

FERONIA LIMONIA – A PATH LESS TRAVELLED

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ABSTRACT

From ancient days to recent civilization, human beings depend on nature for running their life smoothly from day to day. Plants remain a vital source of drugs and now a day's much emphasis have been given to nutraceuticals. *Feronia limonia* belonging to family Rutaceae is well known in Indian traditional systems for its traditional uses. Various parts of the plant have astringent, constipating, tonic for liver and lung, diuretic, carminative, and cardiotoxic traditional uses. Various important phytoconstituents like alkaloids, phenolic compounds, triterpenoids, coumarins, tannins, steroids etc. have been isolated from Kavith. But only few pharmacological activities like antimicrobial, antiviral, antitumour, antifungal and CNS depressant activity have been scientifically reported. From enormous traditional uses documented in various traditional system of medicine and presence of vital phytoconstituents make Kavith (*Feronia limonia*) an important plant to be studied scientifically to prove various traditional uses. In present review we explore Kaitha's description, traditional medicinal uses, phytoconstituents and investigated pharmacological activities in various parts of the plant to show potential ethnopharmacological importance of the plant. So that this review can serve as ready to use material for further research on the plant.

KEY WORDS: *Feronia limonia*, Traditional uses, phytoconstituents, wood apple

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INTRODUCTION

Throughout the ages, humans have relied on Nature for their basic needs for the production of food-stuffs, shelters, clothing, means of transportation, fertilizers, flavours and fragrances, and, not the least, medicines. Plants have formed the basis of sophisticated traditional medicine systems that have been in existence for thousands of years and continue to provide mankind with new remedies. The vast majority of people on this planet still rely on their traditional material medica (medicinal plants and other materials) for their everyday health care needs.

It is also a fact that one quarter of all medical prescriptions are formulations based on substances derived from plants or plant-derived synthetic analogs, and according to the WHO, 80% of the world's population—primarily those of developing countries—rely on plant-derived medicines for their healthcare.

It is likely that the profound knowledge of herbal remedies in traditional cultures developed through trial and error over many centuries, and that the most important cures were carefully passed on verbally from one generation to another. People who use traditional remedies may not understand the scientific rationale behind their medicines, but they know from personal experience that some medicinal plants can be highly effective if used at therapeutic doses. Since we have a better understanding today of how the body functions, we are thus in a better position to understand the healing powers of plants and their potential for their potential as multi-functional chemical entities for treating complicated health conditions. Medicinal plants typically contain mixtures of different chemical compounds that may act individually, additively or in synergy to improve health¹.

The wealth of India is stored in the enormous natural flora which has been gifted to her. Endowed with a diversity of agro-climatic conditions, India is virtually herbarium of the world. The importance of medicinal and aromatic plants has been emphasized from time to time. It is believed that the drug of natural origin shall play an important role in health care particularly in the rural areas of India².

India is having a rich knowledge of phytotherapy from Ayurveda and still hundreds of potent drugs are yet to be evaluated scientifically. Keeping this in view we reviewed one of the potential tree whose fruits are edible and other parts also have potent traditional application but it has not been much studied. So this review will be a ready to use material for budding pharmacologist to evaluate the traditional uses of Kaitha (**Fig 1**), botanical name is *Feronia limonia*.

Taxonomical Classification³

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Sapindales
Family	:	Rutaceae
Genus	:	Limonia

Parts used⁴

Fruits, gum, leaves, bark and pulp are used traditionally.

Synonyms⁵

Limonia elephantum (Correa) Panigrahi, *Limonia acidissima* L., *Schinus limonia* L.

Indian Names⁶

Beng.	:	Kayat Bael, Kavataleal, Kavita
Eng.	:	Wood Apple,
Guj.	:	Kotha, Kondhu
Hindi	:	Kaitha
Kan.	:	Bekalu, Belada hannu, Bilvara, Belalu, Balada, Haminamara
Mar.	:	Kavatha
Punj.	:	Kainth

Tam. : Vilamaram, Vilangai
Tel. : Velaga
Urdu : Kaith

Growth and Distribution

Throughout India, in the hotter and drier parts up to 450m⁷. Also cultivated in Bangladesh, Pakistan and Srilanka⁸. Propagation is done by seed and vegetative method⁹. But high rate of seedling mortality and outbreeding nature of this plant account for poor regeneration and inferior germplasm. To overcome this, *in vitro* propagation through axillary bud proliferation has been developed¹⁰⁻¹¹.

