



SEMECARPUS ANACADIUM LINN: A REVIEW

Dilip Kumar Tiwari* and Dr. Neeraj Upmanyu

People's University Bhopal.

***Corresponding Author: Dilip Kumar Tiwari**

People's University Bhopal.

Article Received on 04/03/2019

Article Revised on 25/03/2019

Article Accepted on 15/04/2019

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

The Indian knowledge of herbal medicines is gaining widespread acceptance globally. In Ayurveda, almost all medicinal preparations are derived from plants, whether in the simple form of raw plant materials or in the refined form of crude extracts, mixtures and so on.^[1] 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.^[2]

Semecarpus anacardium is a well known medicinal plant in Ayurvedic medicine. Semecarpus anacardium Linn. (Family: Anacardiaceae) is distributed in sub-Himalayan region, tropical and central parts of India. The nut is commonly known as 'marking nut' and in the vernacular as 'Ballataka' or 'Bhilwa'.^[3,4] It is one of the most powerful and fast acting Ayurvedic herbs. It is used extensively in piles, skin diseases, etc. Since it is very hot in potency, it is used only after purification procedures.

Chemical and phytochemical analyses of Semecarpus anacardium reveal the presence of bioflavonoid, phenolic compounds, bhilawanols, minerals, vitamins and amino acids. A variety of nut extract preparations from this source are effective against many diseases, viz., arthritis, tumors, and infections and so on. However, the mechanism of the pharmacological action of its nut can be greatly aided by the isolation of its active principle and determination of structure-function relationship.

The aim of this review is to further highlight recently discovered effects and applications of *S. anacardium*.

Taxonomical Classification

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

Botanical Description

It is a medium sized to large tree, 15-25m in height with a grey bark exfoliating in small irregular flakes. Leaves are simple, alternate, obviate oblong, rounded at the apex, coriaceous, glabrous above and more or less pubescent beneath, main nerves 15-25 pairs. Flowers are greenish white fascicled in pubescent pedicles. Fruits are obliquely ovoid or oblong drupes and 2-5cm long. The upper portion of the fruit is cup shaped smooth, fleshy, orange red in colour and sweet & edible when ripe. It is formed of the thickened disc and accrescent calyx base. The lower base which may be turned the nut, consists of smooth, black shining pericarp which is thick, containing between its outer and inner laminae oblong cells full of a corrosive resinous juice. This juice is white when the fruit is immature, but brownish or quite black when the fruit is ripe. The nut is approximately 1" x 0.75" x 0.33" and weighs on an average 3.5g.^[4] Marking nut tree is similar to the cashew nut tree, in having an edible false fruit that is orange & fleshy, like the cashew nut, the true fruit is black oily and bitter, the kernels of the nut are edible, but the juice of the nut is highly vesicant, and has

been traditionally used to mark cloth by washermen. The tree bark exudes a gum resin used in leprosy, venereal infections and nervous debility, juice from the nut is used in ascites, rheumatism, asthma, neuralgia, epilepsy and psoriasis, as well as for warts and tumours, the juice of the nut was effective against epidermal carcinoma, it also has some antidiabetic activity, nut bruised and the exudates is used as an abortifacient and a vermifuge.^[6]

SYNONYMS

Common names in Sanskrit: Antahsattva, Arusharah, Aruskara (Arukara), Arzohita, Balla'ta (Bhallata, Ballata), Bhallataka (Bhallataka), Bhallatakah, Viravrksa, Visasya; in English: Indian Marking Nut Tree, Marsh Nut, Oriental Cashew Nut; in Hindi: Bhela (Bhel), Bhelwa, Bhilawa (Bhilv), Bhilwa; in Tamil: Erimugi

(Erimuki); in Telugu, Nallajeedi; in Gujarati: Bhilamu; in Russian: Semekarpus Anakardii.

