

A POTENTIAL ETHNOMEDICINAL PLANT: *SEMECARPUS ANACARDIUM* LINN. – A REVIEW

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ABSTRACT

Semecarpus anacardium Linn. (Family: *Anacardiaceae*), commonly known 'Ballataka' or 'Bhilwa', is a plant well-known for its medicinal value in ayurvedic and siddha system of medicine, it is also used for non-medicinal purpose like marking of cloth, hair dye etc since ancient time. Phytochemical analyses of *Semecarpus anacardium* nut shows that, its nut contain a variety of biologically active compounds such as biflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids, which shows various medicinal properties. Traditional healers and physicians use *Semecarpus anacardium* in their clinical practice. Several experiments have proved it's anti-atherogenic, anti-inflammatory, antioxidant, antimicrobial, anti-reproductive, CNS stimulant, hypoglycemic, anticarcinogenic and hair growth promoter activities.

Keywords: *Semecarpus anacardium*, Marking nut, Bioactive compounds, Ayurvedic drugs.

INTRODUCTION

Plants are the basis of life on earth and are central to people's livelihood. The people generally depends upon nearby forest areas to supply their needs such as medicine, timber, fuel-wood, wood, wild vegetables and many more. For thousands of years, cultures around the world have used herbs and plants to treat illness and maintain health. The Indian knowledge of herbal medicines is gaining wide spread acceptance globally. In Ayurveda, almost all medicinal preparations are derived from plants. Herbs and plants are valuable not only for their active ingredients but also for their minerals, vitamins, volatile oils, glycosides, alkaloids, acids, alcohols, esters etc. Higher plants, as sources of medicinal compounds continue to play a dominant role in maintenance of human health since antiquities. Over 50% of all modern clinical drugs are naturally originated¹ and natural products play an important role in drug development programmes of the pharmaceutical industry². According to Edwards³, about two-thirds of 50, 000 medicinal plants in use are still harvested from the natural habitat.

Semecarpus anacardium linn (SA) is one of the best, versatile and most commonly used herbs as a household remedy, distributed in sub-Himalayan region, Tropical region, Bihar, Bengal, Orissa and central parts of India. It has been freely used all over India since centuries. The word *Semecarpus* is derived from Greek word *simeion* meaning marking or tracing and *carpus* meaning nut. *Anacardium* means like cardium; - "Heart shaped marking nut". Maharsi Charaka has categorized bhallataka as dipaniya- an appetizer, bhedaniya – accumulation breaking herb, mutra sangrahaniya – antidiuretic and kusthaghna – anti dermatosis. Bhallataka is acclaimed as a drug of choice in the treatment of piles of vata and kapha types. It has also got the potential to produce allergic manifestations through contact dermatitis.

Plant Morphology/ Botanical Description

It is a medium sized deciduous tree, growing up to 10-15 metres in height. The plant grows naturally in tropical and dry climate. Bark is grey in colour and exudes an irritant secretion on incising. The leaves are simple alternate, 30-60 cm long and 12-30 cm broad. They are glabrous above and pubescent beneath. The

flowers are greenish white, in panicles. Fruits are ripe between December to March and are 2-3 cm broad, ovoid and smooth with a lustrous black. Flowering occurs in June and then onwards the plant bears fruits. It has got no specific soil affinity and Easily recognized by large leaves and the red blaze exuding resin, which blackens on exposure.

Microscopic structure

Fruit - Pericarp differentiated into epicarp, mesocarp and endocarp; in longitudinal section pericarp shows outer epicarp consisting of single layer of epidermal cells which are elongated radially and lignified. Characteristic glands are found in pericarp which exude oil globules and arise as small protuberances in epicarp. Due to pressure exerted by cells of mesocarp, some of epidermal cells and cuticle rupture and oil globules exude from oil glands; mesocarp has a very broad zone, 30-40 layers thick, composed mostly of parenchymatous cells having lysigenous cavities and fibro-vascular bundles, below epidermis a few outer cells of parenchyma smaller as compared to rest; rosette crystals of calcium oxalate found scattered in parenchymatous cells, some cells get dissolved and form lysigenous cavities which increase in size with maturity of fruit, cavities do not have any special lining and contain an acrid and irritant yellowish oily secretion; 19 endocarp consists of two distinct layers, innermost prismatic having very much elongated radial walls, being highly thickened, the outer layer is shorter and thinner than prismatic layer but the cells similar to the former; number of mesocarp parenchyma contain rosette crystals of calcium oxalate and oil drops in oil glands; lysigenous cavities of mesocarp contain oily vesicating substance, insoluble in water and soluble in alcohol, ether, chloroform.

