

An Overview on *Mesua ferrea* Linn - A Traditional Medicinal Herb

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ABSTRACT

Mesua ferrea Linn is an ornamental plant widely used as medicinal plant for the treatment of various ailments. In Hindi it is commonly known as 'Nagakesara' and in English known as 'Ceylon iron wood'. Traditionally, flowers and aromatic leaves of the plant have rich medicinal value. The plant contains flavanoids, alkaloids, steroids, saponins, terpenoids, tannins, phenolic compounds, and coumarins etc. as its chief active constituents. And these active constituents imparts multiple pharmacological activities to the plant which includes anti-inflammatory, anti-oxidant, anti-spasmodic, anti-microbial, anti-diabetic, immuno suppressant, disinfectant activity etc. The present review presents specific information on botany, phytochemical constituents and pharmacological actions of *Mesua ferrea* Linn.

KEY WORDS: *Mesua ferrea* Linn, Calophyllaceae, pharmacognosy, pharmacology, phytochemistry.

I. INTRODUCTION

Mesua ferrea Linn of Calophyllaceae family is a medium to large sized tree and grows up to 18-30 m height. It is widely found in tropical countries like India, Burma, Thailand, China and New Guinea [1]. *Mesua ferrea* is frequently distributed in evergreen lowland forest and on ridges with shallow soils from sea level up to an altitude of 1500 m. *Mesua ferrea* used for various purposes throughout the world, especially for its traditional uses. In India, the past generations extensively use this plant and considered as one of the most useful medicinal plant. The plant traditionally used for the treatment of various ailments like pain, inflammation, rheumatic conditions, improve immunity, and used as antiseptic, antiasthmatic, anti allergic remedy etc [2]. Useful parts include fruits, seed, flowers, Buds,

Leaves and Bark. The plant's phytochemistry consists of glycosides, flavanoids, xanthones, triglycerides, resins, and important oils, some steroids, reducing sugar, fatty acids, tannin, saponin and some proteins [3].

II. PHARMACOGNOSTICAL REVIEW PLANT PROFILE

Mesua ferrea Linn (Calophyllaceae/Guttiferae) is commonly known as in 'Nagkeshar' in Hindi and 'Ceylon Ironwood' in English. It is an evergreen tree of medium to large size with short trunk and usually buttressed at the base. The tree mostly cultivated in avenues and in gardens because they are attractive especially its flowers when young. *Mesua ferrea* Linn present in moist or semi-evergreen forest. They need deep fertile and well drained soil has neutral pH. Stiff clay and low lying conditions are unsuitable [4]. It is liable to frost and drought, but in its natural habitat these conditions are practically unknown [5]. The plant most popular for its oil production, called Kesar oil. The Kesar oil is extracted from its seeds and it is forming 53-73% weight of seeds. Its flowers and leaves are used for snake bite as an antidote, and a paste of the butter and sugar with its flowers is used in the conditions of bleeding piles and burning of the feet. In north Canada the Kesar oil is used as an embrocation in rheumatism and useful in the treatment of itching [6].

TAXONOMICAL CLASSIFICATION

Kingdom - Plantae
Phylum - Tracheophyta
Class - Magnoliopsida
Order - Malpighiales
Family - Calophyllaceae / Guttiferae
Genus - *Mesua*
Species - *Mesua ferrea* Linn [7].

VERNACULAR NAMES

Assam	: Nagashwar
Bengali	: Nagesvara, Nagesar
English	: Cobra's saffron
Gujarati	: Nagakesharaa, Sachu nagakesharaa
Hindi	: Nagakesharaa
Kannada	: Nagasampige, Nagakesharai
Malayalam:	Nangaa, Nauga, Peri, Veluthapala, Nagppu
Tamil	: Naugu, Nagachampakam
Telugu	: Nagachampakamu
Urudu	: Narmushk, Nagakeshara [8].

DISTRIBUTION

Mesua Ferrae Linn is generally assigned in dense mountains of Eastern Himalayas, Bengal, Assam, Tenasserim Burma, Andaman's, evergreen rainforests of northern kanara and southern part of Konkan, huge forests from Western Ghats to southern kanara to Travancore [9].

BOTANICAL DESCRIPTION

Mesua ferrea is an evergreen medium to large-sized ornamental tree.

Bark: The stem bark is reddish-brown to grey in colour with flaky peelings. The surface of the bark is smooth.

Wood: The wood is very durable and has a life of 10-15 years. Sapwood is creamy white or pinkish brown, rather broad; whereas the heartwood is red or deep reddish brown, smooth, straight- or somewhat interlocked grained, medium, to coarse-textured, hard, strong, tough and heavy.