Phytochemistry / Chemical constituents

The most significant components of the *S.anacardium* Linn. are bhilwanols, phenolic compounds,^[7,8] biflavonoid,^[9] sterols, anacardoside,^[8,10] semecarpetin, nallaflavanone, jeediflavanone, semecarpufflavanone, galluflavanone, anacarduflavone^[12], bhilawanol-A, bhilawanol-B, amentoflavone^[11], tetrahydroamentoflavone, semicarpol^[13], anacardic acid, tetrahydrobustaflavone^[14], Otrimethyl biflavanone A1, O-trimethyl biflavanone^[15] A2, O-tetramethyl biflavanone A1, O-hexamethyl bichalcone A, O-dimethyl biflavanone B^[16], O-heptamethyl bichalcone B1^[17], O-hexamethyl bichalcone B2 and Otetramethyl biflavanone C.^[18,19,20,21]

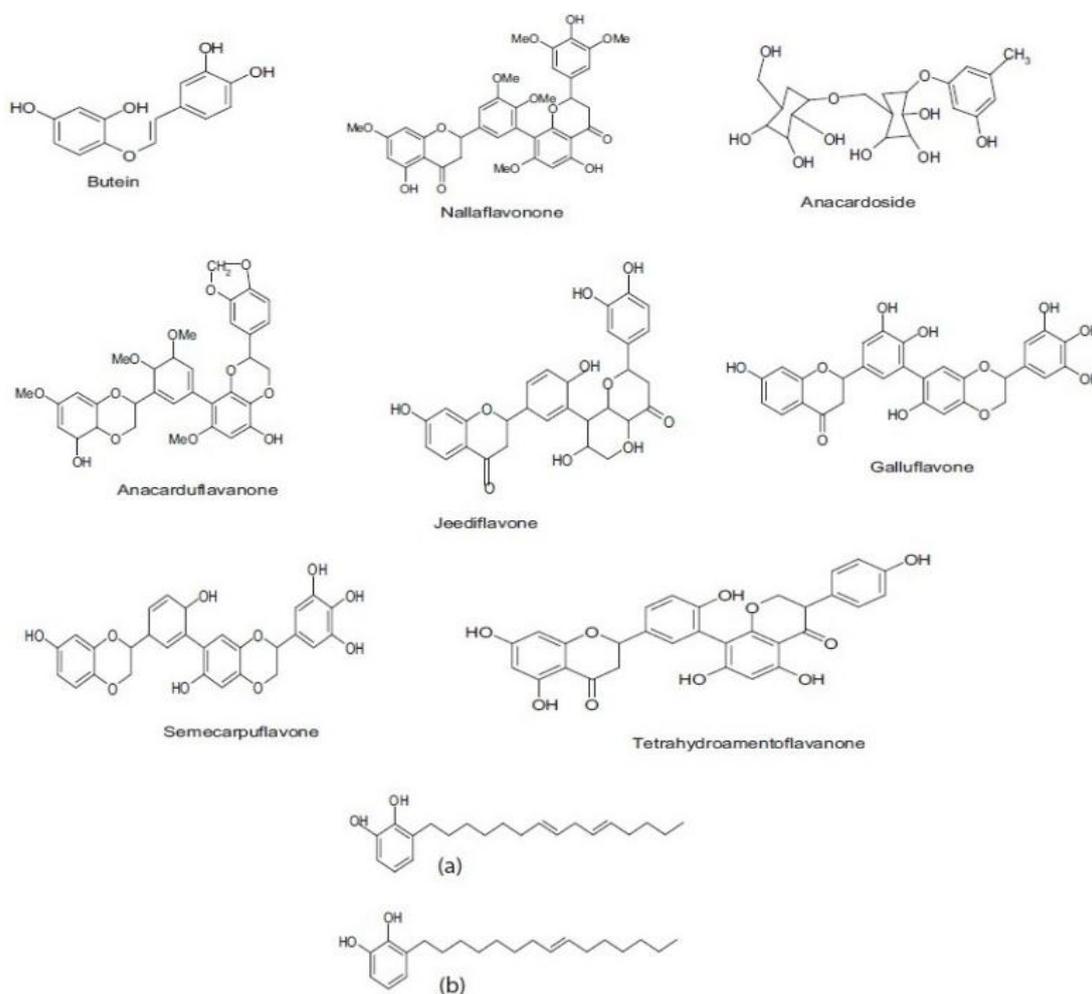


Figure 2: Biochemical constituents of *S. anacardium*. (a) and (b)) are cytotoxic compounds.