Synonyms

Hindi	: Bhilwa, Billar, Bhelwa, Bhilawa
Sanskrit	: Bhallataka, Antahsattva, Arusharah, Aruskara, Arzohita, Bhallata, Viravrksa, Vishasya, Bhallatakah
English	: Marking Nut Tree, Marsh Nut, Oriental Cashew Nut
Tamil	: Erimugi (Erimuki)
Telugu	: Nallajeedi, Bhallatamu
Gujarati	: Bhilamu, Bhilamo
Marathi	: Bibba, Bhilava
Oriya	: Bholataki, Bonebhalia, Amberi
Urdu	: Baladur, billar, bhilavan
Assamese	: Bhala
Nepali	: Bhalaayo

Active Principles/ Phytochemistry

The most significant components of the *S. anacardium* Linn. are bhilwanols, phenolic compounds,^{4,5} biflavonoids,⁶ sterols and glycosides.^{4,7} An alkaloid, Bhilawanol, has been isolated from oil and seeds. Bhilawanol from fruits was shown to be a mixture of cis and Trans isomers of ursuhanol. Oil from nuts, bhilavinol, contains a mixture of phenolic compounds mainly of 1,2-dihydroxy-3 (pentadecadienyl-8, 11) benzene and 1,2-dihydroxy-3 (pentadecadienyl-8', 11')-benzene⁸. On exposure to air, phenolic compounds get oxidized to Quinones. The oxidation process can be prevented by keeping the oil under nitrogen. Nut shells contain the biflavonoids: biflavones A, C, A1, A2, tetrahydrorobustaflavone, B (tetrahydromentoflavone)⁹, jeediflavanone,^{10,11} semecarpufavan^{12,13} and gulluflavone^{14,15}. Other components isolated are anacardic acid, cardol, catechol, fixed oil, semecarpetin, anacardol, anacardoside and semecarpol. The kernel oil contains oleic acid- 60.6%; linoleic acid- 17.1%; palmitic acid- 16%; stearic acid- 3.8%; arachidic acid- 1.4%.

Contain	Per cent
Foreign matter	1%
Acid-insoluble ash	0.5 %
Total Ash	4 %
Water-soluble extractive	5 %
Alcohol-soluble extractive	11 %

Current status

Due to the toxic activities, large size, allergic effect are loss of traditional knowledge generation by generation, most of the peoples don't know the importance and proper use of *Semecarpus anacardium*, that's why now a day's peoples are avoiding to gardening it in surrounding area. now *Semecarpus anacardium* plant has become a wild plant, it found only in forest area. Day by day the quantity of this plant is decreasing, it is need to aware it's importance to society otherwise it will be become rare and we will loss one of important plant from the dictionary of Indian medicinal plants.

Classification

Kingdom	: <i>Plantae</i>
Subkingdom	: <i>Tracheobionta</i>
Super division	: <i>Spermatophyta</i>
Division	: <i>Magnoliophyta</i>
Class	: <i>Magnoliopsida</i>
Subclass	: <i>Rosidae</i>
Order	: <i>Sapindales</i>
Family	: <i>Anacardiaceae</i>
Genus	: <i>Semecarpus</i>
Species:	<i>Anacardium</i>

Properties

Bhallataka is sweet and astringent in taste. It is extremely heat generating.

Folk medicine

Semecarpus anacardium is a one of most popular medicinal valuable plant in world of Ayurveda. Charak, Sushrut and Vagbhatt, the main three treatises of Ayurveda have described the medicinal properties of *Semecarpus anacardium* and its formulation. Bhallataka is used both, internally as well as externally. The fruits, their oil and the seeds have great medicinal value, and are used to treat the wide range of diseases. Detoxified nut of SA were used in Ayurveda for skin diseases, tumors, malignant growths, fevers, haemoptysis, excessive menstruation, vaginal discharge, deficient lactation, constipations, intestinal parasites. (Charaka, Sushruta), Before using *Semecarpus anacardium* for medicinal purpose, it's necessary to detoxifying it because it is highly toxic for body if not use properly. Number of detoxification methods have been recorded the most common detoxification method involves rubbing of *Semecarpus anacardium* seeds with brick powder and then washing the seeds with warm water. The second common recommended method is to tie the seeds in muslin cloth and suspended it in a vessel containing coconut water, then heated for about 3 hrs continuously¹⁶. The seeds oil is mainly used for medicinal purpose. Seeds are generally boiled in milk and the milk is consumed. The seeds oil is used in minimum possible quantity, typically mixed with food items or mustard oil. Externally, the oil is applied on wounds to prevent pus formation and better healing of wounds, It works well, when medicated with garlic, onion and ajavayana in sesame oil. In glandular swellings and filariasis, the application of its oil facilitates to drain out the discharges of pus and fluids and eases the conditions.