Leaf: Elliptical shape, Lanceolate, coriaceous, frequently covered with a waxy bloom underneath. Young leaves are reddish yellow in colour while mature leaves are blue grey to dark green in

appearance and are approximately 7-15 cm long. Leaves are opposite and simple with an entire margin. The upper surface is glabrous where as lower surface glaucous. Leaves have shiny texture with numerous secondary veins, looping, running parallel nearly to the margin, frequently with equally prominent reticulating tertiary veins. Sometimes with more or less persistent stipule-like interpetiolar modified leaves. The base rounded or acute in shape.

Fruit: Ovoid almost round nearly woody with a prominent beak when matured, 2.5-5.0 cm long with persistence enlarged calyx. Pericarp hard, warty, two valved after dehiscence.

Seed: Angular shape, smooth, 1-4 in number, dark brown, up to 2.5cm diameter, cotyledons are fleshy and oily [10].

Flowers: The fragrant flowers are cream coloured, ebracteate, pedicellate, pedicel short, axillary or terminal, solitary or in pairs (cluster) and 2.5-7.5 cm in diameter, bisexual, large, sub-sessile and buds are sub-globose, bracts nil. After the flower parts are dissected it was found that all the four whorl of the flower parts are clearly visible. Sepals are 4 in number, 2 outer slightly shorter than the inner ones and depressed at the based, orbicular, cubbed and puberulous. Petals are seen to be 4 in number, pure white fragrant, spreading, obovate-cuneate, with crisped and undulate margin often torn. Stamens are numerous in number, golden yellow united much shorter than the petals and are slightly united at the based into a fleshy ring. Filaments are small and anthers oblong. Ovary is seen to be superior, bicarpellary, syncarpous, style is found to be twice as long as the stamens, stigmas capitate, style and stigma persistent in young fruit but are shaded away later on [11].



Mesua ferrea Linn tree

Bark

Young leaves

Mature leaves



Fruits

Seeds

Flower

III. PHYTOCHEMICAL REVIEW

Generally it is reported that, *Mesua ferrea* Linn contain coumarins, xanthenes, terpenoids and sterol type of phytochemicals [12]. A research on the stem, heartwood, roots, stem bark and oleo gum resin of *M. ferrea* leads to isolation of large number of phytochemicals and their identification. From heartwood of plant mesuaxanthone-A, mesuaxanthone-B, 1, 5-dihydroxyxanthone (II), euxanthone 7-methyl ether (IV) and β -sitosterol were isolated [13, 14]. Later Govindachari et al isolate an alkyl coumarin- Ferrol-A from the trunk bark of *M. ferrea* [15]. Xanthenes like 2-Hydroxy-, 2-methoxy-, 4-hydroxy-, 1,5-dihydroxy-, 1,7-dihydroxy-, 1hydroxy-5-methoxy-, 1-hydroxy-7-methoxy-, 3-hydroxy-4methoxy- and 1,5,6-trihydroxyxanthone were isolated from the timber [16]. Ferrxanthone, which was isolated from the heartwood [17]. The essential oils contents of the bark, leaves, buds, and flowers (full bloom) of *M. ferrea* analyzed by using high resolution GC and HRGC/MS techniques. The bark oil consist of (E)- α -bisabolene (31.3%) and α -selinene(12.2%), oils contents of tender and mature leaves were found to be α -copaene (19.3% and 9.9%) and β caryophyllene (18.8% and 26.0%) respectively. α -copaene (28.7% and 20.2%) and germacrene D (19.0% and 16.1%) were the major oil constituents of bud and flowers [18].

