

International Journal of Pharmacognosy and Pharmaceutical Sciences



ISSN Print: 2706-7009
ISSN Online: 2706-7017
IJPPS 2023; 5(1): 105-110
www.pharmacognosyjournal.net
Received: 22-11-2022
Accepted: 29-12-2022

Swati M Wakchoure
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Puja G Raut
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Sachin N Jadhav
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Dhananjay Kinikar
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Harshada Dhangar
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Corresponding Author:
Swati M Wakchoure
Assistant Professor,
Department of
Pharmacognosy, SSJCOP,
Asangaon, Thane, Mumbai,
Maharashtra, India

Multipotential traditional plant wood apple (*Limonia acidissima*): A review

Swati M Wakchoure, Puja G Raut, Sachin N Jadhav, Dhananjay Kinikar and Harshada Dhangar

DOI: <https://dx.doi.org/10.33545/27067009.2023.v5.i1b.120>

Abstract

Plants are a significant source of medicine and are crucial to attaining WHO goals for the welfare of all people. As more people become aware of natural goods, *Limonia acidissima* L. (wood apple, elephant apple, monkey fruit) of the Rutaceae family has emerged as one of the most valued plants due to its numerous medical characteristics. Recognizing and identifying various chemical components of the plant that are significant in the field of medicine is the major goal of the current investigation. So, an effort has been made in this article to research the literature on various phytoconstituents, therapeutic benefits, pharmacological activity, and ethno botanical applications and herbal formulation of *Limonia acidissima* L. The compiled plant knowledge can be applied to a variety of medical fields.

Keywords: *Limonia acidissima* L., Phytochemicals, Ethno medicinal, Pharmacological potential, Cosmetics, Marketed formulation

Introduction

Native to the arid plains of India and Ceylon, elephant apples are frequently seen growing wild there. They are also frequently grown in orchards, along highways, and along the borders of fields. Moreover, it is cultivated in Southern America, northern Malaysia, tropical and temperate Asia. *Limonia acidissima* (L.) is a member of the monotypic genus *Limonia*, which is only found in Southeast Asia, India, Pakistan, and Sri Lanka. It is a member of the Rutaceae (Citrus family) family [1] It goes by several other names, including kath bel, kaitha, curd fruit, monkey fruit, and wood apple. For the treatment of a number of illnesses, this plant is administered as medication. *L. acidissima* is a slow-growing, deciduous tree that is upright with a few upward-reaching branches that curve outward at the summit and are split into thin branch lets with drooping ends. a wood-apple.

It has long been known that medicinal herbs or plants may be a valuable source of therapies or curative help. India is renowned around the world for its ancient expertise of "Ayurveda." Ayurvedic knowledge has been used to treat a wide variety of illnesses. Wood apples are very valuable medicinally. Each component of the fruit has therapeutic value. By lowering blood glucose levels, wood apples have anti-diabetic and antioxidant properties. Due to its potential radical scavenging activity of various phytochemicals, wood apple fruit is regarded as one of the natural sources of antioxidants and its anti-oxidant properties using various extracts have been extensively studied [2].

Vernacular Names

English: Wood Apple, Elephant Apple, Monkey Fruit or Curd Fruit

Hindi: Kaitha, Kath Bel or Kabeet

Oriya: Kaitha

Sanskrit: Kapittha or Dadhistha.

Telugu: Vellaga Pandu

Tamil: Vilam

Palam Malayalam: Vilam Kai

Bengali: Koth Bel

Gujarati: Kothu

Malaysia: Belinga

Fig 1: *Limonia acidissima* L. plantFig 2: *Limonia acidissima* L. Fruit**Classification****Family:** Rutaceae**Kingdom:** Plantae**Sub-kingdom:** Tracheobionata**Super division:** Spermatophyta**Division** Magnoliophyta**Class:** Magnoliophyta**Subclass:** Rosidae**Order:** Sapindales**Genus:** *Limonia*. L**Species:** *L. acidissima***Table 1:** Chemical constituents of different parts of *Limonia acidissima* L [1, 2, 3, 5]