It is also use as a brain tonic, blood purifier and haematinic tonic. The combination, *Semecarpus anacardium*, *Terminalia chebula*, *Sesamum indicum* L. seeds powders with jaggery, has excellent results in chronic rheumatic disorders. In dysmenorrhea (painful menstruation) and oligomenorrhea (scanty menstruation), the medicated milk or its oil is salubrious. It reduces the urinary output, hence beneficial in diabetes of kapha type, Bhallataka is the best rejuvenative (rasayana) for skin ailments, vata disorders and as a preventive measure to increase the body

resistance. Winter is the best season for its usage.

Kalpaamrutha (KA), an indigenous-modified Siddha formulation, consists of SA nut milk extract and fresh dried powder of *Emblica officinalis* (EO) fruit along with honey. Kalpaamrutha was found to be nontoxic up to the dose level of 2000 mg/kg.

Pharmacology

Number of drugs are derived from *Semecarpus anacardium* plant which are available in market against several disease like skin disease, tumors, malignant growth, fungal disease, excessive menstruation, vaginal discharge, fever, haemoptysis, constipation and intestinal parasites. (Charaka, Sushruta).¹⁷ Anti-inflammatory, antiarthritic, antioxidant activity, hypolipidemic, hypoglycaemic, anti-atherogenic, anti-inflammatory, antifertility, neuro-protective activities of *Semecarpus anacardium* nut with different solvents are also reported on experimental animal and cell lines.¹⁸⁻²⁷

Anti-Cancer Activity

Nut of *Semecarpus anacardium* have anti-tumours activity. several Studies have been also done in proving the anticancer and hepatoprotective activity of *Semecarpus anacardium* nut.

Mathivadhani et al. studied *Semecarpus anacardium* nut extract use for inhibitory effect on human breast cancer cell line (T47D). At the molecular level, these changes are accompanied by decrease in Bcl(2) and increase in Bax, cytochrome c, caspases and PARP cleavage, and ultimately by internucleosomal DNA fragmentation.²⁸

Arulkumaran et al. investigated the protective efficacy of preparation named as Kalpaamrutha (KA) (containing SA nut milk extract, dried powder of *Phyllanthus emblica* fruit and honey) on the peroxidative damage and abnormal antioxidant levels in the hepatic mitochondrial fraction of 7,12-dimethylbenz(a)anthracene (DMBA)-induced mammary carcinoma rats. On the basis of the observed results, KA can be considered as a readily accessible, promising and novel cancer chemopreventive agent.²⁹

Sugapriya et al. showed restoration of energy metabolism in leukemic mice treated by SA nut milk extract. *Semecarpus anacardium* treatment was compared with standard drug imatinib mesylate. *Semecarpus*

anacardium administration to leukemic animals resulted in clearance of the leukemic cells from the bone marrow and internal organs.³⁰

Sanjay R. Patel et al. study was intended to estimation of the anticancer activity of Methanolic Extract of *Semecarpus anacardium* nut on the human epidermoid larynx carcinoma cell line (Hep 2) by the SRB assay. IC50 value and R2 value of *Semecarpus anacardium* on Hep 2 cell was 468 µg/ml and 0.688 respectively by SRB assay. IC50 value of *Semecarpus anacardium* on Vero cell was not found and R2 value 0.008 by SRB assay.³¹

Srinivasan Sowmyalakshmi et al was testing it's anti-tumor activity against two breast cancer cell lines, MCF-7 [estrogen receptor (ER)-positive] and MDA 231 (ER-negative) using cell viability and apoptosis assays. In terms of cytotoxicity as well as induction of apoptosis, the n-hexane and chloroform fractions of *Semecarpus anacardium* were more significantly active against MDA 231 cells than MCF-7 cells.³²

Traditional Uses

Bhallataka is used for hair care in traditional system of medicines. It is used for dyeing, and promoting hair growth in folk medicine. It was used by washermen to mark cloth before washing, as it imparted a water insoluble mark to the cloth.

Neuroprotective Activity

Semecarpus anacardium has been to use Neuro-protective effect especially on the hippocampus region in stress-induced neuro degeneration like Alzheimer's disease (AD).