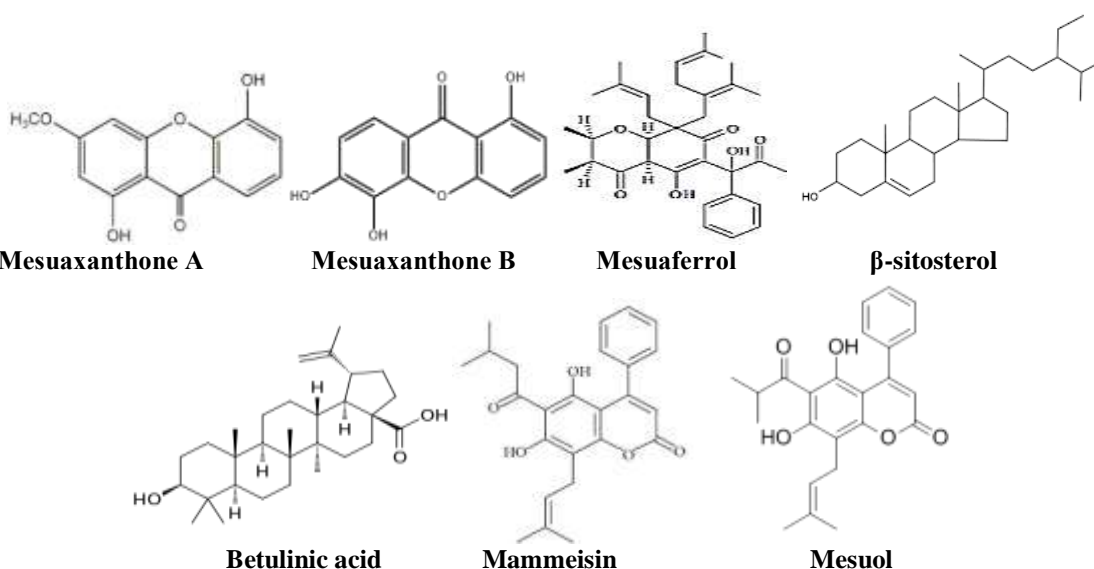
From the stem bark of *M. ferrea* betulinic acid, (-) epicatechin, 1, 6-dihydroxyxanthone, pyranojacareubin were isolated along with two novel compounds i.e., mesuabixanthone-A and mesuabixanthone-B [19]. Mesuferrol-A and -B, (-)

epicatechin, 1, 7-dihydroxy- and 5-hydroxy-1-methoxyxanthone were also isolated from the stem bark by Inuma and colleagues [20]. MesuaferrinA and -B, caloxanthone C, 1,8-dihydro-3-methoxy-6-methylanthraquinone, β -sitosterol, friedelin and betulinic acid seperated from the root bark by one research group [21]. Similarly, mixture of amyryns (α and β), β -sitosterol, calophyllin-B, dehydrocycloguanandin, euxanthone, euxanthone 7-methyl ether (IV), ferruol A, ferrxanthone, friedelin, lupeol, mesuaxanthone-A and mesuaxanthone-B, 1,5-dihydroxyxanthone (II), stigmasterol, jacareubin and 6-desoxy jacareubin have been isolated from the stems and stem bark by different research groups [16,22]. Another research group found new xanthone, mesuaferrin C, along with macluraxanthone, caloxanthone C, β -sitosterol, friedelin and betulinic acid from the root bark [23].

Likely, Teh and colleagues isolated seven xanthenes namely, caloxanthone C, mesuaferrin-A, -B and C, macluraxanthone, 1, 5-dihydroxyxanthone and tovoapyrifolin C from the root bark of *M. ferrea* [24]. HPLC analysis of *M. ferrea* methanol and chloroform extracts shows variety of natural antioxidants namely coumaric acid, ellagic acid, gallic acid, kaempferol, myricetin, rutin, quercetin, and vanillic acid [25]. Another study on its stem bark reveals the presence of friedelin, 3 β friedelanol, lupeol, 3-oxo-betulin and spinasterol [26]. Table highlights the phytochemical composition of selected parts of *M. ferrea* Linn.

SL.NO	PLANT PART	PHYTOCONSTITUENTS IDENTIFIED
1	Heartwood	Mesuaxanthone-A, mesuaxanthone-B 1,5-dihydroxyxanthone (II), euxanthone 7-methyl ether (IV), β -sitosterol Ferrxanthone (1,3-dimethoxy-5,6-dihydroxyxanthone)
2	Trunk bark	Ferrol-A
3	Timber	2-Hydroxy-, 2-methoxy-, 4-hydroxy-, 1,5-dihydroxy-, 1,7-dihydroxy-, 1-hydroxy-5-methoxy-, 1-hydroxy-7methoxy-, 3-hydroxy-4-methoxy- and 1,5,6-trihydroxyxanthone
4	Bark	(E)- α -bisabolene and α -selinene
5	Stem bark	Mesuferrol-A and -B, (-) epicatechin, 1,7-dihydroxy- and 5-hydroxy-1-methoxyxanthone, Friedelin, 3 β friedelanol, lupeol, 3-oxo-betulin and spinasterol
6	Stems	Amyrin (α and β), β -sitosterol, friedelin, lupeol Coumaric acid, ellagic acid, gallic acid, kaempferol, myricetin, rutin, quercetin, and vanillic acid
7	Root bark	Mesuaferrin-A,-B, and -C, caloxanthone C, 1,8-dihydro-3-methoxy-6- methylanthraquinone, β -sitosterol, friedelin and betulinic acid