MORPHOLOGY

A moderate-sized tree with straight sharp strong spines 1.2-3.7 cm long. Leaves smelling of aniseed, alternate, imparipinnate; petiole and rachis flat, often narrowly winged; leaflets 3-9, opposite, 2.5-5 by 1.2-2.5 cm., cuneate or obovate, tip often crenulated. Calyx small, 5-6 lobed; lobes triangular. Petals 5-6, free, elliptic-oblong, 5 mm. long, spreading or deflexed. Stamens 10-12, 1-seriate; filaments equal subulate, densely hairy at the base within; anthers large, linear-oblong. Ovary glabrous sessile. Fruits 5-6.3 cm., globose, hard; pericarp woody, rough, grey-colored. Seeds embedded in an edible pulp¹².

ETHNOMEDICAL USES

Various parts of wood apple have been utilized against various ailments in ethnomedicine.

Unripe Fruits

The unripe fruits are sour, aromatic, astringent, constipating, alexipharmic and are useful in diarrhoea, pruritus and pharyngodynia. The unripe fruit is alexipharmic, astringent to the bowels; removes itching of the body; increases "vata", "pita", and "kapha". Useful in whooping cough. The Hindus consider the unripe fruit to be a useful astringent in diarrhoea and dysentery. It is used as substitute for bael (*Eagle marmelos*) in the treatment of diarrhoea and dysentery^{4-5, 7-8, 12-15}.

Ripe Fruits

In Ayurveda the fruits are considered as sour, sweet, acrid, with flavour and taste; difficult to digest; refrigerant, aphrodisiac, alexipharmic; cures cough, dysentery, heart diseases, vomiting; removes biliousness, "vata", "tridosah", and blood impurities, fatigue, thirst, hiccough; good for throat, asthma, consumption, tumours, ophthalmia, leucorrhoea, the juice put in the ear cures earache. According to Yunani the fruits are cardiogenic, tonic to the liver and the lungs, astringent and binding, diuretic, strengthening the gums; the juice is good for stomatitis, and sore throat; useful in biliousness; topically it relieves pain due to stings of wasps and other insects. They are beneficial in scurvy and sore throat. Fruit pulp is sour, sweet, edible stomachic, stimulant and astringent. The pulp is applied externally as a remedy for the bites of venous insects. Pulp with honey and pipli is given for hiccup and difficulty of breathing. Pulp is used for affections of gums and throat and to tone the breast. Fruit pulp is also used by tribal of Rewa District of Madhya Pradesh against boils and amoebiosis. 50 g pulp of the ripe fruit is mixed in butter milk and taken once daily, for 3 days as vermifuge. 10 g of ripe fruit along with 5 g jiggery is given once a day for 1 month against diabetes^{5,7,9,10,12,16-24}.

Leaves

The leaves are aromatic and carminative, and are prescribed in the indigestions and slight bowel affections of children. The juice of leaves given to children suffering from stomach troubles. The leaves are used in Shahjahanpur district of Uttar Pradesh as astringent, good for vomiting, hiccough and dysentery. The leaves are used traditionally in Ayurveda as antiemetic, aromatic, astringent, carminative, cardiogenic, expectorant, purgative, sudorific, useful in anorexia, bronchitis, calculus, cardiac debility, cough, diarrhoea, gastropathy, hiccup, and in vitiated conditions of vayu^{5, 8, 9,12, 16, 24-26}.

Barks

The bark is aromatic and cooling, and is useful in vitiated conditions of *pitta*. The bark is occasionally prescribed for biliousness and useful in liver diseases.^{4,5,7,8,12,14,15,24-27}

Gum

Transparent gummy substance exuding from the stem when cut and broken resembling gum Arabic, may be used in bowel affections and to relieve tenesmus; reduced to powder and mixed with honey it is given in dysentery and diarrhoea. The gum is demulcent and constipating, and is useful in diarrhoea, dysentery, gastropathy, haemorrhoids and diabetes.^{4,7,8,14}

PHYTOCHEMISTRY

Various parts of *Feronia limonia* contain different chemical components which may be responsible for their varied traditional uses.

