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A REVIEW ON ETHANOMEDICINAL IMPORTANCE OF Kaitha (Feronia limonia L.) PLANT

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ABSTRACT: Kait or kath-bel belongs to the bel variety of fruit-bearing trees. It is called wood apple, curd fruit, elephant apple or monkey fruit in English and as *Feronia elephantum* or *Feronia limonia* in the scientific dictum. A native of South-East Asia, it now mainly grows in the dry plains of India and Sri Lanka and the arid plateaus of Malaya. The slow-growing tree of family Rutaceae which bears fruits only after 15 years. Its flowers are dull red or greenish in colour, which bloom in early March, while the thick-shelled fruit matures October onwards. The fruit is either large and sweetish, or small and acidulous. The different parts of the tree i.e. bark, leaf, fruit pulp and seed have immense medicinal value i.e. antitumour, antimicrobial, antidiabetic, anti-inflammatory, analgesic, antioxidant, hepatoprotective, antimutagenic, antimalarial etc.

KEY WORDS: Kaitha, Rutaceae family, thick shelled fruit, fruit acidulous; immense medicinal value.

INTRODUCTION:

Kaitha (*Feronia lemonia* L. belonging to the family Rutaceae), known as the "poor man's food" in rural India. It is found to all over the plains of Southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. It is an ideal tree to be exploited for growing in wastelands common in wild dry plains, cultivated along roads, edges of fields and occasionally in orchards (Veeraraghavathatham et al., 1996). The tree is very hardy, tolerant to draught and salinity and thrives better in deep, well drained soils of dry forests. It has got tremendous medicinal potential. It has antioxidant, anticancer, antidiabetic, antimicrobial, anti-inflammatory, antipyretic and hepatoprotective activities (Vidhya and Narain, 2011). But due to its ignorant policies regarding to its cultivation, it is neglected today. Due to its remarkable medicinal properties it is time to rediscoverits full value. The aim of the present paper is to introduce many of the wood apple products which are new to the consumers. Since efforts need to be made to introduce them in the market and to evaluate consumer acceptance and economic viability of commercialization of such products. This not only will open new avenues as a means of augmenting the utilization of high yielding nutritious fruit to the best possible extent but will also give a fillip to the establishment of wood apple processing industry (Chandana, 2016).

BOTANICAL CHARACTERISTICS :

Kaitha (*Feronia lemonia L.*) is a moderate sized tree with straight sharp strong spines1.2-3.7 cm long. Leaves smelling of aniseed, alternate Flower blooms in early March and are dull red or greenish in colour, and the thick-shelled fruit matures October onwards. Fruit 5-6.3 cm diameter globose hard, pericarp woody, rough, grey coloured. Each fruit weighs about 150 to 500 g. Each fruit weighs about 150 to 500g. Kaitha fruit is available in the late summer through winter or post monsoon season in Asia. Its fruit is acidic in unripe condition but when ripe, its gives pleasant flavour (Das and Das, 2003). The unripe wood apple pulp is of pale gold color. The ripe fruit pulp (36% of whole fruit) is brown colour, mealy, odorous, resinous, astringent, acid or sweetish with numerous small white seeds scattered through it. As wood apple ripen, greenish white shell develops into a tough, brown speckled wooden shell that looks and feels similar to tree bark. Ripe fruits also emit a sugary yet musky aroma. Ideal, fully ripe wood apples are light brown to toffee brown color. Wood apple pulp has a remarkably long shelf life of two months if refrigerated.

METHOD:

A systematic literature search was conducted to gather information on various plants traditionally used for cardiovascular disorders. This was done through electronic databases (PubMed, SciFinder, Scopus, Scirus, ScienceDirect, Google Scholar and Web of Science) and a library search for articles published in peer-reviewed journals, as well as locally available books.

PHYSICOCHEMICAL CHARACTERISTICS:

The quality of fruits is laid on its physico-chemical characteristics and nutrient composition which decides its consumer acceptability and marketing strategy (Shyamala Devi and Kulkarni, 2018). The fruit is much used in India as a liver and cardiac tonic and when in unripe state, as a means of halting diarrhea and dysentery and for effective treatment for hiccough, sore throat and disease of the gums (Kerkar et al., 2020). It contains phytochemicals like polyphenols, vitamins, saponins, coumarins, amino acids, tri-terpenoids, phytosterols and tannins (Pandey et al., 2014) (Table-I).

