

OPEN  ACCESS



International Journal of Applied Sciences and Biotechnology

A Rapid Publishing Journal

ISSN: 2091-2609

Indexing and Abstracting

CrossRef, Google Scholar, Global Impact Factor, Genamics, Index Copernicus, Directory of Open Access Journals, WorldCat, Electronic Journals Library (EZB), Universitätsbibliothek Leipzig, Hamburg University, UTS (University of Technology, Sydney): Library, International Society of Universal Research in Sciences (EyeSource), Journal Seeker, WZB, Socolar, BioRes, Indian Science, Jadoun Science, Jour-Informatics, Journal Directory, JournalTOCs, Academic Journals Database, Journal Quality Evaluation Report, PDOAJ, Science Central, Journal Impact Factor, NewJour, Open Science Directory, Directory of Research Journals Indexing, Open Access Library, International Impact Factor Services, SciSeek, Cabell's Directories, Scientific Indexing Services, CiteFactor, UniSA Library, InfoBase Index, Infomine, Getinfo, Open Academic Journals Index, HINARI, etc.

CODEN (Chemical Abstract Services, USA): IJASKD

Vol-4, Issue-1 (March, 2016)

Available online at:

<http://www.ijasbt.org>

&

<http://www.nepjol.info/index.php/IJASBT/index>



Impact factor*: 1.422
Scientific Journal Impact factor#: 3.419
Index Copernicus Value: 6.02
IBI Factor 2015:** 4.19

*Impact factor is issued by Universal Impact Factor. Kindly note that this is not the IF of Journal Citation Report (JCR).

#Impact factor is issued by SJIF INNO SPACE; **Impact factor is issued by INFOBASE INDEX.



Mini Review

LAWSONIA INERMIS LINN: A PLANT WITH COSMETIC AND MEDICAL BENEFITS

Ritesh Kumar Sharma*, Anjana Goel and A. K. Bhatia³

Department of Biotechnology, IAH, GLA University, Mathura.

*Corresponding author email: sharmaanshul603@gmail.com

Abstract

Plants play a major role on the earth and human beings depend on plants because of their medicinal properties. About 80% of the world population using plants as a medicinal drugs because plants have no side effects and show synergistic effect unlike modern medicine. In the present study, review and authentication of the various aspects of the plant *Lawsonia inermis* was carried out. This plant is mainly present in subtropical and tropical areas and is used in all over the world. The common name of *L. inermis* is Henna and Mehndi. It has been used for over 9000 years for their cosmetic values as a dye. Traditionally, in Asian countries like India and Pakistan, plant leaves are applied to hands, hairs and feet. Morphologically the plant is a small tree or shrub. *L. inermis* is cultivated for roots, flowers, stem bark and seeds for their medicinal uses. Proteins, carbohydrates and fatty acid are primary metabolites along with secondary metabolite such as tannins, quinines, terpenoids, coumarins etc which are present in *L. inermis* plant. Phytochemical constituents of *L. inermis* are responsible for its analgesic, anti-inflammatory, hepatoprotective and hypoglycaemic properties. The plant has also been reported for antibacterial, antifungal, immunostimulatory, antioxidant and cytotoxic activity. Presence of these properties in *L. inermis* plant develops it as medicine against various pathogenic organism and diseases. This review gives a wide view on the phytochemistry, pharmacological properties and traditional uses of the plant.

Keywords: Phytochemistry; *Lawsonia inermis* Linn.; antimicrobial; anti-inflammatory.

Introduction

Many microbes show high pathogenicity towards human and cause various chronic diseases. Modern medicines are primarily used to treat these diseases. But due to inappropriate use of these medicines, microbes are developing resistance to the medicines and increasing the public health problems (Ali *et al.*, 1995 and Muhammad and Muhammad., 2005). Starting from the human civilization, various plants had been used as medicine but now a days the use of medicinal plants increasing day by day (Natrajan *et al.*, 2003 and Mishra and Sahu., 1977) for treating the diseases alone or in synergy with modern medicines. Because of their wide biological and medicinal activities as well as higher safety margins, plants are used as a medicine for primary healthcare in the different countries of world (Cragg *et al.*, 1997 and Padma, 2005).