Fruits

The fruit contains fruit acids, vitamins and mineral. The dried pulp contains 15% of citric acid, and a small quantity of deliquescent ash consisting of potassium, calcium and iron salt. Seeds and fruits contained oil and protein; oil composed of palmitic, oleic, linoleic and linolenic acids besides traces of palmitoleic and stearic acids; β -sitosterol, β -amyrin, lupeol and stigmasterol from unsaponifiable matter of seed oil. An acidic heteropolysaccharide has been isolated from the ripe fruit which shows antitumor activity against ascites carcinoma cell growth. Three volatile flavour components are obtained from fresh wood apple fruit; they are namely methyl hexanoate, ethyl-3-hydroxyhexanoate, and butanoic acid. The acid-insoluble fraction of the ethereal extract of the dry whole unripe fruit gives stigmasterol. From the methanol extract of defatted fruits of wood apple a new tyramine derivative, dihydroxy acidissiminol was obtained. Two other tyramine derivatives namely, acidissiminol oxide and N-benzoyl tyramine are also reported by Ghosh *et. al.*^{8,9,13,28-32}

Leaves

The leaves and stems contain the coumarins, luvangetin, xanthotoxin and marmesin; the triterpenoids, lupeol and limonin; and the steroids, sitosterol and sitosterol-O- β -D-glucoside. Anisic acid isolated from leaf essential oil as well as methylchavicol, trans-anethole, thymol and p-cymen-7-ol. Estragole, trans-anethole and cis-anethole also determined in leaf oil. The leaves after hydrodistillation yielded an essential oil (0.4%). The essential oil from the leaves has been found rich in methyl chavicol, linalool, caryophyllene, cis-amethole, p-methoxy phenyl-2-propanone, elemicine, 3,4-dimethoxy benzaldehyde and alcohol. Light petroleum ether extract of the leaves afforded stigmasterol; the ether extract gave psorlerin and bergapten while ethyl acetate extract yielded orienthin, vitexin and saporarin. The essential oil is considered as a substitute for anise and funnel oil^{10, 33-38}.

Barks

Two unidentified compounds feronolide (m.p. 115°C) and feonone (m.p. 195°C) isolated from the bark. The stem bark yielded 5,3-dihydroxy-4-methoxy-6,6-dimethylchromeno-flavone along with several known compounds including an alkaloid, five coumarins, a flavonone, a lignin, three sterols and a triterpene^{39,40}.

Roots

The root and root bark were found to contain amino acids, phenolic compounds, sterol and tannins in addition to the alkaloid. Among the amino acids, phenyl alanine, tyrosine and cysteine were found. Maltose and inositol were the sugars present. Phenolic compounds like p-cresol and stigmasterols were also detected. Aurapten, bergapten, isoimpinelline, 6-methoxy-7-geranyloxy coumarin and marmesin isolated from root bark. Roots yielded geranyl umbelliferone, bergapten, osthol, isopimpinelline,

xanthotoxin, marmesin and marmin. A new monoterpenoidfuranocoumarin lactone (fernolin) is isolated from roots of wood apple and its structure is established on the basis of chemical reactions and spectral studies. The petroleum ether extract showed the presence of geranyl umbelliferone, bergapten and osthol whereas the ethanolic extract of roots showed presence of isopimpinelline, xanthotoxin, marmesin and marmin. The roots yielded a flavonoid characterized as 5-hydroxy-2-(4-hydroxyphenyl)-7-methoxy-6-(3-methylbut-2-enyl) chroman-4-one and it is characterized by UV, IR, NMR and mass spectral studies^{28, 41-46}. Structures of some phytochemicals shown in **Fig 2**.