Table-1: Medicinal valuable plant parts and their phytochemical properties (Pandey et al., 2014)

S. No.	Name of Plant Parts	Major Phytochemical	References
1.	Leaf	Polyphones, flavonoid, (imperatorin, bergapten and xanthotoxin), alkaloid, steroid and amino compounds, methyl chavicol (27.2%), thymol (24.4%), t-anethol (10.94%), p-cymen-7-ol (7.3%) and l,4-dimethoxy-2-allylbenzene, orientin, vitexin, isovitexin and saponarin, coumarins include P-amyrin, lupeol,xanthotoxin, umbelliferone, isopimpiiellin and imperatorin, alkaloids, phenolsresins, gum and mucilage, fixed oils and fats	Ahmad et al. (1989) El-Fishawy (1994) El Khrisy et al. (1994) Aneesha et al. (2018) Panda et al. (2013) Jayashree and Londonkar (2014) Vijayvargia et al. (2014)
2.	Fruit pulp	Carbohydrates (70.14%), protein (13.8%), fat (4,3%) and dietary fibre (1.7%), calcium, magnesium, iron, and high amounts of zinc are also reported	Pandey et al. (2014) Asp (1996) Campous et al. (2009)
3.	Seed	Psoralen, bergapten, orientin, vitexin, saponarin, as tannin, saponins, oxalate and phytate, non-bitter oil containing unsaturated fatty acid	Intekhaband Aslam, (2009) Bhanupriya et al (2016) Singh et al. (2009)
4	Bark	Phenol, nitrogen compound, vitamins	Muthulakshmi et al. (2012)

NUTRITIONAL VALUES OF FRUIT:

The fruit of Kaitha (*Feronia lemonia* L.) were figure out by the investigator for imminent, vitamins, minerals, and nutrients, in which present (per 100g) nutritional material. (Table-1I)

Table II: Mineral and Vitamins content of Kaitha fruit pulp (Pandey et al., 2014)

Minerals (ig/g)			
Analyte	Concentration(ig/g)	Analyte	Concentration (/g)
P	1137.35	Cr	1.543
Mg	852.5	Pb	0.163
Ca	711.8	Li	0.241
Fe	23	Mo	0.263
Zn	23.84	Ni	0.819
Cu	6.67	Se	0.768
Mn	3.64	Ti	0.257
Vitamins(ig/g)			
Vitamin C	180	Thiamine(B1)	0.31
Riboflavin(B2)	0.23	Beta-carotene	0.04

PHARMACOLOGICAL PROPERTIES :

A variety of pharmacological properties such as antitumour, antimicrobial, antidiabetic, anti-inflammatory, analgesic, antioxidant, hepatoprotective, antimutagenic, antimalarial and other activities has been exhibited by the extracts and pure compounds derived from wood apple (Srivastava et al., 2019). A summary of the findings of these studies performed is presented below:

a) **Anti-tumour activity**: Cancer is associated with abnormal cell growth with the potential to invade or spread to other parts of the body. Saima et al. (2000) reported that an acidic heteropolysaccharide isolated from the tropical angiosperm Feronia limonia showed some significant in vivo carcinoma cell growth inhibition in the murine model. Similarly, in another study, the antitumor activity of the ethanolic extracts of 12 medicinal plants of Bangladesh, including the vincristine-vinblastine producing *Catharanthus roseus* was studied using the potato disk bioassay technique. In this study, Feronia limonia showed 16.1% inhibition of crown gall tumors but found to be inactive because of the insignificant < 20.0% inhibition of tumors (Haque et al., 2000).

b) **Antimicrobial activity:** One of the major causes of morbidity and mortality in immune compromised patients is pathogenic microorganisms. Microorganisms like bacteria tend to become resistant to drugs, coupled to side effects of some antibiotics. This invites a vital need to control microbial infections using appropriate antimicrobials devoid of side effects. There is evidence that the ethanolic extract of wood apple leaves showed antibacterial activity against variety of bacteria such as Shigella boydii, Shigella dysentery and Shigella flexnerii and demonstrated the reduction in severity and frequency of diarrhoea (Bellah et al., 2015). Kumar et al. (2010) extracted the essential oil from the leaves of wood apple and studied for chemical constituents and antibacterial activity against different clinically isolated Gram positive and Gram-negative bacterial strains by disc diffusion and minimum inhibitory concentration assay. The GC and GC-MS analysis revealed that the leaf essential oil of wood apple contained fourteen compounds representing about 98.4% of the total oil. The major chemical compounds identified were Eudesma-4, 11-dine (46.3%), carvacrol (29.6%) and 1,5-cyclodecandine (13.4%). Researchers reported that the essential oil exhibited moderate antibacterial activity against all the tested bacterial strains with MIC values ranging from 125 to 500 µg/mL except Proteus mirabilis. In a recent study, the protein hydrolyze of wood apple seeds have also shown antimicrobial activity at 300 (mg/ml) against Salmonella typhi, Pseudomonas aeruginosa, Escherichia coli and Klebsiella pneumonia (Sonawane et al., 2013).