Farooq et al. evaluated the beneficial effects of nuts of SA, extracted with milk, on CNS, mainly for its locomotory and nootropic activities in different experimental animal models.³³

Loss of cholinergic cells, particularly in the basal forebrain is accompanied by the loss of neurotransmitter Ach. The *Semecarpus anacardium* is effective in prolonging the half-life of acetylcholine through inhibition of AchE. *Semecarpus anacardium* known to be useful in treating cognitive decline, improving memory or related CNS activity.^{34,35}

Anti-inflammatory activity

Ramprasath et al. investigated that *Semecarpus anacardium* significantly decreased the carrageenan-induced paw edema and cotton pellet granuloma.³⁶

Bhitre et al. prepared the extracts of fruits of SA and tested to study the anti-inflammatory activity using the technique of carrageenan-induced paw edema in albino rats. The extract showed significant anti-inflammatory activity comparable to the reference standard aspirin.³⁷

Satayavati et al. and Bajpai et al, reported the antiinflammatory activity of SA for both immunological and non-immunological origin.³⁸

Singh et al. evaluated that SA extract can inhibit pro-inflammatory cytokine production. *Semecarpus anacardium* extract inhibited the spontaneous and LPS-induced production of pro-inflammatory cytokines IL-1beta and IL-12p40 but had no effect on TNF-alpha and IL-6 production, both at protein and mRNA level. The extract also suppressed LPS-activated nitric oxide production in mouse macrophage cell line, RAW 264.7.³⁹

Premlatha et al. have been reported for immune-modulatory potency, anti-oxidative, membrane stabilizing, tumors marker regulative, glucose level restoring and mineral regulation properties of nut extract in hepatocellular carcinoma and found to detoxify a potent hepatocarcinogen aflatoxin B₁ and causes its metabolites to be excreted in urine.⁴⁰

Mythilypriya et al. studied the anti-inflammatory activity of SA in adjuvant-induced arthritic rat model with reference to mediators of inflammation (lysosomal enzymes) and its effect on proteoglycans.⁴¹

It is reported the presence of phenolic compounds like semicarpol and bhilawanol in the nuts found to inhibit acute tuberculin reaction in sensitized rats and also the primary phase of adjuvant arthritis. The drug also shows immunomodulatory effect during inflammation. *Semecarpus anacardium* blocks the TNF- α thus severity of inflammation is reduced.

Antioxidant activity

Semecarpus anacardium has been reported in various studies to possess potent antioxidant activity. Verma et al. investigated antioxidant activity of the aqueous extract (nuts of SA) in AKR mouse liver during development of lymphoma. Administration of the aqueous extract of SA to lymphoma-transplanted mouse leads to increase in the activities of antioxidant enzymes, whereas LDH activity is brought down significantly indicating a

decrease in carcinogenesis.⁴²

Sahoo et al. investigated the antioxidant activity of ethyl acetate extract of stem bark of SA. Ethyl acetate extract showed the stronger antioxidant activity (due to presence of highest total phenolic content of 68.67% measured as pyrocatechol equivalent) compared to the other (hexane, chloroform and methanol) extracts. The isolation of the ethyl acetate extract of SA stem bark yielded a bright-yellow solid crystal, which was identified as butein. This compound exhibited antioxidant activity (IC₅₀ values of 43.28 at 4.34 µg/ml), which was comparable to rutin, taken as a standard.⁴³

Reactive oxygen species (ROS) and reactive nitrogen species (RNS) are highly reactive transient chemical species, which play an important role in the etiology of tissue injury in rheumatoid arthritis (RA). Treatment with SA recouped the altered antioxidant defense components to near normal levels. These evidences suggest that the free radical mediated damage during arthritis could have been controlled by SA by its free radical quenching and antioxidative potential. (Mol Cell Biochem **276**: 97–104, 2005).⁴⁴

Shanmugam Arulkumaran et al observed that rats treated with Kalpaamruthaa showed normal lipid peroxide level and antioxidant defenses. (Mol Cell Biochem **291**: 77–82, 2006)⁴⁵

The levels of lipid peroxides and antioxidant levels were measured in blood, and vital organs (liver, kidney and breast tissue) of control and experimental animals. In cancer condition, the LPO was increased and antioxidant levels were decreased. On drug (SA and KA) administration, decreased LPO and increased antioxidant levels were seen in control and experimental animals.⁴⁶

Antimicrobial activity

Mohanta et al. found the antimicrobial activity (disc diffusion method) of *Semecarpus anacardium* with different extract. The petroleum ether and aqueous extract fractions of *Semecarpus anacardium* showed inhibitory activity against *Staphylococcus aureus* (10 mm) and *Shigella flexneri* (16 mm) at 100 mg/ml concentration. While chloroform extract showed inhibition against *Bacillus licheniformis*, *Vibrio cholerae* and *Pseudomonas aeruginosa*, the ethanol extract showed inhibition to *Pseudomonas aeruginosa* and *S. aureus*.⁴⁷