PHARMACOLOGICAL ACTIVITIES

Antibacterial Activity

The essential oil from the leaves of the plant exhibit strong to moderate activity against most of the test organisms. *Bacillus subtilis*, *Escherchia coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Shigella sp.*, *Aspergillus niger*, *Rhizopus nodusus*, *Trichophyton rubrum* 5S and *Trichoderma viride* had remarkable susceptibility to the oil. The oil of wood apple was highly active against *Streptococcus aureus* and *hysterophorus* by using filter paper disc method. The essential oil of the plant showed strong activity against *Clostridium velchii*. Feronia leaf extract was ineffective on *Bacillus pumilus* and *X. campestris*, *Vibrio cholerae* was found quite sensitive to this extract^{47, 48, 49, 50-56}.

Antilarvicidal Activity

Acetone extract of the dried leaves found to be effective against larvae of *Culex quinquefasciatus*, *Anopheles stephensi* and *Aedes aegypti*, with LC₅₀ of 129.24, 79.58 and 57.23 ppm, respectively⁵¹.

Antitumor Activity

Peptic polysaccharide from the plant showed significant *in vivo* Ehrlich ascites carcinoma cell growth inhibition²⁹.

Antifungal Activity

The essential oil from the leaves of the plant exhibited antifungal activity against eight tested fungi⁵².

CNS Depressant and CVS Depressant Activity

The isolated alkaloids from the root and root bark had a depressant action on central nervous system and heart⁴¹.

CONCLUSION

Ethnobotany and ethnopharmacology are interdisciplinary fields of research that look specifically at the empirical knowledge of indigenous peoples concerning medicinal substances, their potential health benefits and their health risks associated with such remedies. As can be seen, many of the plant-derived pharmaceuticals and phytomedicines currently in use were used by native people around the world. Some of this knowledge has been documented and codified or studied scientifically. Also of the hundreds of thousands of species of living plants, only a fraction has been investigated in the laboratory. The importance of ethnobotanical inquiry as a cost-effective means of locating new and useful tropical plant compounds cannot be over emphasized. Most of the secondary plant compounds employed in modern medicine were first discovered through ethnobotanical investigation.

Since we have a better understanding today of how the body functions, we are thus in a better position to understand the healing powers of plants and their potential for their potential as multi-functional chemical entities for treating complicated health conditions. Medicinal plants typically contain mixtures of different chemical compounds that may act individually, additively or in synergy to improve health. A single plant may, for example, contain bitter substances that stimulate digestion, anti-inflammatory compounds that reduce swellings and pain, phenolic compounds that can act as an antioxidant and venotonics, anti-bacterial and anti-fungal tannins that act as natural antibiotics, diuretic

substances that enhance the elimination of waste products and toxins and alkaloids that enhance mood and give a sense of well-being.

Modern allopathic usually aims to develop a patentable single compound or a “magic bullet” to treat specific conditions. Traditional medicine often aims to restore balance by using chemically complex plants, or by mixing together several different plants in order to maximize a synergistic effect or to improve the likelihood of an interaction with a relevant molecular target.

In this background we have selected the plant *Feronia limonia* (L.) (Wood apple) for reviewing its traditional uses, investigated phytochemical and pharmacological activities. From the review it is clear that although the plant is exhaustively used for various ailments in ethnopharmacology as well as having various important chemical constituents but not well studied scientifically for its pharmacological activities. This review provide ready to use material for the budding pharmacologist if they want to work on the plants.

Wood apple is a rare and an endangered tree species but equally a valued plant for its edible fruits and immense medicinal properties. Hence even its *in vitro* propagation has been done by axillary branching and multiple shoot induction. If some of the phytochemicals from wood apple will be proved for its traditional uses, the cultivation of the plant can be done even on the barrel land, and it will be a good profitable business for the farmers as well.