Plant part	Chemical Constituents
Fruit	Polyphenols, Vitamins, Saponins, Coumarins, Amino acids, Tri-terpenoids, Phytosterols, Tannins, Flavonoids, Steroids, Glycosides, Fat, Calcium, Magnesium, Iron, Umbelliferone, Dictamnine, Xanthotoxol, Scoparone, Xanthotoxin, Isopimpinellin, Isoimperatorin and Marmin
Leaves	Acidissimi, Acidissiminol. Alkaloids, Phenolsresins, Gum and mucilage, Fixed oils and fats, Stigmasterol, Psoralen, Bergapten, Orientin, Vitedin, Saponarin, Tannins, Essential oil.
Bark	Marmesin, Feronolide, Feronone
Fruit pulp	Carbohydrates, Protein, Fat and dietary fibre
Seed	Fixed oil, Carbohydrates, Proteins, Amino acid
Roots	Bargapten, Osthol, Isopimpinellin, Marmesin, Marmin. Feronia lactone, Geranylum, Belliferone
Shell	Psoralene, Xanthotoxin, 2, 6-dimethoxybenzoquinone, Osthenol Amino acid
Unripe Fruit	Stigmasterol
Pulp	5,4-dihydroxy-3-(3-methyl-but-2-enyl) 3,5,6-trimethoxyflavone 7-O-b-D-glucopyranoside, Citric acid, fruit acids, Mucilage, minerals, Alkaloids, Coumarins, Fatty acids, Sterols, Umbelliferone, Dictamnine, Xanthotoxol, Scoparone, Xanthotoxin, Isopimpinellin, Isoimperatorin, Marmin

Table 2: Medicinal Uses of *Limonia acidissima* L [1, 3, 4]

Plant part	Medicinal Uses
Fruit	Liver tonic, Astringent, Cardiac tonic, Sore throat and Diseases of the gums, Peptic ulcer, tumors, hepatitis, In blood purification, Stomachic, Stimulant, Diuretic, aphrodisiac, liver tonic, anti-as, stomachic, Stimulant, diuretic, Aphrodisiac, liver tonic, anti-asthmatic, antidiarrheal, leucorrhoeal, antidiarrheal, leucorrhoeal
Leaves	Astringent, Flatulence, Diarrhoea, Dysentery (especially in children) and Haemorrhoids, Indigestion, Breast cancer, Uterus cancer, Infertility, Progesterone deficiency, flu and respiratory disorders, Astringent, Carminative and Hepatoprotective activity
Bark	Venomous wounds, Pon crushing, Demulcent, Constipating, Anti-diarrheal and Anti-haemorrhoidal

Traditional uses of *Limonia acidissima* L

Wood Apple is thought to be quite effective in preventing sunstroke and many other summertime health problems. To help prevent piles and ulcers, wood apples contain tannin and phenolic compounds that are strong in antioxidant qualities. It also aids in the treatment of diarrhoea, dysentery, and other conditions. Wood apples help cleanse the body because they contain the molecules riboflavin and thiamine. Its juice keeps the intestines healthy while reducing any renal issues. Because of its known expectorant qualities, wood apples are thought to be beneficial in treating a variety of respiratory illnesses like asthma, bronchitis, and sore throats. It boosts defences against bacterial, fungal, and viral infections. Due to its high fibre content, it has laxative qualities and hence aids in digestion.

The leaves contain tannins and an essential oil. They are astringent and are used internally, often combined with milk and sugar, in the treatment of indigestion, flatulence, diarrhoea, dysentery (especially in children) and haemorrhoids [1]. An oil derived from the crushed leaves is applied on itchy skins [1]. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhoea in children [1].

Effect of active constituents *Limonia acidissima* L and Cosmetic [6]

Flavonoids: Polyphenolic substances known as flavonoids are found in nature. Flavonoids are secondary plant metabolites that have antioxidant properties and share the chromane ring with tocopherols. In this activity, the primary

mechanisms involve the direct induction of oxygen and nitrogen free radicals, as well as the inhibition of enzymes that produce oxygen radicals. During tissue inflammation and reperfusion, "iron chelation and decrease of leukocyte adherence to the blood vessel wall is used.

Cosmetics

- Flavonoids play a key role in the ageing process of the skin. By preventing extracellular matrix-degrading enzymes like collagenase, elastases, and hyaluronidases from breaking down the extracellular matrix, flavonoids like kaempferol postpone skin ageing.
- Flavonoids provide the best Antioxidant activity and protect the product from rancidity. The pulp of *Limonia acidissima* L. contains ascorbic acid which is responsible for antioxidant activity.
- Flavonoids also give anti-bacterial, anti-microbial and anti-fungal properties. Quercetin has been reported to completely inhibit the growth of *Staphylococcus aureus*.