Nair et al. found that the alcoholic extract of dry nuts of *Semecarpus anacardium* showed

bactericidal activity *in vitro* against three gram negative strains (*Escherichia coli*, *Salmonella typhi* and *Proteus vulgaris*) and two gram positive strains (*Staphylococcus aureus* and *Corynebacterium diphtheriae*). Subsequent studies have shown that the alcoholic extracts of different parts of the plant (leaves, twigs and green fruit) also possess anti-bacterial properties, especially the leaf extract.⁴⁸

Sharma et al also found that due to presence of flavonoid, alcoholic extract of dry nuts of *Semecarpus anacardium* show antifungal activity (*Aspergillus fumigatus* and *Candida albicans*) at 400 mg/ml concentration. Both the fungi were show inhibition in growth, reduction in size of cells and Sporulation also decreased.⁴⁹

Sharma et al investigate that it's nut oil show significant anti-microbial activity against several Gram positive (*Bacillus subtilis*, *Staphylococcus aureus*) and Gram negative (*Proteus vulgaris*, *Escheria coli*) Bacteria.⁵⁰

Anti-spermatogenic effect

Semecarpus anacardium extract feeding caused Anti-spermatogenic effect evidenced by reduction in numbers of spermatogenesis cells and spermatozoa in male albino rats. Reduction in sperm density in cauda epididymides may be due to changes in the androgen metabolism. Meiotic and post-meiotic germ cells were highly sensitive to androgen concentration and the alteration in androgen level in testes may affect the transformation of spermatocytes to spermatids.⁵¹

Antiatherogenic effect

The imbalance between the prooxidants and antioxidants is the main cause of development of atherosclerosis. To prevent such condition, antioxidant therapy is beneficial. *Semecarpus anacardium* shows such antioxidant property. It has capacity to scavenge the super oxide and hydroxyl radicals at low concentrations. The process of atherogenesis is initiated by peroxidation of lipids in low-density lipoproteins, was also found inhibited by *Semecarpus anacardium*.⁵²

Sharma et al. demonstrated the cardiac activity of SA, as it generally reduces the tissue and serum hyperlipidemia by the inhibition of intestinal cholesterol absorption coupled with peripheral disposal thus possessing anti-atherosclerotic activity.⁵³ It is possible that the beneficial antiatherogenic

effect may be related to its antioxidant, anticoagulant, hypolipidemic, platelet anti-aggregation and lipoprotein lipase releasing properties. The mechanism of hypotriglyceridemic effect has also been shown to be partly due to stimulation of lipoprotein lipase activity.

Hypoglycemic effect

Arul *et al.* studied the effect of ethanolic extract of dried nuts of SA on blood glucose and investigated in both normal (hypoglycemic) and streptozotocin-induced diabetic (antihyperglycemic) rats. The ethanolic extract of SA (100 mg/kg) reduced the blood glucose of normal rats. The blood glucose levels were measured at 0, 1, 2 and 3 h after the treatment and antihyperglycemic activity of SA was compared with tolbutamide, a sulfonyl urea derivative used in diabetes mellitus.^{54,55}

Krishnamurthy *et al.* observed that Kalpaamrutha (KA), increased levels of total cholesterol, free cholesterol, phospholipids, triglycerides and free fatty acids and decreased levels of ester cholesterol in plasma, liver and kidney found in cancer-suffering animals were reverted back to near normal levels on treatment with KA and SA.²³ Glucose produced by gluconeogenesis and glycogenolysis plays an important role in aggravating hyperglycemia in diabetes, and altered mitochondrial function is associated with impaired energy production. The levels of the enzymes involved in Glycolysis and TCA cycle increased, while that of gluconeogenesis decreased. The activities of the mitochondrial complexes were also favorably modulated. These effects may be attributed to the hypoglycemic and the antioxidative activity of *Semecarpus anacardium*. Means it is able to restore the altered activities of the enzymes involved in carbohydrate metabolism and energy production.⁵⁶

Poisoning nature and its antidote

Semecarpus anacardium is classified in Ayurveda under the category of toxic plants.⁵⁷ *Semecarpus anacardium* is extremely hot and sharp in its attributes; it should be used with caution. Individuals showing allergic reactions to it, should stop and avoid the usage of bhallataka. It should not be used in small children, very old persons, pregnant women and individuals of predominant pitta constitution. The use of the same should be restricted in summer season. The toxic symptoms of its internal use are skin rashes, burning, itching, and excessive thirst and

sweating, reductin in urine output with coloured urine, sometimes blood in the urine (hematuria) may appear.