REFERENCES

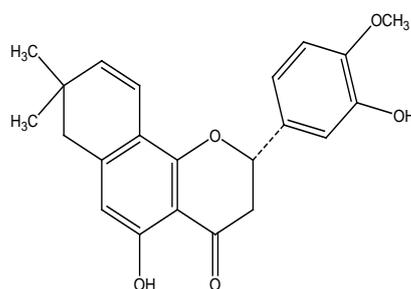
1. Gureeb-Fakem Ameenah. Medicinal plants: Tradition of yesterday drug of tomorrow. Mol. Aspects of Med. 2006; 27:1-93.
2. Devgun Manish, Nanda Arun and Ansari SH. *Pterocarpus marsupium* Roxb.- A Comprehensive Review. Phcog. Rev. 2009; 3(6): 359-363.
3. [http://en.wikipedia.org/wiki/Limonia_\(plant\)](http://en.wikipedia.org/wiki/Limonia_(plant)) accessed on 16-06-2010
4. Panda H. Medicinal Plants Cultivation and Their Uses, (Asia Pacific Business Press, Delhi, year) pp. 301-302.
5. Chatterjee Asima and Pakrashi S C. The Treatise on Indian Medicinal Plants, (Publications and Information Directorate, New Delhi, 1994; pp.100-106.
6. Anonymous. The Ayurvedic Pharmacopoeia of India, (Ministry of Health and Family Welfare, Department of ISM & H, New Delhi, 1999; 72-73.
7. Arya Vaidya Sala. Indian Medicinal Plants (Oriental Longman, place, year) pp. 327-232.
8. Bakshi DNG, Sensarma P and Pai DC. A Lexicon of Medicinal Plants in India, (Naya Prokash, Calcutta, 2001; 186-187.
9. Parajapati ND, Purohit SS, Sharma Arun K. and Kumar Tarun. A Hand Book of Medicinal Plants, (Agrobios, Jodhpur), 2003: pp. 235.
10. Anonymous. The Wealth of India, Vol. III (National Institute of Science Communication, New Delhi, 2002: pp.125.
11. Hiregoudar LV, Murthy HN, Hema BP, Hahn EJ and Paek KY. Multiple shoot induction and plant regeneration of *Feronia limonia* (L.) Swingle. Scienta Horticulturae. 2003; 98: 357-364.
12. Kirtikar KR and Basu BD Indian Medicinal Plants, 2nd ed, Vol. I, (Bishen Singh Mahinder Pal Singh, Dehra Dun, 1998: pp. 496-498.
13. Dymock William, Warden CJH and Hooper David. Pharmacographia Indica, Vol. I, (Shrishti Book Distributors, New Delhi, 2005: pp.281-284.
14. Nandkarni KM. Indian Materia Medica, Vol. I, (Popular Prakashan, Bombay), pp. 535-537.
15. Joshi Shankar Gopal. Medicinal Plants, (Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2004: pp. 347-348.
16. Aslam Mohammad and Masood Anwar. Medicinal trees of Shahjahanpur District of Uttar Pradesh: Chemical composition, medicinal importance and biological activities. In: V.K. Singh, J.N. Govil, Shamima Hashmi and Gurdip Singh. Recent Progress in Medicinal Plants, Vol. VII. Studium Press LLC, USA; 2003. p. 231-239.