According to the World Health Organisation 20,000 species of plants are now in use due to their medicinal values and more than 80% of world's population are using them for their primary health care (Pandey *et al.*, 2008 and Vijayan *et al.*, 2007). In India approx 3000 plant species are used as traditional medicines and have various therapeutic properties. (Prakash *et al.*, 2010). A wide range of information, knowledge and benefits of medicinal plants

exist in our early literature of Chinese, Unani, Ayurvedic and Siddha medicine (Goyal *et al.*, 2008).

The diverse uses of *L. inermis* are described in ancient history of India and its considerable role in natural herbal medicines or Ayurveda (Lavhate *et al.*, 2007). The present study was carried out to review and authenticate the various aspects of plant *Lawsonia inermis*, commonly known as Henna or Mehndi.

Plant description

Botanical description

This plant is multi branched, deciduous shrub or small tree having 2.6 m height. Leaves of this plant are 1.3-3.2cm broadly or elliptic lanceolate. Flowers are white or rose-colored, which are used as a fragrant agent in local scent. Pedicel is short less than 1.3 cm, numerous in number and slender in shape. Calyx is 3-5 mm, long broadly campanulate; lobes are 2.5-3 mm, long, suborbicular or subreniform and undulate. Stamens are 8, which are inserted in pairs on the calyx-tube. Capsules are slightly veined outside, globose and diameter of the capsule is 6 mm. Persistent calyx support capsule with the tipped style (Nadkarni, 1982). Pea shape and globose seed capsules,

which are red in color. Seeds are brown pitted, numerous small and pyramidal in shape (Sukh, 2006).

Habitat

L. inermis is mainly cultivated for cosmetic purposes and as traditional medicine in all over the world but native place of this plant is tropical as well as subtropical regions mainly India, Sri Lanka and the Middle East. Plant leaves of this plant are used as dye which stains the hair, hands and feet mainly in Asian countries (Jallad and Jallad, 2008).

Chemical constituents

The phytochemistry of henna is largely studied by many practitioners of traditional herbal medicines, revealing many interesting informations. Lawsone ($C_{10}H_6O_3$) is the colouring component present in leaves of henna and gets fixed well by wool, silk and tenaciously by the skin (Tommasi, 1920). Abd-el-Malek *et al.*, (1973) isolated four compounds by thin layer chromatography. Out of these three fractions were identified as gallic acid (149-91-7), lawsone (2-hydroxy- 1,4-naphthoquinone)(I) (83-72-7), and 1,4-naphthoquinone (130-15-4).

Bhardwaj *et al.* (1978) isolated lacoumarin, which is a coumarin, from *L. inermis* leaves. Two xanthenes i.e. 1, 3-dihydroxy-6,7-dimethoxyxanthone and 1-hydroxy-3,6-diacetoxy-7-methoxyxanthone were isolated from plant leaves and commonly known as laxanthone I and II, respectively. Another xanthone, named as laxanthone III was identified from chemical and spectral data of *L. inermis*.

From leaves extract of *L. inermis*, apigenin-4'-glucoside, apigenin-7-glucoside, luteolin-7-glucoside, and luteolin-3'-glucoside were also isolated (Chakrabartty *et al.*, 1982). The methanol extract of *L. inermis* leaves yielded stigmaterol, β -sitosterol and 1,2-dihydroxy-4-glucosyloxynaphthalene (Babili *et al.*, 2013; Chakrabartty *et al.*, 1982). Luteolin, acacetin-7-O-glucoside and glucoside of β -sitosterol were isolated from *L. inermis* leaves extracts (Muhammad and Muhammad 2005). Two pentacyclic triterpenes were also isolated from the bark of *L. inermis*, which were then recognized as (20S)-3 β ,30-dihydroxylupane and 3 β ,30-dihydroxylup-20(29)-ene (hennadiol) (Chakrabartty *et al.*, 1982).