Tannins

Tannins are a diverse category of high molecular weight polyphenolic chemicals that include proteins, polysaccharides, alkaloids, nucleic acids, and minerals, among other things. Gallotannins, Ellagitannins, Complex Tannins, and Condensed Tannins are the four groups of tannins based on their structural similarities. In 1905, (Maximilian Nierenstein) investigated the natural tannins present in many plant species.

Cosmetics

- Tannin contains precipitate proteins that are used to heal burns and protect inflamed skin surfaces,
- Tannins have antimicrobial, antioxidant, and astringent properties.
- Tannins slow down the ageing process of the skin.
- Tannins also protect against hair loss.

Saponin

Saponins are bioactive substances that are mostly produced by plants. Chemically, they exist as polycyclic triterpenes or steroid glycosides. They can interact with cell membranes and lower the surface tension of an aqueous solution due to their lyobipolar characteristics. The term "saponin," which is derived from the Latin word "sapo," alludes to the stable soap-like foam that results from this process in an aqueous solution.

Cosmetics

- Saponins are recognised as natural surfactants; in aqueous solutions like soap, they produce stable foam.
- They serve as a foaming agent in toothpaste, liquid detergent, and shampoo.
- As an emulsifier and long-lasting foaming agent, saponins are also employed.
- Cosmetics using anti-oxidant, anti-aging, and regenerative saponin extract as an active component

Alkaloids

Alkaloids get their name from the word "alkaline," which was once used to denote any base that included nitrogen. They are often organic bases that combine with acids to generate salts, which, when soluble, result in alkaline

solutions. Alkaloids are a class of chemical substances that exist in nature and mostly include basic nitrogen atoms. Several related chemicals with neutral or even mildly acidic characteristics are also a part of this group.

Cosmetics

- Alkaloids are in charge of an object's antibacterial and antifungal properties.
- Due to their capacity to operate as scavengers of free radicals, donate hydrogen or electrons, or have metal chelating activity, pyridine alkaloids have been reported to have significant antibacterial capabilities and have antioxidant activities.
- Alkaloid has a warming effect that might be applied, for example, to the treatment of the feet.
- Alkaloids work to prevent wrinkles.
- Moreover, alkaloids aid with skin tightening.

Pharmacological Activity of *Limonia acidissima* L

Anti-Diarrhoeal activity

Plants include a variety of beneficial chemical compounds that are used to alleviate diarrhoea.

Alcoholic and aqueous extracts of *Limonia acidissima* Linn's bark were tested for their ability to treat diarrhoea and reduce gastrointestinal motility. The passage of charcoal meal through the gastrointestinal system was greatly slowed down by ethanol extract, which demonstrated notable anti-diarrheal action.

Anti-diabetic activity

Plants include a variety of beneficial chemical components, including flavonoids and phenols that are used to treat diabetes. Methanolic extract, aqueous stem bark extract, and fruit extract were used to carry out the anti-diabetic activities. In streptozotocin-induced diabetic rats, the anti-diabetic activity of 95% ethanolic extracts of unripe wood apple fruits was assessed at 250mg/kg body weight, and it was discovered that it significantly decreases blood glucose levels in the fasted, fed, and streptozotocin-induced diabetic rats. In rats with diabetes brought on by alloxan, hypoglycemic effects are also seen ^[2].

Anticancer activity

L. acidissima Linn fruit. 's extract has anticancer properties ^[13]. Fruit extracts from fractions one through four as well as the crude extract (ethanolic extract) were utilised to ascertain the ED50 value in two distinct breast cancer cell lines, SKBR3 and MDAMB-435, which represents a 50% reduction of cancer cell growth. the bio-assays of *L. acidissima* Linn extracts. In the human breast cancer cells SKBR3 and MDAMB-435, the ethanolic extract demonstrated an anticancer impact. This fraction, at a concentration of 100 g/ml, dramatically decreased cell growth in both cancer cells after 48 hours of treatment. Cell cycle examination of the fruit extract fraction 3 in MDAMB-435 cells revealed that it caused an increase of cells in the G2/M phase, however in SKBR3 cells, no appreciable alteration in the cell cycle was found ^[14].

Anti-oxidative property

Antioxidant activity of the crude methanol extract of *Limonia acidissima* L. stem bark and its various organic soluble partitionates were examined ^[15]. On the stable radical 1,1-diphenyl-2-picrylhydrazyl (DPPH), the

partitionates' antioxidant (free radical scavenging) activity was assessed. The crude methanolic extract's chloroform soluble fraction (CL) has the greatest capacity to scavenge free radicals. The pet ether soluble fraction (PE) also showed significant antioxidant activity at the same time. By using the FRAP and DPPH radical scavenging assays, the methanolic extract of *Limonia* fruit was further examined for its capacity to scavenge free radicals [15]. Several *Limonia acidissima* leaf extracts have been shown to have *in vitro* antioxidant activity [16, 17].