17. Jadeja BA, Odedra NK, Danger NR and Baxi US. Ethnomedicinal plants used by the people of Saurashtra to cure diarrhoea. *Plant Archives*. 2005; 5(2): 381-392.
18. Dwivedi SN. Traditional health care among tribals of Rewa district of Madhya Pradesh with special reference to conservation of endangered and vulnerable species. In: J.K.Maheshwari. *Ethnobotany and Medicinal Plants of Indian Subcontinents*. Scientific Publishers, Jadhpur; 2000. pp. 315-319.
19. Warman CK. *Trees of India*. CBS Publishers and Distributors, New Delhi; 1999: pp. 112.
20. Singh VK, Govil JN and Singh Gurdip. *Recent Progress in Medicinal Plants, Vol I*. SCI Tech Publishing LLC, USA; 2002. pp. 113.
21. Pal DC and Jain SK. *Tribal Medicine*. Naya Prokash, Calcutta; 1998. pp. 170-171.
22. Vaidya Bhagwan Dash. *Materia Medica of Ayurveda*. B.Jain Publishers Ltd, 1994. pp. 306.
23. Reddy TVVS, Naidu BVAR and Prasanthi S. Antidiabetic Plants of India, Part-I. In: Irfan Khan and Atiya Khanum, editors. *Antidiabetic Plants of India*. Ukaaz Publications, Hyderabad, 2005. pp. 1-41.
24. Gill AS, Bisaria AK and Shukla SK. Potential of agroforestry as source of medicinal plants. In: J.N.Govil Ed. *Current Concepts of Multidiscipline Approach to the Medicinal Plants (part I)*, Vol. XII. Today & Tomorrow's Printers and Publishers, New Delhi, 1998. pp. 1-28.
25. Rajasab AH and Isaq Mahamad, Documentation of folk knowledge on edible wild plants of North Karnataka. *Indian J. Trad. Knowledge*. 2004; 3(4): 419-429.
26. Ranjan Priya. A contribution to some of the medicinal plants of Indo-Nepal border area adjoining the district of Madhubani and Sitamarhi. In: J. K. Maheshwari. *Ethnobotany and Medicinal Plants of Indian Subcontinental*. Scientific Publishers, Jodhpur, 2000. pp.655.
27. Chopra RN, Nayar SL and Chopra IC. *Glossary of Indian Medicinal Plants*. National Institute of Science Communication and Information Resources, New Delhi, 2002. pp. 117.
28. Rastogi RP and Mehrotra BN. *Compendium of Indian Medicinal Plants, Vol. II*. CDRI, Lucknow and PID, New Delhi, 1995. pp. 317-318.
29. Saima Y, Das AK, Sarkar KK, Sen AK and Sur P. An antitumor pectic polysaccharide from *Feronia limonia*. *Bio. Macromol*. 2000; 27:333-335.
30. MacLeod Alexander J and Pieris NM, Volatile flavour components of wood apple (*Feronia limonia*) and a processed product. *J Agri. Food Chem*. 1981; 29: 49-53.
31. Chakroborty DP. Chemical examination of *Feronia elephantum* Corr. *J Sci. Industr. Res*. 1959; 18 B: 90-91.
32. Ghosh P., Ghosh MK., Thakur SM., Dutta J, Akihisa T, Tamura T, et. al. Dihydroxy acidissiminol and acidissiminol exodie, two tyramine derivative from *Limonia acidissima*. *Phytochem*. 1994; 37(3): 757-760.
33. Rastogi RP and Mehrotra BN. *Compendium of Indian Medicinal Plants, Vol. IV*. CDRI, Lucknow and PID, New Delhi, 1995. pp. 316.
34. Rastogi RP and Mehrotra BN. *Compendium of Indian Medicinal Plants, Vol. V*. CDRI, Lucknow and PID, New Delhi, 1998. pp. 368.
35. Ahmad A, Misra LN, Thakur R.S. Composition of the volatile oil from *Feronia limonia* leaves. *Planta Med.*, 1989; 55(2): 199-200.
36. Garg SC, Essential oil of *Feronia elephantum* Corr: A rich source of methyl chavicol. *Indian Perfumer*. 2003; 47(1): 100-101.
37. Gupta SR., Sehadri TR., Sharma CS., and Sharma ND. Chemical components of *Feronia limonia*. *Planta Med.*, 1979; 36(1): 95-96.
38. Shah NC., Agrawal SK., Ahmed A, and Nigam MC. The essential oil of *Feronia limonia*: a substitute for anise and funnel oils. *Parfum. Kosmet.*, 1985; 66(3): 182-183.
39. Rastogi RP and Mehrotra BN. *Compendium of Indian Medicinal Plants, Vol. I*. CDRI, Lucknow and PID, New Delhi, 1995. pp. 186.
40. Rahman Mohd. Mukhlesur and Gray Alexander I. Antimicrobial constituents from the stem bark of *Feronia limonia*. *Phytochem*. 2002; 59: 73-77.