Gupta *et al.* (1992) isolated a sterol from the roots of *L. inermis*, namely lawsaritol and elucidated it as 24 β -ethylcholest-4-en-3 β -ol and from the stem bark of *L. inermis* as 3-methylnonacosan-1-ol. Two triterpenoids, lawnermis acid and its methyl ester were isolated from the methanol extract of the defatted *L. inermis* seeds (Handa *et al.*, 1997). The isolation of two pentacyclic triterpenoids was done from the aerial parts of *Lawsonia alba*. Through spectroscopic studies, the structures of lawsonic acid (I) and lawsonin (II) have been elucidated as 3 β -E-ferulyloxy-lup-20(29)-en-28-oic acid and 3 β -E-ferulyloxy-urs-11-en-13 β -ol, respectively (Siddiqui and Kardar, 2001).

Biological uses

Charaka Samhitaa has described *L. inermis* for the treatment of epilepsy and jaundice. This plant has been suggested as a medicine for malignant ulcers in Sushruta Samhitaa (Sukh, 2006). *L. inermis* also demonstrated to have antibacterial, antifungal, antiamoebiasis, astringent, antihemorrhagic, hypotensive, refrigerant and sedative properties (Abdulmoneim, 2007). It was found effective in headache, insomnia, hemicranias, lumbago, burns, bronchitis, boils, abortifacient, dysuria, herpes infection, hysteria, nervous disorders, bleeding disorder, prurigo ophthalmia, syphilitis, sores, sore eyes, scalds, amenorrhoea, gonorrhoea, scabies, liver disorders, vulnerary, dysentery, venereal diseases, calculus, smallpox, spermatorrhoea, diuretic, jaundice, leprosy, enlargement of the spleen, calcalous affections, obstinate skin diseases and spleen diseases (Abdulmoneim 2007; Kirtikar and Basu 2005; Gogte 2000; Khare 2007; Nadkarni 1982; Chetty 2008; Chopra *et al.*, 1956; Reddy, 1988).

Hypoglycaemic activity

Syamsudin *et al.*, (2008) conducted a study to determine the effect of *L. inermis* leaves ethanol extract on glucose level on artificially induced diabetes in rats. Ethanol plant leaves extract significantly decreased glucose level showing hypoglycaemic activity. They also reported the hypolipidemic activity of this extract. A significant *in-vitro* anti hyperglycemic activity of *L. inermis* methanolic leaves extract was demonstrated by Arayne *et al.*, (2007).

Antioxidant activity

In a study conducted by Das Gupta et al (2003) revealed that methanolic extract was effective in increasing the antioxidant enzymes, hepatic glutathione reductase (GR), superoxide dismutase (SOD) and catalase activities. Philip *et al.* (2011) performed the experiment on *L. inermis* seeds to determine the antioxidant and free radical scavenging activity. Four different extracts of *L. inermis* seeds viz. ethanol extract (ET), dichloromethane extract (DCM), petroleum ether extract (PE) and aqueous extract (AQ) are compared for their flavonoid and total phenolic content as well as antioxidant activity . They concluded that the ethanolic extract of *L. inermis* seeds is efficient antioxidant as compared to aqueous extract, petroleum ether extract and dichloromethane extract due to the presence of higher concentration of phenolic and flavonoids compounds in ethanol extract.

Wound Healing Activity

Muhammad and Muhammad (2005), investigated that water and chloroform extracts of *L. inermis* (henna plant) leaves was found effective against the growth of microorganisms which causes burn wound infections. Ethanolic extract of *L. inermis* accelerate the healing process in experimental animals as compared to control animals (Nayak *et al.*, 2007).

Immunomodulatory effect

According to Mikhaeil *et al.*, (2004), methanolic extract of henna leaves at 1 mg/ml concentration displays immunomodulatory action which is showed by the stimulation of T-lymphocyte proliferative responses. As per Dikshit *et al.* (2007) Naphthoquinone fraction shows significant immunomodulatory effect, obtained from leaves *L. Inermis*.