		Mesuaferriin C, macluraxanthone, 1,5-dihydroxyxanthone and tovopyrifolin C
8	Leaves	Bcaryophyllene 12,13-Furano-8-hydroxynaphthyl-6-O-b2',3',4',6'-tetrahydroxy-5'5'dimethyl cyclohexyl ether
9	Flower	α -copaene, germacrene D Trans-Caryophyllene, α -Humulene, γ Muurolol, β -caryophyllene oxide δ cadinene, γ -Cadinene, β -selinene, β -bisabolene
10	Seeds	Mesuol, Mammeisin



PHYTOCHEMICAL STUDIES

The preliminary phytochemical screening helps to determine the secondary metabolites present in the plant parts. The secondary metabolites like flavanoids, alkaloids, steroids, saponins, terpenoids, tannins etc. The ethanolic extract of various parts of *M. ferrea* were analyzed with standard phytochemical screening procedure reported elsewhere [9, 27-30].

PHYTOCHEMICALS	BARK	FLOWER	LEAVES	FRUIT	SEEDS
Alkaloids	+	+	+	-	-
Tannins	+	+	+	+	+
Saponins	+	+	+	+	+
Flavonoids	+	+	-	-	-
Terpenoids	+	+	+	+	-
Glycosides	+	-	+	+	-
Steroids	+	+	+	+	-
Coumarins	-	+	+	+	+
Amino acids	-	-	-	-	-
Carbohydrates	+	+	+	+	+

IV. PHARMACOLOGICAL REVIEW

The anti-inflammatory activity of *Mesua ferrea* was done on hexane, ethyl acetate and methanol extract of bark by both in-vivo and in-

vitro methods. These bark extracts exhibited inhibitory effects on pro-inflammatory mediators such as nitric oxide, prostaglandin E2, tumour necrosis factor- α and interleukin-1 β production in

concentration dependent manner in LPS induced RAW 264.7 cells and Carrageenan induced paw oedema in Wistar rats. This study shows that the ethyl acetate extract possess significant anti-inflammatory activity [31]. R. Prathima et al investigates the anti-inflammatory activities of *Mesua ferrea* by using 80% ethanol extract of stem bark using animal models of Female Wistar albino rats. The results obtained from this study indicated that the 80% ethanol extract of *Mesua ferrea* bark shows potent anti-inflammatory activity in both acute and chronic models [32]. A study conducted by K. Krishna Chaitanya et al reported that the ethyl acetate bark extracts of *Mesua ferrea* (MFBEE) shown significant in vitro anti-inflammatory and antioxidant activities. In vitro anti-inflammatory studies reveal that the ethyl acetate extract of bark exhibited dose dependent 5-LOX inhibitory activity. The inhibitory activity of 5-LOX at 100µg/ml was found to be 76.58% with IC₅₀ values of 46.65µg/ml. At the concentration of 500µg/ml MFBEE has shown more protective effect (77.13%) in the HRBC stabilization. In vitro antioxidant studies shows that the *Mesua ferrea* bark ethyl acetate extract has exhibited a dose-dependent DPPH, ABTS, NBT riboflavin and nitric oxide (NO) free radical scavenging activity with reference to standards. Hence *Mesua ferrea* bark ethyl acetate extract can be used for development of new anti-inflammatory and antioxidant agents [33].

The In vivo and In vitro studies on *Mesua ferrea* flower methanolic extract concluded that it could act as an insulinotropic agent in the diabetes, by enhancing insulin secretion [34]. From the investigation done by Parshuram Mishra et al and team concluded that methanolic extract of *Mesua ferrea* is a potent antioxidant and hepatoprotective agent. Optimum dose of methanolic extract of *Mesua ferrea* was 100 mg/kg of body weight [35]. The preliminary phytochemical screening indicate the presence of most of the phytochemicals such as flavonoids, steroids, reducing sugars, cardiac glycosides and triterpenoids in hexane fruit extract of *Mesua ferrea* Linn. TLC and bioautography agar overlay assay of *M. ferrea* fruit extract of hexane indicated the presence of flavonoids as the active compounds against multidrug-resistant *Enterococcus* sp. The maximum zone of inhibition in *M. ferrea* was found to be 22.5 ± 0.90 mm against *Enterococcus* sp. And the hexane fruit extract shows significant anti-microbial activity [30].