Before using of *Semecarpus anacardium* as internal medicinal purpose, it is necessary to detoxifying it by washing with warm water or other method. one should adopt a bland and cooling diet consisting of rice, milk, butter, ghee because they suppress the side-effect of it. The salt and spices should be strictly restricted and during bhallataka treatment, it is recommended to avoid exposure to sun, heat and excessive sex. The fresh juice of the leaves of amlika (*Tamarindus indica*) internally, is one of the antidotes for such symptoms.

SUMMARY AND CONCLUSION

Semecarpus anacardium is a one of most important medicinally important plant which may be use as alternatives of medicine. Several studies show that it nut's extract have various phytochemical which is able to fight against several disease but due to the it's poisonous nature it should be used with caution.

Now a day's this plant found only in forest area because peoples are not aware properly with it's importance or poisonous nature or large size peoples are cutting this plant speedily from their surrounding area, it should be conserve.

REFERENCES

1. Stuffness M and Douros J. Current status of the NCI plant and animal product program. *J. Nat. Prod.* 1982;45:1-14.
2. Baker JT, Borris RP, Carte B, Cordell GA, Soejarto DD, Cragg GM, Gupta MP, Iwu MM, Madulid DR, Tyler VE. Natural product drug discovery and development: New perspective on international collaboration. *J. Nat. Prod.* 1995;58:1325-1357.
3. Edwards R. No remedy in sight for herbal ransack. *New Science.* 2004;181:10-11.
4. Mathur HN, Agarwal JS. Phenolic modified resin of oil varnishes. *J Sci Indian Res* 1953;12:411.
5. Rao NS, Row LR, Brown RT. Phenolic constituents of *Semecarpus anacardium*. *Phytochemistry.* 1973;12:671-81.
6. Ishatulla K, Ansari WH, Rahman W, Okigawa M, Kawanon N. Bioflavanoids from *Semecarpus anacardium* linn. *Indian J Chem.* 1977;15:617-22.

- 7 Govindachary TR, Joshi BS, Kamal VM. Phenolic constituents of *Semecarpus anacardium*. Indian J Chem. 1971;9:1044.
- 8 Prakasa Rao NS, Ramachandra Row L, Brown RT. Phenolic constituents of *Semecarpus anacardium*. Phytochemistry. 1973;12(3):671-681.
- 9 Gil R.R., Lin L., Cordell G.A., Kumar M., et al. "Anacardoside from the seeds of *Semecarpus anacardium*". Phytochem. 1995;39(2):405-407.
- 10 Murthy SSN. Chemical and phytochemical analyses of *Semecarpus anacardium* nut. Phytochem. 1985;24:1065-69.
- 11 Nardkarni K.M. "Indian Material medical". Popular prakashan. 1976;1(3):1119-1125.
- 12 Murthy SSN. Jeediflavone- a bioflavonoid from *Semecarpus anacardium*. Phytochem. 1984;23(11):925-927.
- 13 Murthy SSN. A bioflavonoid from *Semecarpus anacardium*. Phytochem. 1983;22:1518-1520.
- 14 Murthy SSN. A biflavanone from *Semecarpus anacardium*. Phytochem. 1983;22:2636-2638.
- 15 Gedam PH, Sampathkumaran PS, Sivasamban MA. Composition of bhilawanol from *Semecarpus anacardium*. Indian J Phytochem. 1974;13:513-515.
- 16 Sharma S, Rastarangini, by P kashinathshatri, commentary by shri Haridattashastri (motilal Banarasidas, Varanasi). 1975:735.
- 17 Chopra RN. Indigenous drugs of India. 2nd ed. Calcutta: Academic Publishers; 1982.; pp. 407-9.
- 18 Premalatha B.; Sachdanandam P. Effect of *Semecarpus anacardium* nut milk extract on rat serum alpha-fetoprotein level in aflatoxin B1-mediated hepatocellular carcinoma. Fitoterapia. 1999;70(3):279-283.
- 19 Premalatha B, Sachdanandam P. *Semecarpus anacardium* L nut extract administration induces the in vivo antioxidant defense system in aflatoxin B1 mediated hepatocellular carcinoma. J Ethnopharmacol. 1999;66:131-139.
- 20 Mathivadhani P, Shanthi P, Sachdanandam P. Effect of *Semecarpus anacardium* nut extract on ECM and proteases in mammary carcinoma rats. Vascul Pharmacol. 2007;46(6):419-426.
- 21 Premalatha B, Sachdanandam P. Stabilization of lysosomal membrane and cell membrane glycoprotein profile by *Semecarpus anacardium* Linn. Nut milk extract in experimental hepatocellular carcinoma. Phytother Res. 2000;14:352-355.
- 22 Premalatha B, Sujatha V, Sachdanandam P. Modulating effect of *Semecarpus anacardium* Linn. nut extract on glucose metabolising enzymes in aflatoxin B1 induced experimental hepatocellular carcinoma. Pharmacol Res. 1997;36:187-192.
- 23 Veena K, Shanthi P, Sachdanandam P. The biochemical alterations following administration of Kalpaamruthaa and *Semecarpus anacardium* in mammary carcinoma. Chem Biol Interact. 2006;161(1):69-78.
- 24 Smit HF, Woerdenbag HJ, Singh RH, Meulenbeld GJ, Labadie RP, Zwaving JH. Ayurvedic herbal drugs with possible cytostatic activity. J Ethnopharmacol. 1995;47(2):75-84.
- 25 Premalatha B, Sachdanandam P. Modulating role of *Semecarpus anacardium* L. nut milk extract on aflatoxin B(1) biotransformation. Pharmacol Res. 2000;41(1):19-24.
- 26 Chakraborty S, Roy M, Taraphdar AK, Bhattacharya RK. Cytotoxic effect of root extract of *Tiliacora racemosa* and oil of *Semecarpus anacardium* nut in human tumour cells. Phytother Res. 2004;18(8):595-600.
- 27 Arathi G, Sachdanandam P. Therapeutic effect of *Semecarpus anacardium* Linn. nut milk extract on carbohydrate metabolizing and mitochondrial TCA cycle and respiratory chain enzymes in mammary carcinoma rats. J Pharm Pharmacol. 2003;55(9):1283-90.
- 28 Mathivadhani P, Shanthi P, Sachdanandam P. Apoptotic effect of *Semecarpus anacardium* nut extract on T47D breast cancer cell line. Cell Biol Int. 2007;31:1198-206.
- 29 Arulkumaran S, Ramprasath VR, Shanthi P, Sachdanandam P. Alteration of DMBA-induced oxidative stress by additive action of a modified indigenous preparation-- Kalpaamruthaa. Chem Biol Interact. 2007;167:99-106.
- 30 Sugapriya D, Shanthi P, Sachdanandam P. Restoration of