Hepatoprotective activity

90% ethanol extract of *L. inermis* and its ethyl acetate fraction showed hepatoprotective activity. Hepatotoxicity was induced in rats by Carbon tetrachloride (CCl₄). Ethanol extract and its ethyl acetate fractions of 200 and 400 mgkg⁻¹b.wt. treated groups showed significantly decreases in alkaline phosphatase (ALP), serum transaminases (AST and ALT) and total bilirubin (TB). So, it's indicated that *L. inermis* seeds use in liver disorders. Against CCl₄ (0.5 mL kg⁻¹, i.p.) induced mice, these extract increases the albumin and total protein level significantly (p<0.01) in dose dependent manner. The seeds extract and its fraction also lowered the levels of hepatic malondialdehyde by inhibiting the production of free radicals and prevented CCl₄ induced oxidative stress by significantly restoring the levels of reducing glutathione. The histopathological examination of liver sections supplemented these biochemical parameters and suggested that ethyl acetate fraction has a more significant (p<0.05) hepatoprotective effect against CCl₄ induced hepatotoxicity in rats. (Chaudhary *et al.*, 2012). Hepatoprotective and lipid peroxidation inhibitory property occur due to the presence of flavonoids (Tapas *et al.*, 2008).

Anti Trypanosome

Wurochekke *et al.* (2004) investigated the in-vitro and in-vivo antitrypanosomal activity of *L. inermis* leaves and they concluded that the crude methanolic extract of *L. inermis* leaves had *in-vitro* activity against *Trypanosoma brucei* at concentration of 8.3 mg mL⁻¹ of blood while *in-vivo* study indicated that the treatment tends to ameliorate the disease condition but did not affect the level of parasitaemia and pack cell volume. Tadesse and Mirutse (2009), conducted *in-vitro* experiments and concluded that crude aqueous and hydro alcoholic extract of *Lawsonia inermis* show no antihelmenthic effect.

Antifungal activity

Khan and Nasreen (2010), tested the antifungal activity of methanolic extracts of five plants against 10 phytopathogenic fungi and *Candida albicans* B017. *L. inermis* showed the greatest percent inhibition of mycelial growth of target fungi (76.47-87.77%) among all the extracts tested. The protein fractions of *L. inermis* exhibited four to five times more percentage inhibition of mycelial growth of *Bipolaris oryzae* and *Colletotrichum lindemuthianum* than the nonprotein fractions. According to Khan and Nasreen (2010), the active compounds

responsible for the effectiveness against plant pathogens were proteinaceous in nature or were proteins. Aqueous, methanol and chloroform crude extracts *L. inermis* leaves showed the *in-vitro* antimicrobial activity by inhibiting the growth of different strains of pathogenic fungi. (Saadabi, 2007; Habbal *et al.*, 2005).

Anti-Cancer activity

Endrini *et al.* (2002) conducted a study in which MTT based cytotoxic assay was used for anticarcinogenic activity of *L. inermis* chloroform extract. In this viable tumour cells had mitochondrial dehydrogenase enzyme, which reduce the soluble tetrazolium salt in to insoluble coloured formazone. After dissolution of formazone it can be measured by spectrophotometer. The effect of this extract was tested on normal liver cell lines and liver cancer cell lines. Cell inhibition or cell killing was the explained by the IC₅₀ value. Cytotoxicity was determined with IC₅₀ values of 0.3 and 24.85µg/ml against liver and human breast cancer cell lines. Effect of *L. inermis* extract on mice having solid Ehrlich tumour was tested and found effective. On the 12th day, *L. inermis* extract received mice were compared with control mice receiving water only. Control mice showed higher diameters of the gluteal solid tumor mass than *L. inermis* treated group. It was also found that extract treated mice showed increased pH level and reduced level of glutathione lipid peroxidation than the control. It indicated the possibility of cancer cell metabolism inhibition by the extract (Zumrutdal *et al.*, 2008).

A similar study showed that extracts of *L. inermis* stop the multiplication of DLA induced tumour cells in mice. It also increased the mean survival time and life span of mice. These results concluded that *L. inermis* used as a novel drug in the cancer treatment (Priya *et al.*, 2011).