Hepatoprotective

The ethanolic extract of *L. acidissima* fruit pulp's hepatoprotective potential was examined in rats whose livers had been injured by carbon tetra chloride (CCl₄). MELA demonstrated a notable dose-dependent protective effect against CCl₄-induced liver damage, which is mostly attributable to the extract's antioxidant properties [18].

Bio sorbent

As a biosorbent, *Limonia acidissima*'s leftover fruit shell is employed. For the elimination of methylene blue from aqueous solution, powdered raw materials and treated materials (raw materials treated with acid) of certain micron sizes were utilised. The outcomes shown that chemically treated material removes colour more successfully than raw material at higher temperatures. The latter is a regulating element for adsorption. Temperature rise impacts the solubility and chemical potential of the adsorption. The highest amount of dye is removed from treated material (35 °C) and raw material (25 °C) [19].

Antibacterial activity

It was discovered that *Limonia acidissima*. leaves' ethanolic extract has a wide range of action against both Gram-positive and Gram-negative bacterial strains that cause the most prevalent bacterial illnesses 36,18,15. By using the agar well diffusion technique, the antibacterial activity was assessed against Gram-positive and Gram-negative microorganisms. Hexane extract was found to be less active, whereas chloroform extract had mild to moderate activity and methanol extract shown strong antibacterial activity with substantial inhibition zones [20].

Antifungal Activity

The pulp of the *Fredonia Limonia* Linn fruit shown antifungal activity against various pathogenic fungi when it was extracted using different solvents (petroleum ether, chloroform, methanol, and water). Eight different fungus were examined, and the plant's essential oil showed antifungal effectiveness against all of them [21].

Antihyperlipidemic activity

Fruit powder administered for 28 days at doses of 2.5, 5 and 10 g/kg body weight decreased lipid profiles and hepatic glucose-6-phosphatase while significantly raising hepatic glycogen, hexokinase, and HDL. It may be caused by the presence of fibres, phytosterols, saponins, polyphenols, flavonoids, and ascorbic acid.

Antimicrobial Action

According to reports, Gram-positive and Gram-negative bacteria, which cause the majority of bacterial illnesses, are

both sensitive to ethanolic extract from *Limonia acidissima* L. leaves.

Wound Healing properties

Rate experiments were conducted using methanol extract of *Limonia acidissima* L. fruit pulp. When the extracts were applied to the wound in the excision model, the wound gradually shrank and needed a mean of 16.0 +/- 0.8 days to heal properly. Incision wound models treated with MELA showed increased wound breaking strength and shorter epithelization times [23].

Adsorbent

Limonia acidissima L.'s leftover fruit shell is employed as an adsorbent. In this procedure, activated carbon made from the shell of the *Limonia acidissima* L. plant was used to remove the methylene blue dye from any solution. The adsorptive removal of the dye methylene blue is significantly influenced by the agitation time, dye concentration, adsorbent dosage, and temperature [24].

Diuretic activity

The diuretic activity of the *Limonia acidissima* may be due to the presence of triterpenoids, glycoside, flavonoid, polyphenols and coumarin found in the methanolic extracts (obtained through the MAE and BSE).

Anti-inflammatory activity

Wood apple is also rich in anti-inflammatory properties helping reduce the risks of cardiovascular diseases. Having wood apples during monsoons will help in preventing infections due to bacteria and virus. Wood apple is also known to improve and boost your metabolism.

Analgesic activity

A daily spoonful of dried apple peels for 12 weeks resulted in subjects with moderate loss of range of motion in their joints and related chronic pain to experience improvements in their necks, shoulders, backs, and hips, as well as lower pain scores.

Neuroprotective activity

Wood apple's neuroprotective properties were examined, and it was discovered that at doses of 250 mg and 500 mg per kilogramme of body weight, it protects rats' brains from damage caused by ischemia and reperfusion.

Spermatotoxic activity

By administering ethanolic extracts at 250 and 500 mg/kg to adult male rats for 55 days, researchers were able to study the wood apple fruit pulp's antispermatogenic activities and determine that they were the cause of the drop in sperm count, motility, and viability. Moreover, by 24.58% and 29.86%, respectively, they increased the fraction of defective sperm and decreased testicular protein content [27].