Antiatherogenic effect the imbalance between the pro-oxidants and antioxidants is the main cause of development of atherosclerosis. To prevent such condition, antioxidant therapy is beneficial. *Semecarpus anacardium* (SA) shows such antioxidant property. It has capacity to scavenge the superoxide and hydroxyl radicals at low concentrations. The process of

atherogenesis initiated by peroxidation of lipids in low-density lipoproteins was also found inhibited by SA.^[22]

Cardioprotective Effect Asdaq et al found that of hydroalcoholic extract of *Semecarpus anacardium* nuts (SANE) against isoproterenol (ISO) induced myocardial damage in rats. A change in biomarkers and antioxidants levels reflects the influence of prophylactic treatment.

The CK-MB activities were fallen in serum and elevated in heart tissue of animals treated with low and high doses of SANE as well as PRO compared to ISO control. The LDH activity were significantly reduced in serum with both and high doses of SANE while no change was noted in heart tissue with both doses compared to ISO control. Further, high and low doses of SANE caused significant elevation in SOD and CAT activities compared to ISO control^[23]

Anti inflammatory activity Ramprasath et al. investigated the antiinflammatory effects of SA nut extract on developing and developed adjuvant arthritis. *Semecarpus anacardium* significantly decreased the carrageenan-induced paw edema and cotton pellet granuloma. These results indicate the potent antiinflammatory effect and therapeutic efficacy of SA Linn. Nut extract against all phases of inflammation is comparable to that of indomethacin.^[24]

Selvam et al investigated the Bioactivity guided fractionation of ethyl acetate extract led to the isolation of major active principle, tetrahydroamentoflavone (THA), a biflavonoid. The in vitro cyclooxygenase (COX-1) catalyzed prostaglandin biosynthesis assay of THA gave an IC₅₀ value of 29.5 µM (COX-1) and 40.5% inhibition at 100 µg/mL (COX-2). The in vivo carrageenan induced paw edema assay resulted in dose dependent anti-inflammatory effect of THA and the activity was comparable to that of ibuprofen, one of the well known NSAIDs.^[25]

Patil et al investigated that aqueous extract of *Semecarpus Anacardium* fruit for acute and sub-acute antiinflammatory property in albino rats and compared with the reference drug indomethacin. It was found that percentage reduction in the paw- oedema was 58.13% with Indomethacin, 48.83% and 53.48% with 100 mg/kg and 200 mg/kg *Semecarpus Anacardium* extract. Reduction in the granuloma formation was 60.2% with Indomethacin, 54.7% and 56% with 100 mg/kg and 200 mg/kg *Semecarpus Anacardium* extract respectively.^[26]

CNS activity Farooq et al. evaluated the beneficial effect of nuts of SA, extracted with milk, on CNS, mainly for its locomotor and nootropic activities in different experimental animal models. The extract tested but a slight CNS depressant effect was noted with only 150 mg/kg of the extract and it was found to possess nootropic activity.^[27]

Antimicrobial activity Mohanta et al. prepared the aqueous and organic solvent extracts of the plant and screened for antimicrobial (disc diffusion method) and phytochemical properties. The petroleum ether (PEE) and aqueous extract fractions (AQE) showed inhibitory activity against *Staphylococcus aureus* (10 mm) and *Shigella* (16 mm) at 100 mg/ml, respectively. While chloroform extract showed inhibition against *Bacillus licheniformis*, *Vibrio cholerae* and

Pseudomonas aeruginosa, the ethanol extract showed inhibition to *Pseudomonas aeruginosa* and *S. aureus*.^[28]

Nair et al. found that the alcoholic extract of dry nuts of SA (Bhallatak) 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 antibacterial properties, especially the leaf extract. No dermatotoxic effect (irritant property) was observed in the mouse skin irritant assay.^[29]