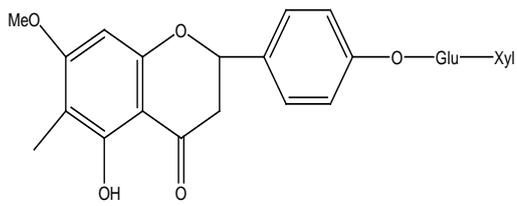
41. Patel BD, Shrivastava R and Uppadhyay RK. Phytochemical and pharmacological studies of root and root bark of *Feronia limonia* (L.) Swingle. *Indian J Forestry*. 1982; 5(1): 14-17.
42. Rastogi RP and Mehrotra BN. *Compendium of Indian Medicinal Plants*, Vol. III. CDRI, Lucknow and PID, New Delhi, 1993. pp. 292.
43. Agrawal A. Siddiqui IR. and Singh J. Coumarins from the roots of *Feronia limonia*. *Phytochem*. 1989; 28(4): 1229-1231.
44. Banerji J, Ghoshal N, Sarkar S and Kumar M. Studies on Rutaceae: Part II-chemical investigations of constituents of *Atalantia wightii*, *limon creniaulata*, *Feronia limonia*, *citrus limon* and synthesis of Luvangetin, xanthyletin and marmin. *Indian J Chem*. 1982; 21B: 496-497.
45. Talapatra SK, Chaudhuri MK and Talapatra B. Coumarins from root bark of *Feronia elephantum*. *Phytochem*. 1973; 12: 236-237.
46. Intekhab Javed and Aslam M. Isolation of a flavonoid from *Feronia limonia*. *J. Saudi Chem. Society*. 2009; 3: 295-298.
47. Garg SC. Antimicrobial activity of the essential oil of *Feronia elephantum* Correa. *Indian J Pharm Sci*. 2001; 63(2): 155-157.
48. Geda Arvind and Bokadia MM. Antimicrobial activity of essential oils on human pathogenic bacteria. *Sci. Cult*. 1980; 46(1): 33-35.
49. Sharma GP. Jain NK. and Garg BD. Antibacterial activity of some essential oils. *Indian Drugs*, 1979; 17(1): 14-15.
50. Mehta P., Chopra S and Mehta A. Antimicrobial properties of some plant extract against bacteria. *Folia Microbiol.*, 1983; 28(6): 467-469.
51. Rahuman A Abdul, Gopalkrishnan Geetha, Ghouse B Saleem, Arumugam S, and Himalayan B. Effect of *Feronia limonia* on mosquito larvae. *Fitoterapia*, 2000; 71: 553-555.
52. Gupta C and Singh VP. *In-vitro* antifungal effect of essential oil of some medicinal plants. *Sci. Cult*. 1982; 48(12): 441-443.
53. Purohit SD and Tak Kiran. *In vitro* propagation of an adult tree *Feronia limonia* L. through axillary branching. *Indian J Exp. Biol.*, 1992; 30: 377-379.
54. Hossain M, Biswas BK, Karim MR., Rahman S, Islam R, and Jorder OI, *In vitro* organogenesis of elephant apple (*Feronia limonia*). *Plant Cell Tiss. Org. Cult*. 1994; 39: 265-268.
55. Handique PJ and Bhattacharjee S, *In vitro* propagation of wood apple (*Feronia elephantum* Correa.). *Ad. Plant Sci*. 2000; 13: 241-243.
56. Hiregoudar LV., Murthy HN. Hema BP. Hahn EJ and Paek KY. Multiple shoot induction and plant regeneration of *Feronia limonia* (L.) Swingle. *Scientia Horticulturae* 2003; 98: 357-364.



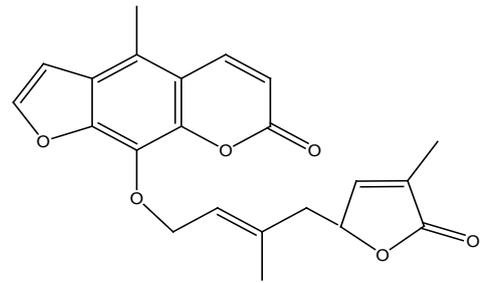
Fig 1: fruits of *Feronia limonia*



(-)-(2S)-5,3'-dihydroxy-4'-methoxy-6'',6''-demethylchromeno-(7,8,2'',3'')-flavanone



Flavone glycoside-7-O-methylporiol-4'-B-D-glucopyranoside



Feronlin

Fig 2: Phytochemical constituents of F. Limonia

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