- energy metabolism in leukemic mice treated by a siddha drug: *Semecarpus anacardium* Linn. nut milk extract. Chem Biol Interact. 2008;173:43-58.
- 31 Patel SR, Suthan AP, patel RM. in-vitro cytotoxicity activity of *Semecarpus anacardium* extract against Hep2 cell line and Vero cell line. International Journal of Pharm Tech Research. 2009;1(4):1429-1433.
- 32 Sowmyalakshmi S, Nur-E-Alam M, Akbarsha MA, Thirugnanam S, Rohr J, chendil D. Investigation on *Semecarpus anacardium* L a siddha medicine for breast cancer. Planta. 2005;220(6):910-918.
- 33 Farooq SM, Alla TR, Rao NV, Prasad K, Shalam K, Satyanarayana S.A. study on CNS effect of nut milk extract of *Semecarpus anacardium*. Pharmacology. 2007;1:49-63.
- 34 Vinutha B, Prashanth D, Salma K, Sreeja SL, Pratiti D, Padmaja R, Radhika S, Amit A, Venkateshwarlu K, Deepak M. Screening of selected Indian medicinal plants for acetylcholinesterase inhibitory activity. J Ethnopharmacol. 2007;109(2):359-63.
- 35 Bos G. "Baladhur (marking nut)-a popular medicinal drug for strengthening memory" Bulletin of the School of Oriental and African Studies, University of London. 1996;59(2):229-236.
- 36 Ramprasath VR, Shanthi P, Sachdanandam P. Immunomodulatory and antiinflammatory effects of *Semecarpus anacardium* LINN. Nut milk extract in experimental inflammatory conditions. Biol Pharm Bull. 2006;29:693-700.
- 37 Bhitre MJ, Patil S, Kataria M, Anwikar S, Kadri H. Antiinflammatory activity of the fruits of *Semecarpus anacardium* Linn. Asian J Chem 2008;20:2047-50.
- 38 Satyavati GV, Prasad DN, Das PK, Singh HD. Antiinflammatory activity of *Semecarpus anacardium* Linn. A preliminary study. Indian J Physiol Pharmacol. 1969;13:37-45.
- 39 Singh D, Agarwal A, Mathias A, Naik S. Immunomodulatory activity of *Semecarpus anacardium* extract in mononuclear cells of normal individuals and rheumatoid arthritis patients. J Ethnopharmacol. 2006;108:398-406.
- 40 Premalatha B, Sachdanandam P. Potency of *Semecarpus anacardium* Linn. Nut milk extract against aflatoxin B(1)-induced hepatocarcinogenesis: Reflection on microsomal biotransformation. Pharmacol Res. 2000;42:161-166.
- 41 Mythilypriya R, Shanthi P, Sachdanandam P. Therapeutic effect of Kalpaamruthaa, a herbal preparation on adjuvant induced arthritis in wistar rats. Inflammopharmacology. 2008;16:21-35.
- 42 Verma N, Vinayak M. *Semecarpus anacardium* nut extract promotes the antioxidant defence system and inhibits anaerobic metabolism during development of lymphoma. Biosci Rep. 2009;29(3):151-64.
- 43 Sahoo AK, Narayanana N, Sahanaa S, Rajanb SS, Mukherjee PK. In vitro antioxidant potential of *Semecarpus anacardium* L. Pharmacologyonline. 2008;3:327-35.
- 44 Vanu Ramkumar Ramprasath, Palanivelu Shanthi and Panchanatham Sachdanandam; *Semecarpus anacardium* Linn. nut milk extract, an indigenous drug preparation, modulates reactive oxygen/nitrogen species levels and antioxidative system in adjuvant arthritic rats. Molecular and Cellular Biochemistry. 2005;276:97-104.
- 45 Shanmugam Arulkumaran, Vanu Ramkumar Ramprasath, Palanivelu Shanthi2 and Panchanatham Sachdanandam; Restorative effect of Kalpaamruthaa, an indigenous preparation, on oxidative damage in mammary gland mitochondrial fraction in experimental mammary carcinoma. Molecular and Cellular Biochemistry. 2006;291: 77-82.
- 46 Krishnamurthi Veena, Palanivelu Shanthi and Panchanatham Sachdanandam; Therapeutic efficacy of Kalpaamruthaa on reactive oxygen/nitrogen species levels and antioxidative system in mammary carcinoma bearing rats. Molecular and Cellular Biochemistry. 2007;294:127-135.
- 47 Mohanta TK, Patra JK, Rath SK, Pal DK, Thatoi HN. Evaluation of antimicrobial activity and phytochemical screening of oils and nuts of *Semecarpus anacardium*. Sci Res Essay. 2007;2:486-90.
- 48 Nair A, Bhide SV. Antimicrobial properties of different parts of