c). Antidiabetic activity: Diabetes mellitus is a chronic metabolic disorder characterized by raise of blood glucose levels known as hyperglycaemia and other late complications such as retinopathy, nephropathy. Due to its fatal complications, diabetes is the seventh leading cause of death in the human society. Gupta et al. (2009) evaluated the anti-diabetic activity of ethanolic extract wood apple fruits on blood glucose level in normal and streptozotocoin induced diabetic rats. Results indicated that the blood glucose levels was significantly lowered in fasted, fed and streptozotocin induced

diabetic male albino rats. It also improved the oral glucose tolerance. Marked degranulation in B-cells of extract treated rats, associated with the blood glucose lowering was observed. It was assumed that extract probably lowered the blood glucose concentrations by stimulating insulin secreting activity. Similarly in another study antidiabetic activity of wood apple fruits was analyzed in streptozotocin induced diabetic rats. Phytochemical screening at preliminary stage revealed the presence of high content of flavonoid compounds in methanolic extracts of wood apple. Treatment of diabetic rats with the extract at the dose of 200 and 400 mg kg-1 for 30 days showed significant decrease in blood glucose levels and also decreased levels of serum cholesterol, regain of body weight in the subjects (Priya et al., 2012). Similar results were also reported by Putta and Kilari (2014), who also found significant antihyperglycemic, antihyperlipidemia activity of methanolic pericarp extracts of wood apple and significant protection against damage to kidney in streptozotocin induced diabetic rats. The above-mentioned activity could be due to its antioxidant potential of wood apple.

d). Antioxidant activity: Antioxidant activity and antimutagenic effect of phenolic compounds in wood apple ripe fruit pulp was studied by analyzing the total phenolic content by Folin-ciocalteu method and antioxidant activity by the DPPH assay. The phenolic glycoside extract presented higher (229.0 mg/g, GAE) total phenolic content followed by phenolic ester (37.5 mg/g) and free phenolics (11.0 mg/g), whereas the antioxidant activity was found to be 88.7%, 11.8% and 3.8% respectively. Phenolic glycoside extract showed antioxidant activity higher than that of commercial antioxidant trolox (64.6%) and butylated hydroxytoluene (83.2%) (Phapale and Thakur, 2010).

e). Hepatoprotective activity: The study aimed to evaluate the hepatoprotective potential of a methanolic extract and of marmesin isolated from the root bark of wood apple. Activity levels of aspartate aminotransaminase (AST) and alanine aminotransaminase (ALT), cell viability and cell death were evaluated in Hep G2 cells (human liver hepatoma cells) treated with CCl4 in the presence or absence of wood apple extract or marmesin. It was found that the in-vitro co-supplementation of methanolic extract or marmesin significantly minimized alteration in levels of AST and ALT and improved cell viability. Oral administration of methanolic extract or marmesin significantly prevented CCl4-induced elevation in the plasma markers of hepatic damage and hepatic lipid peroxidation and a decrease in hepatic antioxidants. In-vivo hepatoprotective potential of methanolic extract and marmesin was evident from the minimal alterations in the histoarchitecture of liver (Jain et al., 2012).

f). Neuroprotective activity: Rakhunde et al. (2014) studied the effect of methanolic extract of wood apple fruit (250 mg/kg, 500 mg/kg body weight) and Vitamin E as reference standard drug on 30 min induced ischemia, followed by reperfusion by testing the neuro behavioral tests. The biochemical parameters such as catalase, superoxide dismutase (SOD), malondialdehyde and nitric oxide were also measured in animals brain in control and treated rats. It was found that the methanolic extract of wood apple fruit (250 mg/kg, 500 mg/kg body weight) treated groups showed a statistically significant improvement in the neurobehavioral parameters such as motor performance. The biochemical parameters in the brains of rats showed a significant reduction in the total nitrite ($P< 0.01$) and lipid peroxidation ($P< 0.01$), also a significant enhanced activity of enzymatic antioxidants such as catalase ($P< 0.01$) and SOD ($P< 0.05$), hence suggested the neuroprotective and antioxidant activity of wood apple on ischemia reperfusion induced brain injury.