A Parag et al was investigated that the antimicrobial activity of the methanolic leaf extract of *Semecarpus anacardium* L. against medicinally important bacteria *Staphylococcus epidermidis* (ATCC 12228), *Micrococcus luteus* (ATCC10240), Methicillin-resistant *Staphylococcus aureus* (Hospital-isolate), *Propionibacterium acnes* (MTCC 1951) and yeast, *Malaassezia furfur* (MTCC 1374) using the MIC and MBC/MFC analysis. The lowest MIC and MBC values were obtained for *Staphylococcus epidermidis* which was 100 mg/mL. The methanolic leaf extracts were subjected to evaluation for antioxidant activity by DPPH free radical scavenging method and Nitric oxide radical scavenging method. Using DPPH method, IC₅₀ values for methanolic leaf extract was 916.58 ± 2.14 µg/mL and for ascorbic acid was found to be less than 20 µg/ml respectively. IC₅₀ values for methanolic leaf extract and ascorbic acid was found to be 51.33 ± 2.00 µg /ml and 36.81 ± 2.06 µg /ml respectively using Nitric oxide radical scavenging method. The antioxidant activity of these extracts can be attributed to the presence of tannins, saponins and flavonoids.^[30]

Zabin et al. found that the petroleum ether nut extract of *Semecarpus anacardium* exhibited antibacterial property against gram positive bacteria and gram negative bacteria by Agar well method. The nut extract showed inhibitory activity against test organisms like *Escherichia coli* (19 mm), *Micrococcus luteus* (23 mm), *Salmonella typhi* (26mm), *Bacillus subtilis* (14 mm) and *Klebsiella pneumonia* (22 mm). The antibacterial activity of nut extract of *Semecarpus anacardium* is due to Petroleum Ether extractable compound.^[31]

Antioxidant activity Pal et al found that petroleum ether and ethanol extracts of nuts of *S. anacardium* showed higher antioxidant activity than other extracts of it. The antioxidant activities of the extracts are close and identical in magnitude and comparable to that of standard antioxidant compounds used. The antioxidant activities of the extracts were concentration dependant.^[32]

Balachandra et al study the effect of *Semecarpus anacardium* nut milk extract on AFB1 mediated

hepatocellular carcinoma. This extract was administered orally (200 mg/kg body weight/day) for 14 days to hepatocarcinoma bearing rats. The level of lipid peroxides and antioxidant enzymes' activity were determined in liver and kidney homogenates. Marked increase in lipid peroxide levels and a concomitant decrease in enzymic antioxidant levels were observed in carcinoma induced rats, while drug treatment reversed the conditions to near normal levels.^[33]

*Sumithira P et al was checked the active principle compound of *Semecarpus anacardium* for antiviral and antioxidant activity. Both plant extract was non toxic to the Vero cell line. The antiviral activity was done using MTT assay for measles for mumps virus. The antioxidant activity of the two medicinal plants was evaluated using DPPH assay. The extract of the *Semecarpus anacardium* showed potent antioxidant activity when compared with known synthetic standard of Butylated Hydroxy Toluene (BHT)^[34]

Anthelmintic activity Pal et al. found that the different extracts of nuts of *Semecarpus anacardium* were evaluated separately on adult Indian earthworm (*Pheritima posthuma*). It was found that petroleum ether, chloroform extract of *S. anacardium* (PESA and CESA, respectively) showed better anthelmintic activities than ethanol (EESA) and aqueous (AESA) extract of it. The anthelmintic effects of PESA and CESA at 10 mg/ml and EESA at 20 mg/ml concentration are comparable to that of the effects produced by the reference standards, albendazole (10 mg/ml) and piperazine citrate (10 mg/ml).^[35]