- Semecarpus anacardium*. Indian Drugs. 1996;33:323-328.
- 49 Sharma K, Shukla SD, Mehta P, Bhatnagar M. Fungistatic activity of *Semecarpus anacardium* Linn. nut extract. Indian J Exp Biol. 2002;40(3):314-8.
- 50 Sharma A, Barman N and Malwal M. Antimicrobial efficacy of nut oil of *Semecarpus anacardium*: A marking nut tree. Biotechnology. 2010;9(3):383-386.
- 51 Sharma A, Verma PK, Dixit VP. Effect of *Semecarpus anacardium* fruits on reproductive function of male albino rats. Asian J Androl. 2003;5:121-124.
- 52 Mary NK, Babu BH and Padikkala J. "Antiatherogenic effect of Caps HT2, a herbal Ayurvedic medicine formulation". Phytomedicine. 2003;10(6):474-482.
- 53 Sharma A, Mathur R, Dixit VP. Hypocholesterolemic activity of nut shell extract of *Semecarpus anacardium* (Bhilawa) in cholesterol fed rabbits. Indian J Exp Biol 1995;33:444-448.
- 54 Arul B, Kothai R, Christina AJ. Hypoglycemic and antihyperglycemic effect of *Semecarpus anacardium* Linn in normal and streptozotocin-induced diabetic rats. Methods Find Exp Clin Pharmacol. 2004;26:759-762.
- 55 Kothai R, Arul B, Kumar KS, Christina AJ. Hypoglycemic and antihyperglycemic effects of *Semecarpus anacardium* linn in normal and alloxan-induced diabetic rats. J Herb Pharmacother. 2005;5(2):49-56.
- 56 Jaya Aseervatham, Shanthi Palanivelu and Sachdanandam Panchanadham. *Semecarpus anacardium* (Bhallataka) Alters the Glucose Metabolism and Energy Production in Diabetic Rats. Hindawi Publishing Corporation Evidence-Based Complementary and Alternative Medicine. 2011.
- 57 Sharma Sadanand, Rastarangini, by P Kashinath shastri, commentary by Shri Haridatta shastri (Motilal Banarsidas, Varanasi), 1975:670.