Larvicidal activity

The larvicidal and pupicidal activities of the extracts are excellent. *L. acidissima*'s hexane extract has ovicidal efficacy against *Cx. Quinque fasciatus* and *Ae. Aegypti* eggs at 79.2% and 60%, respectively, at 500 ppm concentration [28]. At 3% aqueous extract, wood apple leaf kills *Culex quinquefasciatus* larvae with a 90% success rate. Moreover, the chloroform and methanol extract exhibits 95% mortality

at 100 ppm. The presence of a terpene in wood apple leaves, which prevents *Aedes aegypti* eggs, larvae, and pupae from developing, led to the discovery of mosquitocidal action [30].

Antiulcer activity

The phenolic compounds presents in the fruit is responsible for protection against ulcer on gastric wall and leucocytes infiltration of submucosal layers.

Side effect of Wood apple (elephant apple fruit)

- Ripened fruit is heavy for digestion and intake excess quantity can lead to decrease digestive capacity
- Hyperacidity if taken in excess quantity
- Unripe fruit is not ideal in case of throat or voice disorder

Ayurvedic Medicines containing Kapitta-Elephant apple

- Vajra Kapat rasa- For treatment of diarrhea and mal absorption syndrome
- Nyagrodhadi choorna-In urinary obstruction, dysuria, urinary disorder, diabetes
- Dashamoolarishta- Used in anemia, after delivery care of mother, cold, cough, digestive disorder

Conclusion

Wood apple, or *Limonia acidissima* L., is another name for this member of the Rutaceae family. The wood apple is well recognised for a variety of qualities in several sectors. A fully ripe fruit may be eaten right away, and it is well known for its blend of sweet and bitter flavours and the variety of meals it can be used in. Wood apple has a variety of medical purposes, including as a tonic for the heart and lungs, an anti-diarrheal in unripe fruit, an anti-diabetic in wood apple leaves, and an anti-sore throat remedy in fruit pulp. Along with its therapeutic benefits, wood apple also demonstrates a number of pharmacological actions, including those for wound healing, antioxidant defence, adsorption, and anti-bacterial, anti-fungal, anti-diabetic, and serum to protective effects. All of these properties are covered in this article. The main aspect of this article is to focus on the cosmetic properties of the wood apple. The various components of the wood apple are in charge of various functions, and we may utilise those functions while making cosmetics. We can utilise an essential oil extract from wood apple leaves in cosmetic products since it has antibacterial properties.