Antifungal activity Jain et al. investigated that different Concentration of methanolic extract of *Semecarpus anacardium* L. nuts oils (6.25, 12.5, 25, 37.5, 50, 62.5 µg/ml) of *S. anacardium* were tested against four fungal strains namely *Fusarium oxysporum*, *Rhizoctonia solanii*, *Alternaria spp.*, and *Sclerotium rolfsii*. The excellent inhibitory activity was observed against *Rhizoctonia solanii* (100%) followed by *Sclerotium rolfsii* (92.59 %), *Alternaria spp.* (72.34 %) and *Fusarium oxysporum* (47.19 %) at 62.5 µg/ml. Among different fungi tested *R. solanii* and *Sclerotium rolfsii* were found to be more sensitive to crude extract when compared to others.^[36]

Immunomodulatory activity Singh et al study that ethanolic extract of SA nuts for its anti-inflammatory activities in vitro using peripheral blood and synovial fluid mononuclear cells of healthy individuals and rheumatoid arthritis (RA) patients. SA extract inhibited the spontaneous and LPS induced production of pro inflammatory cytokines IL-1 and IL-12p40 but had no effect on TNF- and IL-6 production, both at protein and mRNA level. The crude extract also suppressed LPS induced nuclear translocation of transcription factors, NF-B and AP-1; the inhibition of NF-B was through the inhibition of IB phosphorylation. The extract also

suppressed LPS activated nitric oxide production in mouse macrophage cell line.^[37]

Antiulcer Activity Kumar et al investigated that methanolic and aqueous extracts of *Semecarpus anacardium* seeds for gastric protective activity on ethanol plus pylorus ligation induced ulcer models. a number of biochemical parameters such as gastric volume, pH of gastric content, free acidity and total acidity, dissolved mucous substances such as total protein, hexoses, hexosamine, fucose and sialic acid were estimated in 90% alcoholic precipitate of gastric juice and macroscopically sections were examined on the test and control group animals. the extract at a concentration of 200mg/kg produced a protective effect on ulcer-induced models and was comparable with the standard drug cimetidine. some of the antioxidant enzyme levels (lipid peroxidation, superoxide dismutase and catalase) were also determined.^[38]

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 (anti hyperglycemic) 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.^[39]

Krishnamurthy et al. developed Kalpaamruthaa (KA), a modified Siddha preparation, which contains SA Linn., EO and honey, and studied for the variations in lipids, lipid-metabolizing enzymes and lipoproteins in cancerous animals and the effect of KA on the lipid metabolism. The 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. The effects of KA were found to be more effective than SA.^[40]

Anti-carcinogenic activity Mathivadhani et al. studied SA nut extract for inhibitory effect on human breast cancer cells (T47D). Cytotoxicity analyses suggested that these cells had become apoptotic. *Semecarpus anacardium* was discovered to induce rapid Ca(2+) mobilization from intracellular stores of T47D cell line, and its cytotoxicity against T47D was well correlated with altered mitochondrial transmembrane potential. 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. Taken together, our results provide unprecedented evidence that SA triggers apoptotic signals in T47D cells.^[41]

Arulkumaran et al. investigated the protective efficacy of preparation named as Kalpaamruthaa (KA) (includes 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. DMBA-treated rats also showed decline in the activities of mitochondrial enzymes. In contrast, rats treated with SA and KA showed normal lipid peroxidation antioxidant defenses in mitochondrial enzymes, and indicate the anticarcinogenic activity of KA during DMBA initiated mammary carcinogenesis. On the basis of the observed results, KA can be considered as a readily accessible, promising and novel cancer chemopreventive agent.^[42]

Sugapriya et al. showed restoration of energy metabolism in leukemic mice treated by SA nut milk extract. Leukemia bearing mice showed a significant increase in LPOs, glycolytic enzymes, a decrease in gluconeogenic enzymes and significant decrease in the activities of TCA cycle and respiratory chain enzymes as compared to control animals. *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.^[43]

Mallik et al. were studied the in vitro cytotoxic activity of ethanolic extract of *Semecarpus* on two different cell lines.