Anti-bacterial and cytotoxicity properties of the leaves extract of methanol of *Mesua ferrea* was done by Ahmed Idris Adewale et al through in vitro methods shows that the leaves possess both anti-bacterial and cytotoxicity activity [36]. Also the methanolic extract of *Mesua ferrea* leaves possess antimicrobial and antioxidant activity. The presence phenolic compounds and flavonoids in the methanolic leaf extract were responsible for these pharmacological properties of the plant [37]. Analgesic activity of *Mesua ferrea* Linn was done by Md. Taufiq Hassan et al in their leaves. This study includes the n-hexane extract of *Mesua ferrea* leaves administered by mice orally, produces significant analgesic action against chemical (acetic acid-induced visceral pain) models of nociception in mice [38]. The immunosuppressive activity of *Mesua ferrea* was investigated in its aqueous extract of leaves. Immunosuppressive activity was determined by extracting variable doses of crude flavonoids (6.25-100 mg/ml; 50 µl) from its leaves on human whole blood using specific antigen (i.e. hepatitis B vaccine containing surface antigen, 20 µg/ml; 10 µl) is to estimate its blood counts, CD14 monocyte marker and observed its cytotoxicity. The study reported that the extracted flavanoids possess maximum inhibition of blood counts, CD14 monocyte marker and cytotoxicity at higher doses and concluded that crude flavonoids extracted possess immunosuppressive activity against HBsAg [39]. The crude extract and its ethanol and ethyl acetate fractions of *M. ferrea* leaves consist of saponins, phenolic compounds, flavonoids, and terpenoids secondary metabolites. On FTIR finger printing confirm the presence of terpenoids and glycosides in those samples. Due to the presence of those secondary metabolites the leaves of *Mesua ferrea* shows a considerable antibacterial, antifungal, and free radical scavenging activity [40]. The methanolic extract of leaves of *Mesua ferrea* exhibited significant thrombolytic activity. Thrombolytic effect of the fraction was investigated in clot lysis experiment. In thrombolytic activity test the extract exerted 36.32% lysis of the blood clot while the positive control (streptokinase) and negative control shows 85.45% and 7.5% lysis respectively. So that the study concluded that the *Mesua ferrea* shows significant thrombolytic activity [41].

The human blood was treated with aqueous root extract of *Mesua ferrea* of variable doses (0.5 – 30 mg/ml) and evaluated for lymphocytes, monocytes and granulocytes count by flow cytometry and observed the monocyte marker

i.e. CD14 marker and TNF alpha in peripheral blood mononuclear cells and its hemolytic activity was also determined. The aqueous extract shows increased count in lymphocytes and reduced level of granulocytes and monocytes and it is evidenced through the decline of CD14 surface marker and TNF alpha which are the indicators of inflammation in human peripheral blood mononuclear cells. And the study concluded that the root aqueous extract of *Mesua ferrea* showed anti-inflammatory activity [42]. The seeds and the oil extracted from the seeds shows some pharmacological activities. Methanolic and hexane

extracts of seeds shows considerable antimicrobial activity. The crude oil extracted from seeds by the use of petroleum ether possesses potential antispasmodic activity. But the purified oil was devoid of any antispasmodic activity. The Nahar seed kernel oil (NSKO) emulsion validated better disinfection and inactivation of water surface bacteria. Therefore it expresses good potential for usage as alternative and natural disinfectants. The crude oil emulsion possesses disinfection property at a concentration of 2 mg/ml and above [43-45].

Pharmacological activity of different solvent extracts:

PLANT PART USED	EXTRACT/COMPOUND	TYPE OF STUDY	RESULT
Bark	Ethyl acetate	In-vitro and In-vivo	Anti-Inflammatory activity
		In-vitro	Anti-oxidant activity
	80% ethanol	In-vivo	Anti-inflammatory activity
Flower	Methanol	In-vitro and In-vivo	Anti-diabetic activity
		In-vivo	Hepato-protective activity Anti-oxidant activity
Fruit	Hexane	In-vitro	Anti-microbial activity
Leaves	Methanol	In-vitro	Anti-bacterial activity Cytotoxicity
		In-vitro	Anti-microbial activity Anti-oxidant activity
		In-vitro	Thrombolytic activity
	Hexane	In-vivo	Analgesic activity
	Aqueous	In-vitro	Immunosuppressive activity
	Ethyl acetate Ethanol	In-vitro	Anti-oxidant activity Anti-microbial activity
Root	Aqueous	In-vitro	Anti-inflammatory activity
Seeds	Methanol Hexane	In-vitro	Anti-microbial activity
	Petroleum ether	In-vitro	Anti-spasmodic activity
	Hexane	In-vitro	Disinfection potential

V. INDUSTRIAL APPLICATIONS

Away from pharmacological aspects, *M. ferrea* seed oils have numerous industrial applications as an alternative biofuel in the diesel and compression ignition engines, in paint industry. And it is also can be used as a multi-purpose

industrial coating preparation and as biomaterials (nanocomposites etc.). In cushions and pillows stamens are used as a fragrant stuffing. For heavy construction including railway sleepers, transmission posts, heavy-duty furniture, posts and

tool handles wood of *Mesua ferrea* used as material [46].