References

1. Dhakar Anjana, *et al.* Pharmacological properties and phytochemical of *Limonia acidissima*: a review. World J Pharm Res. 2019;8:637-645.
2. Bhavsar Smit, *et al.* A Review on Potential of Medicinal Plant: *Limonia acidissima* L. International Association of Biologicals and Computational Digest. 2022;1.2:159-165.
3. Bagul Vishakha, *et al.* Wood Apple (*Limonia acidissima* L.): A multipurpose herb in cosmetics. Int. J. Sci. Dev. and Res. 2019;4(7):172-181.
4. Parvez G, Ranjan Kumar Sarker. Pharmacological potential of wood apple (*Limonia acidissima*): A Review. IJMFM and AP. 2021;7(2):40-47.
5. Bagul Vishakha, *et al.* Wood Apple (*Limonia acidissima* L.): A multipurpose herb in cosmetics. Int. J. Sci. Dev. and Res. 2019;4(7):172-181.
6. Bagul Vishakha, *et al.* Wood Apple (*Limonia acidissima* L.): A multipurpose herb in cosmetics. Int. J. Sci. Dev. and Res. 2019;4(7):172-181.
7. Allen BM. Malayan Fruits. An introduction to cultivated species. Donald Moore Press Ltd. Singapore; c1967.
8. Khare CP. Indian Medicinal Plants: An Illustrated Dictionary, Springer Science, Springer Verlag.
9. Morton JF. Wood-Apple. In: Fruits of warm climates, Flare Books, Miami, Florida, 1987, 19019.
10. Dr. N Sasidharan (Dr. B P Pal Fellow), Kerala Forest Research Institute, Peechi. 5. Bhandari MM. Flora of the Indian desert, Scientifi Publishers, Jodhpur, 1978, 92.
11. Anacletus FC, Nwauche KT, Ugwu GM. Hepatoprotective and nephroprotective potentials of aqueous leaves extract of *Limonia acidissima* in phenylhydrazineinduced anaemic wistar Rats. Asian J Pharma. Res. Develop. 2019;7(1):27-33.
12. Aneesha A, Rao RN, Tejaswini SN, Durga LSA, Haseena SK, Maneesha B. Phytochemical studies and anti-ulcer activity of *Limonia acidissima* linn. leaf in treating ethanol induced ulcer Albino rats. Indian J Res. Pharm. Biotec. 2018;6(3):104-110.
13. Dhanamani M, Lakshmi Devi S, Kannan S. Ethnomedicinal plants for cancer therapy: A review. Hygeia j drugs med. 2011;3:1-10.
14. Pradhan D, Tripathy G, Patnaik S. Screening of antiproliferative effect of *Limonia acidissima* Linn. Fruit extracts on human breast cancer cell lines. Afri J Pharm Pharmacol. 2012;6:468-473.
15. Anitha S, Umadevi S, Savita H, Geetha D, Srinivas K. Therapeutic effect of wood apple on hypertension and diabetes. Eco. Env. & Cons. 2015;21(2):1101-1106.
16. Attarde DL, Chaudhari BJ, Bhambar RS. Phytochemical investigation and *in vitro* antioxidant activity of extracts from leaves of *Limonia acidissima* linn. (Rutaceae). J pharmres. 2011;4:766.
17. Merinal S, Viji Stella Boi G. *In vitro* antioxidant activity and total phenolic content of leaf extracts of *Limonia crenulate* (Roxb.) J Nat. Prod. Plant Resour. 2012;2:209-214.
18. Ilango K, Chitra V. Wound Healing and Anti-oxidant Activities of the Fruit Pulp of *Limonia acidissima* Linn (Rutaceae) in Rats. Trop J Pharm Res. 2010;9:223-230.
19. Torane RC, Mundhe KS, Bhav AA, Kamble GS, Kashalkar RV, Deshpande NR. Removal of Methylene Blue from Aqueous Solution Using Biosorbent. Der Pharma Chemical
20. Vijayvargia P, Vijayvergia R. A review on *Limonia acidissima* L.: Multi potential medicinal plant. Int J Pharm Sci Rev Res. 2014;28(1):191-195.
21. Chitra V. Hepatoprotective and antioxidant activities of fruit pulp of *Limonia acidissima* linn. International Journal of Health Research. 2009, 2(4).
22. Ilango K, Chitra V. Wound healing and anti-oxidant activities of the fruit pulp of *Limonia acidissima* Linn (Rutaceae) in rats. Tropical Journal of Pharmaceutical Research, 2010, 9(3).
23. Senthilkumar KL, Kumawat BK, Rajkumar M. Antidiarrhoeal activity of bark extracts of *Limonia acidissima* Linn. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2010;1(4): 550-553.

24. Bhadusha N, Ananthabaskaran T. Adsorptive Removal of Methylene Blue onto ZnCl₂ Activated Carbon from Wood Apple Outer Shell: Kinetics and Equilibrium Studies, E-Journal of Chemistry; c2011. p. 1696-1707
25. Krishna D, Padma Sree R. Removal of chromium from Aqueous-solution by *Limonia acidissima* hull powder as adsorbent, i-manager's Journal of Future Engineering & Technology. 4, 23-36.
26. Chromium in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, Guidelines for drinking-water quality, World Health Organization, Geneva. 1996;2:1-6.
27. Balamuruganvelu S, Abilash SC, Shree Lakshmidivi S, Geethavani B, Premlal KR, Jaikumar S, *et al.* Antioxidant Activity of *Limonia acidissima* In high fat diet induced hyperlipidemic rats. Int. J. Phytopharm. 2015;6(4):181-183.
28. Banerjee Indrani, Ravindra C Pangule, Ravi S Kane. Antifouling coatings: recent developments in the design of surfaces that prevent fouling by proteins, bacteria, and marine organisms. Advanced materials. 2011;23(6):690-718.
29. Reegan Appadurai Daniel, *et al.* Effect of niloticin, a protolimonoid isolated from *Limonia acidissima* L. (Rutaceae) on the immature stages of dengue vector *Aedes aegypti* L. (Diptera: Culicidae). Acta tropica. 2014;139:67-76.
30. Banerjee Indrani, Ravindra C Pangule, Ravi S Kane. Antifouling coatings: recent developments in the design of surfaces that prevent fouling by proteins, bacteria, and marine organisms. Advanced materials. 2011;23(6):690-718.