g). Antihyperlipidemic activity: After administrating fruit powder at 2.5, 5 and 10 g/kg body weight for 28 days reduces lipid profile, hepatic glucose-6-phosphatase, and significant increases hepatic glycogen, hexokinase and HDL. The presence of fibres, phytosterols, saponins, polyphenols, flavonoids and ascorbic acid may be responsible for that (Rupal et al., 2013).

h). Diuretic activity: The methanolic extract of leaves has significantly increase urine output. The extent of urination and electrolyte excretion namely Sodium, potassium and chloride ions depend on extraction method. It was found that Microwave assisted extraction (MAE) has better activity as compared to Bath Sonicator extraction (BSE)(Parial et al., 2009).

i). Antiulcer and wound healing activities: It was found that that wood apple fruit pulp is effective against indomethacin-induced gastric ulcer in rats. At 500mg/kg it inhibits gastric ulceration by reducing gastric HCl concentration through increasing intra-gastric pH (Mishra et al., 2009). Wound healing activity of methanolic fruit extract increased by tightening wound-breaking strength, decreased epithelization period, increased wound contraction, and increased granulation tissue weight and hydroxyproline concentration at 400 mg/kg of the extract (Ilango and Chitra, 2010). L. acidissima extracts significantly protect the gastric mucosa against ethanol induced injury by the reduction in the mucosal lesions on dose dependent manner. The phenolic compounds present in the fruit is

responsible for protection against ulcer on gastric wall and leucocytes infiltration of submucosal layers at 400 mg/kg leaf extract (Aneesha et al., 2018).

j): Analgesic activity: The analgesic activity was found against acetic acid- induced writhing mice and found 60.53% on methanol, 59.65% on acetone extracts of fruit peel as against 78.07% on standard drug Diclofenac Na (Islam et al., 2020).

k). Spermatotoxic activities: Dhanapal et al. (2012) studied antispermatogenic activities of wood apple fruit pulp in adult male rats by treating with ethanolic extracts at 250 and 500mg/kg for 55 days and reveals that they were responsible for decline in sperm count, motility and viability. They also increased proportion of abnormal sperm and reduce testicular protein content by 24.58% and 29.86%, respectively.

l). Antidiarrheal activity: Senthilkumar et al. (2010) determined antidiarrhoeal and gastrointestinal motility reducing activity on aqueous bark extract of wood apple and found marked antidiarrheal activity by reducing average faeces weight and reduce GI motility (Senthilkumar et al., 2010). Similar data was found by Thomas method on castor oil-induced diarrhea at 500mg/kg of methanol and acetone peel extracts and observed 47.13% and 44.83% inhibition (Islam et al., 2020).

m). Ear ailments: The Ayurveda also mentions their use in the treatment of various ear ailments like earache, putikarnaand karnsarva. Freshly collected luke warm juice of kapittha (Feronia limonia), matulunga, smgvera is used for the treatment of ear ache (Dash and Kashyap, 1984). Being aromatic, astringent, carminative, purgative and sudorific in nature the leaves of the wood apple has been used in Ayurveda for the treatment of various ailments such as gastropathy, anorexia, diarrhoea, indigestion, flatulence, vomiting, hiccough and other troubled conditions of vatta and cardio tonic and in management of other cardiac debilities (Parajapati et al., 2003).

n). Liver tonic: It has also been reported to be a curative agent for the treatment of asthma, tumours and as a 'liver tonic' in the traditional systems of medicine (Pandey and Dravyaguna, 2001).

Conclusion: Several published studies indicate that the consumption of wood apple could ameliorate a wide range of illnesses. A fruit with such diverse values and immense capabilities indicates its potentialities for processing commercially into valuable products like jams, jellies, sweets, savory chutneys and juice (Chopra and Singh, 2001). The value-added products of these fruits have expected to catch the national and international markets if it is properly focused. But the fruit is being utilized to a limited extent in the preparation of products. The review paper mainly emphasizes on the nutritional, food and medicinal value of this underutilized fruit and envisages enormous scope for future research and further pharmacological investigation on wood apple.

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