VI. CONCLUSION

Mesua ferrea Linn a traditional plant medicine having multiple pharmacological actions possess considerable potential value clinically. The recent studies shows that *Mesua ferrea* is a rich source of various secondary metabolites like flavanoids, tannins, terpenoids, steroids, phenolic compounds etc. The evidence presented in this review has shown that *Mesua ferrea* Linn has tremendous to be integrated in to conventional medical practice for the treatment and management of various ailments such as diabetes, inflammation, cancer and other disease complications. It is an ingredient of several Ayurvedic and Unani formulation. Apart from medicinal uses it is also being used commercially in polymer industry, painting, as a firewood and substitute for gasoline, preparation of nanoparticles. Further studies on this plant may helps to explore the important, necessary and unknown benefits of *Mesua ferrea* Linn.

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REFERENCES

- [1]. Perumal Rajalakshmi, Vellingiri Vadivel, Natesan Ravichandran, Pemalah Brindha. Investigation on pharmacognostic parameters of sirunagapoo (*Mesua ferrea* L): a traditional indian herbal drug. *Pharmacogn J.* 2019; 11(2):225-230.
- [2]. Adiana Mohamed Adib, Nurhanan Murni Yunos, Chee Beng Jin. Anti-cancer, antimicrobial, and antioxidative potentials of *Mesua ferrea* L. and its phytochemical constituents: a review. *Asian J. Pharmacogn* 3(3):5 -19.
- [3]. Choudhury S, Ahmed R, Barthel A, Leclercq PA. Volatile oils of *Mesua ferrea* (L.). *Journal of Essential Oil Research.* 1998; 10(5):497-501.
- [4]. Wealth of India, Raw materials. Vol- 6(L-M), 1962.
- [5]. Kadambi K. *Mesua ferrea* Linn: Its silviculture and management. *Indian Forester*, 80(9), 1954, 531-550.
- [6]. Kritikar KR, Basu BD, Indian medicinal plants. Vol I, 2nd ed., 1935.
- [7]. Muhammad Asif, Seyedeh Fatemeh Jafari, Zafar Iqbal, Vageesh Revadigar, Chern Ein Oon, Aman Shah Abdul Majid, Amin Malik shah Abdul Majid. Ethnobotanical and phytopharmacological attributes of *Mesua ferrea*: a mini review. *Journal of Applied Pharmaceutical Science* Vol. 7 (04), pp. 242-251, April, 2017.
- [8]. C Roshy Joseph, Ilanchezhian R, Patgiri Biswajyoti, CR Harish. Pharmacognostical study of Nagakeshara (*M.ferrea* Linn)-an ingredient in vyaghrihareetaki avaleha. *IJRAP* 2010, 1(2), 264-272.
- [9]. Amit Sharma, Surabhi Sharma, Rohit, Naresh and Bharat Parashar. *Mesua ferrea* linn: - A review of the Indian medical herb. *Sys Rev Pharm.* 2017; 8(1):19-23.
- [10]. Sahu Alakh N, Hemalatha S, Sairam K. Phyto-pharmacological review of *Mesua ferrea* linn. *International Journal of Phytopharmacology*, 5(1), 2014, 6-14.
- [11]. Sahu AN, Hemalatha S, Sairam K. Quality Control Studies of *Mesua ferrea* Linn. Flowers. *International Journal of Herbal Medicine*, 1(2), 2013, 124-130.
- [12]. Keawsa-ard S, Kongtaweelert S. Antioxidant, Antibacterial, Anticancer Activities and Chemical Constituents of the Essential Oil from *Mesua ferrea* Leaves. *Chiang Mai J Sci*, 2012; 39:455-63.
- [13]. Chow YL, Quon HH. Chemical constituents of the heartwood of *Mesua ferrea*. *Phytochemistry*, 1968; 7: 1871-74.
- [14]. Govindachari TR, Pai BR, Subramaniam PS, Ramdas Rao U, Muthukumaraswamy N. Constituents of *Mesua ferrea* L.-II: Ferruol A, a new 4-alkylcoumarin. *Tetrahedron*, 1976a; 23: 4161-65.
- [15]. Govindachari TR, Pai BR, Subramaniam PS, Rao UR, Muthukumaraswamy N. Constituents of *Mesua ferrea* L.-I: Mesuaxanthone A and mesuaxanthone B. *Tetrahedron*, 1967b; 23: 243-48.
- [16]. Gunasekera SP, Ramachandran S, Selliah S, Sultanbawa MUS. Chemical investigation of ceylonese plants. Part XVII. Isolation and structures of the xanthenes in the extractives of *Mesua ferrea* L. (form *M. salicina* Pl. and Tr.) (Guttiferae). *J Chem Soc Perkin Trans* 1, 1975; 244750.
- [17]. Walia S, Mukerjee SK. Ferrxanthone, a 1, 3, 5, 6-tetraoxygenated xanthone from *Mesua ferrea*. *Phytochemistry*, 1984; 23:1816-17.