The 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay of ethanolic extract was carried out on HeLa and SiHa cell lines for determination of cytotoxicity. The IC₅₀ values of ethanolic extract of *S. anacardium* in HeLa and SiHa cell lines were 44.0 µg/ml and 57.0 µg/ml, respectively. The extract was standardized by thin-layer chromatography and Gas chromatography-mass spectrometry.^[44]

Reproductive Function (Antispermato-genic Effect)

Semecarpus anacardium extract feeding caused antispermato-genic effect evidenced by reduction in numbers of spermato-genic cells and spermatozoa in male albino rats.^[41] Vinutha et al. investigated for SA (stem bark), extracts including methanolic and successive water extracts for acetylcholinesterase (AChE) inhibitory activity (in vitro). Results indicated that methanolic extracts to be more active than water extracts. The potent AChE-inhibiting methanolic plant extracts of SA (stem bark) comes to be 38 g/ml.^[45]

Nephrotoxicity Choudhari et al. studied the toxicity study on a few blood parameters in male albino rats at acute and sub-chronic levels with SA nut oil extract (50% w/v) in ground nut oil. Albino rats (Wistar strain) were treated orally with three sub-lethal doses. There was a significant decrease in hemoglobin percent and lowering of erythrocytes, indicating 'anemia' during toxicity study. He also evaluated the acute and sub-

chronic effect of crude extract on activity of some kidney enzymes GOT, GPT, SDH, LDH and histology of kidney of albino rat (Wistar strain) in either sex. Significant alteration in activity levels of marker enzymes of kidney as well as histological structure leading to nephritis were observed, indicating renal dysfunctioning in albino rat. Results exhibited nephrotoxicity inducing potential of SA nut oil extract.^[46,47]

Prabhu et al. studied the antimutagenic effect of SA under in vivo condition. Mice were intraperitoneally treated with 500 and 250 mg/kg of SA, which. Showed a significant inhibition of induced aberrations at the 12 h pretreatment period. The results on the reduction of induced chromosome aberrations clearly show that SA serves as an antioxidant because of the presence of flavonoids which scavenge free radicals. The action of SA oil extract has definite beneficial role against mitomycin-C induced mutagenicity and its administration may be protective and therapeutic.^[48]

In this study, Krishnarajua et al. found that aqueous extracts of medicinal plants were screened for their cytotoxicity using brine shrimp lethality test. Out of the 120 plants tested, SA (*Anacardiaceae*) showed significant cytotoxicity with LC₅₀ 29.5 µg, respectively.^[49]

Toxicity Since *Bhallataka* 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. For its allergic reactions like rash, itching and swelling, the antidotes used externally are coconut oil, rala ointment, ghee, coriander leaves pulp or butter mixed with *musta* (*Cyperus rotundus*). 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 oily part of the nut is toxic and its degree of removal is proportional to its safety margin.

Nephropathy is associated with exposure to toxins of plant origin. It was noted that with the exception of *Djenkol* bean nephrotoxicity, SA toxins lead to acute renal failure due to hemodynamic effects.^[50]

Traditional Uses

Bhallataka is used for hair care in traditional system of medicines.

CONCLUSION

Semecarpus anacardium is used for various medicinal properties. The fruit and nut extract shows various activities like antiatherogenic, anti-inflammatory, antioxidant, antimicrobial, anti-reproductive, CNS stimulant, hypoglycemic, anticarcinogenic and hair growth promoter. More efforts are needed to study the

traditional uses of the plant and the subsequent validation of activity and the mechanism of action.]