Antibacterial activity

Yemini traditional healer's uses ethanol extracts of 20 plants species for the treatment of pathogenic diseases. Both gram positive and gram negative bacteria used for the antibacterial screening of different plant species. Among all the plant species tested, *L. inermis* ethyl acetate extract was showed highest antibacterial activity (Ali *et al.*, 2001). Dama *et al.* (1999) studied quinonic compounds from *L. inermis in-vitro* for antimicrobial properties. Kirkland and Marzin (2003) conducted genotoxic studies on lawsone and suggested that it is a weak bacterial mutagen for *Salmonella typhimurium* strain TA98 and was more clearly mutagenic for strain TA2637. Overall, it is suggested that *L. inermis* possess no genotoxic risk to the consumer. Antibacterial effect was also reported by the aqueous extract of leaves of *L. inermis* (Baba-Moussa *et al.*, 1997). Aqueous, methanol and chloroform crude extracts *L. inermis* leaves showed the *in-vitro* antimicrobial activity by inhibiting the growth of different strains of pathogenic bacteria. (Saadabi, 2007; Malekzadeh, 1968; Habbal *et al.*, 2005).

Sharma (1990), reported *in-vitro* and *in-vivo* studies on tuberculostatic activity of *L. inermis*. In *in-vitro* tuberculostatic activity of henna, he reported that 6 µg/ml of herb inhibits the growth of *Mycobacterium tuberculosis* H37Rv and *Tubercle bacilli* from sputum on Lowenstein Jensen medium. In his *in-vivo* studies, he also reported that dose of 5 mg/kg body weight in guinea pigs and mice led to a significant resolution of experimental tuberculosis following infection with *Mycobacterium tuberculosis* H37Rv. Abd-el-Malek *et al.* (1973) showed antibacterial activity in *Lawsonia inermis* leaves ethanol extract.

Synergistic effect

Bhuvanewari *et al.* (2002) reported the use of leaves of the plant in treating urinary tract infection which is mainly caused by *Staphylococcus aureus*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa* and *Proteus mirabilis*. *S. aureus* cause pimples, boils and skin diseases which was treated by plant leaves. Two antibiotic classes which are cell wall inhibitor and nucleic acid inhibitor are less potent than drug (Gentamycin, Erythromycin, Tetracycline, Chloramphenicol and Streptomycin) which inhibit protein synthesis. For this study plant extract synergism used in the formation of drugs by combining the plant drug with modern medicine in treating the different diseases because now days organism show resistance against antibiotics (Ajaiyeoba, 2000).

Abortifacient activity

Aguwa (1987) studied the abortifacient activity of methanolic extract of *Lawsonia inermis* root and indicated that the methanolic extract shows dose-dependent effect in the induction of abortion in mice, rats and guinea pig. The results were confirmed by its ethno medicinal use in the procurement of abortion in humans in some parts of Nigeria.

Conclusion

Now, the scenario of the world is changing towards the use of nontoxic plant products. Also, nowadays a big problem has arisen, development of drug resistant pathogen against modern medicines. So, herbal medicines are the alternatives of modern drugs with their synergistic effects for treating the infectious diseases of human civilization. By exploring various literatures we reveal that *L. inermis* plant have broad spectrum of pharmacological activities and due to these activities of *L. inermis* it can be used as a remedy in herbal medicines. Various phytoconstituents are present in this plant, thus enabling it for treating different diseases in various areas. Furthermore, for treating different diseases a broad investigation is required to develop its medicinal utility. This plant has various medicinal properties such as antibacterial, antiviral, antimyotic, antimicrobial etc. As this plant has various therapeutic activities, it deserves special consideration by scientists and researchers for developing a milestone drug of this time. However, further assessment is required to explore the hidden potentials of *L. inermis* and its therapeutic applications for human welfare.