- [18]. Choudhury S, Ahmed R, Barthel A, Leclercq PA. Volatile Oils of *Mesua ferrea* (L.) from Assam, India. *J Essent Oil Res*, 1998; 10: 497501.
- [19]. Singh S, Gray AI, Waterman PG. Mesuabixanthone-A and Mesuabixanthone-B: Novel Bis-Xanthones from the Stem Bark of *Mesua ferrea* (Guttiferae). *Nat Prod Lett*, 1993; 3:53-8.
- [20]. Iinuma M, Tosa H, Tanaka T, Riswan S. Two new dimeric xanthones in *Mesua ferrea*. *Heterocycles*, 2004; 43: 1996-99.
- [21]. Teh S, Ee G, Rahmani M, Taufiq-Yap Y, Go R, Mah S. Pyranoxanthones from *Mesua ferrea*. *Molecules*, 2011; 16:5647-54.
- [22]. Keawsard S, Liawruangrath B, Kongtaweelert S. Bioactive Compounds from *Mesua ferrea* Stems. *Chiang Mai J Sci*, 2015; 42:185-95.
- [23]. Ee GCL, Teh SS, Rahmani M, Taufiq-Yap YH, Go R, Mah SH. A new furanoxanthone from the root bark of *Mesua ferrea*. *Lett Org Chem*, 2012; 9:457-59.
- [24]. Teh SS, Ee GCL, Mah SH. Chemical Constituents and New Xanthone Derivatives from *Mesua ferrea* and *Mesua congestiflora*. *Asian J Chem*, 2013; 25:8780-84.
- [25]. Rajesh KP, Manjunatha H, Krishna V, Kumara Swamy BE. Potential in vitro antioxidant and protective effects of *Mesua ferrea* Linn. bark extracts on induced oxidative damage. *Ind Crops Prod*, 2013; 47:18698.
- [26]. Islam R, Ahmed I, Sikder AA, Haque MR, Al-Mansur A, Ahmed M, Rasheed M, Rashid MA. Chemical Investigation of *Mesua nagassarium* (Burm. f.) Kosterm. *J. Basic Appl. Sci*, 2014; 10: 124-28.
- [27]. Harjeet Singh, B. K. Sarkar, Jagdish Chandra Arya, Shashi Pal, Ravi Kumar, Veerendra Gupta, Ravindra Singh, S. C. Verma. Phytochemical and Anti-Inflammatory Evaluation of Herbal Gel Prepared from Bark Extract of *Mesua Ferrea* Linn. *Journal of Drug Delivery & Therapeutics*. 2019; 9(5-s):53-56.
- [28]. N. Raja Naik and P. Indira. Pharmacognostical studies on *Mesua ferrea*, *Carica papaya*, *Asimum sanctum* and *Tribulus terrestris*. In *rayalaseema*, a.p. *IJPSR*, 2015; Vol. 6(5): 2223-2227.
- [29]. Narender Prasad.D, B.Ganga Rao, Prayaga Murthy.P, E.Sambasiva Rao, T.MallikarjunaRao, V.S.Praneeth.D. Evaluation of phytochemical constituents and in-vitro antibacterial activity of *Mesua ferrea* leaves. *IJPT*,2011; Vol. 3, Issue No.4:3624-3630.
- [30]. Chhabra Akshita, Bharath V Vijay, Dahiya Praveen. Evaluation of phytochemical screening and antimicrobial efficacy of *Mesua ferrea* and piper cubeba fruit extracts against multidrug-resistant bacteria. *Pharmacophore*, 11(2) 2020: 15-20.
- [31]. Krishna Chaithanya K, Gopalakrishnan V K, ZenebeHagos, Nagaraju B, Kamalakararao K, Haftom Kebede, Patricia Ponce Noyola, John DogulasP, Tentu Kasi Naidu, GovindaRao D. In vitro and In vivo Anti-inflammatory Activities of *Mesua ferrea* Linn. *IJPPR*, 2018; 10(3); 103-111.
- [32]. R. Prathima, H. Manjunatha, V. Krishna, Shivanand Kandagalla and B. S. Sharath. Studies on anti-inflammatory effect of *Mesua ferrea* linn. In acute and chronic inflammation of experimental animals. *IJPSR*, 2018; Vol. 9(2): 517-525.
- [33]. K. Krishna Chaitanya, K. Kamalakara Rao, Y.N. Sastry, Dr. S.B. Padal, Dr. A. Rajya lakshmi, Dr. D. Govinda Rao. Anti-Inflammatory, Antioxidant and Phytochemical Analysis of *Mesua Ferrea* Bark Extracts. *IJCTPR*, 2015, 3(3):891-902.
- [34]. Umamahesh Balekari and Ciddi Veeresham. Insulinotropic Activity of Methanolic Extract of *Mesua ferrea* Linn. *Journal of Basic & Applied Sciences*, 2015, 11, 410-417.
- [35]. Sandeep Garg, Kameshwar Sharma, Rajeev Ranjan, Pankaj Attri and Parshuram Mishra. In vivo Antioxidant activity and hepatoprotective effects of methanolic extract of *Mesua ferrea* linn. *Int.J. PharmTech Res.*2009, 1(4), 1692-1696.
- [36]. Ahmed Idris Adewale, Mohamed Elwathig Saeed Mirghani, Suleyman Aremu Muyibi, Jamal Ibrahim Daoud, Mikail Maryam Abimbola. Anti-Bacterial and Cytotoxicity Properties of the Leaves Extract of *Nahar* (*Mesua ferrea*) Plant. *Adv. in Nat. Appl. Sci.*, 6(5): 583-587, 2012.
- [37]. Akhtar Nahid, Choudhury Neelabh, Kumar Navneet. Exploration of the phytoconstituents and potentials of the *Mesua ferrea* collected from the Assam region in India for antioxidant and microbicidal activity. *International Journal*