REFERENCES

- Farnsworth NR, Soejarto DD. Global importance of medicinal plants. In: Akerele O, Heywood V, Syngé H editors. *Conserv Med Plants*. New York. Cambridge University Press, 1991; 2551.
- Dhalla S, Chan KJ, Montaner JS, Hogg RS. Complementary and alternative medicine use in British Columbia: A survey of HIV positive people on antiretroviral therapy. *Complement Ther Clin Pract*, 2006; 12: 242-8.
- Chopra RN. *Indigenous drugs of India*. 2nd ed. Calcutta. Academic Publishers, 1982; 4079.
- Khare CP. *Encyclopedia of Indian medicinal plants*. *Encyclopedia of Indian Medicinal Plants.*, 1982; 419-21.
- Kirtikar KR, Basu BD. *Indian medicinal plants*. Dehradun, India: International Booksellers and Publishers, 1975; 3: 667.
- 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.
- Mathur HN, Agarwal JS. Phenolic modified resin of oil varnishes. *J Sci Indian Res.*, 1953; 12: 411.
- Rao NS, Row LR, Brown RT. Phenolic constituents of *Semecarpus anacardium*. *Phytochemistry*, 1973; 12: 671-81.
- Ishatulla K, Ansari WH, Rahman W, Okigawa M, Kawanon N. Bioflavanoids from *Semecarpus anacardium* linn. *Indian J Chem.*, 1977; 15: 617-22.
- Govindachary TR, Joshi BS, Kamal VM. Phenolic constituents of *Semecarpus anacardium*. *Indian J Chem.*, 1971; 9: 1044.
- Indap MA, Ambaye RY, Gokhale SV. Anti tumour and pharmacological effect of oil from *Semecarpus anacardium* Linn. *f. Indian J Physiol Pharmacol*, 1983; 27: 83-91.
- Majumdar SH, Kulkarni SB, Chakraborty GS. Medicinal potentials of *Semecarpus anacardium* nut: A review. *J Herb Med Toxicol*, 2008; 2: 9-13.
- Murthy SS. Semicarpetin: A biflavonoid from *Semecarpus anacardium*. *Phytochemistry*, 1988; 27: 3020-2.
- Murthy SS. New dimeric flavone from *Semecarpus anacardium*. *Proc Indian Natl Sci Acad*, 1987; 57: 632.
- Murthy SS. A biflavonoid from *Semecarpus anacardium*. *Phytochemistry*, 1985; 24: 1065-70.
- Murthy SS. Confirmation of the structure of Jeediflavonone: A biflavonone from *Semecarpus anacardium*. *Phytochemistry*, 1984; 23: 925-7.
- Murthy SS. A biflavonone from *Semecarpus anacardium*. *Phytochemistry*, 1983; 22: 1518.
- Murthy SS. Naturally occurring biflavonoid derivatives: Galluflavonone, a new biflavonoid from *Semecarpus anacardium*. *Indian J Chem.*, 1985; 24: 398-402.
- Gedam PH, Sampathkumaran PS, Sivasamban MA. Composition of bhilawanol from *Semecarpus anacardium*. *Indian J Phytochem*, 1974; 13: 513-5.
- Murthy SS. New biflavonoid from *Semecarpus anacardium* linn. *Clin Acta Turcica*, 1992; 20: 30.
- Rahman KM, Rahman MS, Begum Rashid B. Preliminary cytotoxicity screening of some medicinal plants of Bangladesh, Dhaka Univ. *J Pharm Sci.*, 2008; 7: 47-52.
- 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: 444-8.
- Asdaq SMB, Chakraborty M. Myocardial potency of *semecarpus anacardium* nut extract against isoproterenol induced myocardial damage in rats *International Journal of Pharmaceutical Sciences Review and Research*, 2010; 22: 10-17.
- Ramprasad 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.
- Selvam C, Jachak SM. A cyclooxygenase (COX) inhibitory biflavonoid from the seeds of *Semecarpus anacardium*. *J Ethnopharmacol*, 2004; 95: 209-12.
- Patil Savita, Gumma Kashinath, Md Mateenuddin. Study of anti-inflammatory property of aqueous extract of *semecarpus anacardium* fruit in rats *Linn Int J Cur Res Rev.*, Oct, 2013; 05(20): 101-104
- Farooq SM, Alla TR, Rao NV, Prasad K, Shalam K, Satyanarayana S. A study on CNS effect of nut milk extract of *Semecarpus anacardium*. *Pharmacologyonline*, 2007; 1: 49-63.
- 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.
- Nair A, Bhide SV. Antimicrobial properties of different parts of *Semecarpus anacardium*. *Indian Drugs*, 1996; 33: 323-8.
- Parag.Raman Bhanu Assessment of *semecarpus anacardium* (linn.f.) leaf methanolic extract for their antibacterial, antifungal and antioxidant activity *International Journal of Pharmacy and Pharmaceutical Sciences*, 2013; 5(1): 170-174.
- Bagewadi Zabin K, Siddanagouda R. S and Baliga Praveen G. Phytochemical Screening and Evaluation of Antimicrobial Activity of *Semecarpus anacardium* Nuts *International Journal of Pharmacology and Pharmaceutical Technology (IJPT)*, ISSN: 2277 – 3436, 2012; 1(2): 68-74.
- Pal D. K, Kumar S. Chakraborty P, Kumar M. A study on the antioxidant activity of *Semecarpus anacardium* L.f. nuts *Journal of Natural Remedies*, 2008; 8/2: 160–163.
- Balachandran Premalatha, Vallinayagam Muthulakshmi *Semecarpus anacardium* Nut Extract

