catechu* Journal of Biopesticides,1(2):197 - 198 (2008)
25. **Bibhabasu Hazra**, (*Bose Institute), Kolkata*, **Rhitajit Sarkar, Santanu Biswas**, **Nripendranath Mandal**, The Antioxidant, Iron Chelating and DNA Protective Properties of 70% Methanolic Extract of 'Katha' (Heartwood extract of *Acacia catechu*)journal of complementary & integrative medicine vol.7 / 2010 /issue 1.
26. Naik GH, Priyadarsini KI, Satav JG, Banavalikar MM, Sohoni DP, Biyani MK, Mohan H,Comparative antioxidant activity of individual herbal components used in Ayurvedic medicine, 63(1), 2003, 97-104.
27. Sharma P. C., Yelne M. B., Denni T. J., *Database on Medicinal Plants used in*

Ayurveda, Volume 1, Central Council For Research in Ayurveda and Siddha, Dept.of ISM & H, Min. of Health & Family Welfare, Govt. of India, 216-224. 2000.)

28. Kokate CK, Purohit AP, Gokhale SB, Pharmacognosy, 39th Edition, Nirali Prakashan, Pune, 2005,607-611.
29. Harborne JB, Phytochemical methods, A Guide to Modern Techniques of Plant Analysis, Edition2, Chapman & Hall, London, 2005, 85, 86, 126, 196.
30. Rage N, Dahanukar S, Karandikar SM. Hepatoprotective effect of cyanidanol against carbon tetrachloride induced liver damage. Indian Drugs 1984;22: 556-60.
31. Sham JS:Hypotensive effect of Acacia Catechu. Planta Medica 1984;.50 (2);177-180.
32. Joshi S. H. 2000. Medicinal Plant. Oxford and IBH Pub Co Pvt Ltd. New Delhi. 271 PP.
33. Singh, R., Jain, A., Panuar, S., Gupta, D. and Khare, S.K. 2005. Antimicrobial activity of some natural dyes. *Dyesand pigments*, 66 (2): 99 – 102.
34. Tripathi, P. and Dubey, N.K. 2003. Evaluation of someplant extracts in the management of rot and mandarin oranges. *Indian Phytopathology*, 56 (4): 481 – 483
35. Brahmachari Goutam and Dilip, G. 2006. Progress in the research on naturally occurring flavones and flavonls: An over view. *Current organic Chemistry*, 10 (8): 873– 898
36. Gulzar A. et al. / Journal of Pharmacy Research 2010, 3(11),2583-2584)
37. *Devi et al.* Pharmacognostical studies on *acacia catechu* willd and identification of Antioxidant principlesint j pharm pharm sci, vol 3, suppl 2, 2011, 108 -111
38. Usher G. *Acacia catechu Willd* (Catechu, Dark catechu). A dictionary of plant. 1st ed. Delhi: CBS publishers and distributors; 1984
39. Trease GE, Evans WC. Flavone and related flavonoid glycoside. Pharmacognosy. 4th ed. London: Bailliere Tindall; 1972.
40. Mathew AG, Parpia HAB. Food browning as a polyphenol reaction. In: Chichester CO, Mrak EM, Stewart GF,editors. Advances in food research. New York: Academic Press; 1971. p. 75-145
41. Rajnarayana K, Reddy MS, Chaluvadi MR, Krishna DR. Bioflavonoids classification, pharmacological, biochemical effects and therapeutic potential. Indian J Pharmacol 2001;33:2-16
42. Geetha BS, Mathew BC, Augusti KT. Hypoglycemic effects of Leucodelphinidin derivative isolated from *Ficus bengalensis* (Linn.). Indian J Physiol Pharmacol 1994;38:220-222
43. Gupta SS. Prospects and perspectives of natural plants products in medicine. Indian J Pharmacol 1994;26:1-12
44. Singh KN, Mittal RK and Barthwal KC. Hypoglycemic activity of *Acacia catechu, Acacia suma, Albizzia odoratissima* seed diets in normal albino rats. Indian J Med Res 1976;64:754-757
45. Singh N, Tyagi SD, Agarwal SC. Effects of long term feeding of acetone extract of *Momordica charantia* (whole fruit powder) on alloxan diabetic albino rats. Indian J Physiol Pharmacol 1989;33:97-100

46. Rajnarayana K, Reddy MS, Chaluvadi MR, Krishna DR. Bioflavonoids classification, pharmacological, biochemical effects and therapeutic potential. Indian J Pharmacol 2001;33:2-16
47. Trease GE, Evans WC. Flavone and related flavonoid glycoside. Pharmacognosy. 4th ed. London: Bailliere Tindall; 1972
48. Voravuthikunchai SP, Limsuwan S. Medicinal plant extracts as anti-Escherichia coli O157:H7agents and their effects on bacterial cellaggregation. *J Food Prot* 2006 Oct; 69(10):2336–2341
49. Rani P, Khullar N. Antimicrobial evaluation ofsome medicinal plants for their anti-enteric potential against multi-drug resistant *Salmonellatyphi. Phyto Res* 2004, Oct 8; 18(8): 670–673.
50. United States Patent 7108868. Isolation of a dualcox-2 and 5-lipoxygenase inhibitor from acacia. http://www.freepatentsonline.com/7108868.html.
51. Yunlyu S, Rhim JY, Park WB, Anti herpeticactivities of flavanoids against *Herpes simplex* virus type 1 (HSV-1) and type 2 (HSV-2) *invitro. Arch Pharm Res* 2005; 28(11): 1293–1301.
52. Mahmood N, Pizza C, Aquino R, Colman S,Burke A, Hay A. Inhibition of HIV infection by flavonoids. *Int Conf AIDS* 1993 June 6–11; 9:467.
53. Chung JE, Kurisawa M, Kim YJ, Uyama H,Kobayashi S. Amplification of antioxidant activity of catechin by polycondensation withacetaldehyde. *Biomacromolecules* 2004; 5(1): 113–118.
54. Heller A, Koch T, Schmeck J, Van Ackern K: Lipid mediators in inflammatory disorders. *Drugs* 1998;55:487–496.
55. Kuehl FA Jr, Egan RW: Prostaglandins, arachidonic acid and inflammation. *Science* 1980;210:978–984.
56. Burnett BP, Silva S, Mesches MH, Wilson S, Jia Q: Safety evaluation of a combination, defined extract of *Scutellaria baicalensis* and *Acacia catechu*. *J Food Biochem* 2007
57. A Medicinal Extract of *Scutellaria baicalensis* and *Acacia catechu* Acts as a Dual Inhibitor of Cyclooxygenase and 5-Lipoxygenase to Reduce inflammationjournal *J Med Food* 10 (3) 2007, 442–451