- of Biology Research, Volume 2; Issue 4; October 2017; Page No. 12-16.
- [38]. Md. Taufiq Hassan, Mohammad Shawkat Ali, Md. Alimuzzaman and Sheikh Zahir Raihan. Analgesic Activity of *Mesua ferrea* Linn. Dhaka Univ. J. Pharm. Sci. 5(1-2): 73-75, 2006.
- [39]. Amit Gupta, Sushama R. Chaphalkar. Immunopharmacological activity of flavonoids isolated from *Mesua ferrea*, *Ficus benghalensis* and *Jasminum auriculatum*. Current Life Sciences 2016; 2 (2): 49-54.
- [40]. Dwi Hartanti, Zainur Rahman Hakim, Anna Nurlativah, Arinda Nur Cahyani, Fadhilah Zahra Nadia, Asmiyenti Djaliasrin Djalil. Phytochemicals content, FTIR fingerprint and bioactivity of crude extract and fractions of *Mesua ferrea* L. leaves. Research Journal of Life Science 2019; 6 (1), 54-65.
- [41]. Mohammad Imran Hossain, Md Hossan sakib, Asif Al Mahmood, Naymul Karim, Mohammad Shahin Alam, Md. Ariful Islam, Monalisha Sharma. Study on in-vitro thrombolytic activity of methanolic extract of *Mesua ferrea* leaves. International Journal of Medical and Health Research 2015; Volume: 1, Issue: 2, 52-55.
- [42]. Amit Gupta, Pallavi R. Khamkar and Sushama R. Chaphalkar. In vitro anti-inflammatory activity of root aqueous extract of *Mesua ferrea* in human whole blood and peripheral blood mononuclear cells using flow cytometry. Int. J. of Pharm. Life Sci. 2014; 5(10):3903-3909.
- [43]. Vandana Rawat, Kumud Upadhyaya. Evaluation of antimicrobial activity and preliminary phytochemical screening of *Mesua ferrea* seeds extract. Journal of Natural Products, Vol. 6(2013):17-26.
- [44]. D.N. Prasad, S.P Basu & A.K. Srivastava. Antispasmodic activity of the crude and purified oil of *Mesua ferrea* seed. Ancient Science of Life 1999; Vol. No. XIX (1&2); 74-75.
- [45]. Ahmed Idris Adewale, Mohamed Elwathig Saeed Mirghani, Suleyman Aremu Muyibi, Jamal Ibrahim Daoud and Mikail Maryam Abimbola. Disinfection studies of Nahar (*Mesua ferrea*) seed kernel oil using pour plate method. African Journal of Biotechnology 2011; Vol. 10(81), 18749-18754.
- [46]. Lim TK. 2012. Edible medicinal and non-medicinal plants. New York: Springer.