- Induced Changes in Enzymic Antioxidants Studied in Aflatoxin B1 Caused Hepatocellular Carcinoma Bearing Wistar Rats International Journal of Pharmacognosy, 2008; 35(3): 161–166.
34. Sumithira P", S. Dhivya Mangala", A.M. Sophie' and C. Padma Latha Antiviral and antioxidant activities of two medicinal plants Int J Curr Sci., 2012; 256-261.
 35. Pal Dilip Kumar, Mohapatra Tapas Kumar Evaluation of anthelmintic activity of nuts of *Semecarpus anacardium* Ancient science of life, January, February, March – 2008; XVII(3): 41-44.
 36. Jain Paras, Singh Soni Kumari, phytochemical screening and antifungal activity of *semecarpus anacardium* l. (an anti-cancer plant IJPSR, 2014; 5(5): 1884-1891.
 37. Singh Divya, Agrawal Amita, Immunomodulatory effect of *semecarpus anacardium* extract in mononuclear cell of normal individual & rheumatoid arthritis patient Journal of Ethanopharmacology, 2006; 108: 398-406.
 38. Kumar Manoj, Jangra Meenu1, Sharma Sunil Evaluation of antiulcer activity of various extracts of *Semecarpus anacardium* seeds Pharmacognosy, Journal | February, 2011; 3(20): 38-41.
 39. 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: 759-62.
 40. Veena K, Shanthi P, Sachdanandam P. The biochemical alterations following administration of *Kalpaamruthaa* and *Semecarpus anacardium* in mammary carcinoma. Chem Biol Interact, 2006; 161: 69-78.
 41. 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.
 42. 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.
 43. 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.
 44. Mallic Nasar k, Khan Washim, Singh Mahaveer In vitro anticancer potential of *Semecarpus anacardium* Linn Drug Development and Therapeutics, Jan-Jun, 2016; 7(1): 55-58.
 45. Vinutha B, Prashanth D, Salma K, Sreeja SL, Pratiti D, Padmaja R, et al. screening of selected Indian medicinal plants for acetyl cholinesterase inhibitory activity. J Ethnopharmacol, 2007; 109: 359-63.
 46. Choudhari CV, Deshmukh PB. Acute and subchronic toxicity study of *Semecarpus anacardium* on hemoglobin percent and R.B.C. count of male albino rat. J Herb Med Toxicol, 2007; 1: 43-5.
 47. Choudhari CV, Deshmukh PB. Effect of *Semecarpus anacardium* pericarp oil extract on histology and some enzymes of kidney in albino rat. J Herb Med Toxicol, 2008; 2: 27-32.
 48. Prabhu D, Rajwani LS, Desai PV. The antimutagenic effect of *Semecarpus anacardium* under in vivo condition. Asian J Chem, 2005; 12: 13-6.
 49. Krishnarajua AV, Rao TV, Sundararajua D, Vanisreeb M. Assessment of bioactivity of Indian medicinal plants using brine shrimp (*Artemia salina*) lethality assay. Int J Appl Sci Eng, 2005; 3: 125-34.
 50. Matthai TP, Date A. Renal cortical necrosis following exposure to sap of the marking-nut tree (*Semecarpus anacardium*). Am J Trop Med Hyg, 1979; 28: 773-4.