References

- Abdelgadir EH, Ahmed RH, Adam SIY and Husein AM (2010) Evaluation of toxicological activity (Acute and sub-chronic toxicities) of the aqueous extract of *Lawsonia inermis* seeds on wistar rats. *J Pharmacol Toxicol* **5**: 324-333. DOI: 10.3923/jpt.2010.324.333
- Abd-el-Malek Y, El-Leithy MA, Reda FA and Khalil M (1973) Antimicrobial principles in leaves of *Lawsonia inermis*. *Landwirtschaftliche und Technische Mikrobiologie* **128**: 61-67. DOI: 10.1016/s0044-4057(73)80039-5
- Abdulmoneim MA (2007) Evaluation of *Lawsonia inermis* Linn (Sudanese Henna) leaf extract as an antimicrobial agent. *Research Journal of Biological Sciences* **2**: 417-423
- Aguwa CN (1987) Toxic Effects of the Methanolic Extract of *Lawsonia inermis* Roots. *Pharm Biol* **25**: 241-245
- Ajaiyeoba EO Onocha PA Olarenwaju OI (2000) In vitro Anthelmintic properties of *Buchhozia coriacea* and *Gynandropsis gynadra*. *J Pharmaceut Biol* (in press)
- Ali BH AK Bashir and MOM Tanira (1995) Anti-inflammatory antipyretic and analgesic effects of *Lawsonia inermis* L (Henna) in rats. *Pharmacology*, **51**: 356-363. DOI: 10.1159/000139347
- Ali NAA, Julich WD, Kusnick C and Lindequist U (2001) Screening of Yemeni medicinal plants for antibacterial and cytotoxic activities. *J Ethnopharmacol*, **74(2)**:173-179. DOI: 10.1016/S0378-8741(00)00364-0
- Arayne MS, Sultana N, Mirza AZ, Zuberi MH and Siddiqui FA (2007) *In vitro* hypoglycemic activity of methanolic extract of some indigenous plants. *Pak J Pharm Sci*, **20(4)**:268-273
- Baba-Moussa F, Nacoulma O, Ouattara A, Nguyen HP, Akpagana K and Bouchet P (1997) Antibacterial activity of total aqueous extracts of *Combretum micranthum* *Lawsonia inermis* and *Waltheria indica* plants from west African pharmacopoeia. *Revue de Medecines et Pharmacopees Africaines* **11(12)**:197-203
- Babili Fatiha El Valentin Alex and Chatelain Christian (2013) *Lawsonia Inermis*: Its Anatomy and its Antimalarial Antioxidant and Human Breast Cancer Cells MCF7 Activities. *Pharmaceut Anal Acta*, **4**:1
- Bhardwaj DK, Jain RK, Jain BC and Mehta CK (1978) 1 Hydroxy 37 dimethoxy 6 acetoxanthone a new xanthone from *Lawsonia inermis*. *J Agric Food chem* **17**: 1440-14411
- Bhuvane-Swari K Ghana S Kuruvilla A Appala Raju B (2002) Inhibitory concentrations of *Lawsonia innemis* dry powder for urinary pathogens
- Biswas K, Chattopadhyay I, Banerjee RK and Bandyopadhyay U (2002) Biological activities and medicinal properties of neem (*Azadirachta indica*). *Currnt Sci* **82(11)**:1336-1345
- Chakrabartty Tarakeswar Poddar Gurudas St Pyrek (1982) Constituents of Indian medicinal plants. *Phytochemistry*, **21**:1814-1816

- Chakrabartty, Tarakeswar, Poddar, Gurudas and Pyrek (1982) Constituents of Indian medicinal plants *Phytochemistry (Elsevier)* **21**: 1814-1816
- Chaudhary GD, Poonia P, Kamboj P and Kalia AN (2012) Hepatoprotective potential of *Lawsonia inermis* L (seeds). *Int J Phytopharmacol* **3**: 66-73
- Chetty KM (2008) Flowering plants of Chittoor Edn 1 Andhra Pradesh pp 132
- Chopra RN, Nayer SL and Chopra IC (1956) Glossary of India Medicinal Plants CSIR Publications New Delhi pp 151
- Cragg GM, Newman DJ and Sander KM (1997) Natural products in drug discovery and development. *J Nat Prod* **60**: 52-60. DOI: 10.1021/np9604893
- Dama LB, Poul BN and Jadhav BV (1999) Antimicrobial activity of Naphthoquinonic compounds. *Journal of Ecotoxicology and Environmental Monitoring*, **8**:213-215
- Dasgupta T Rao AR Yadava PK (2003) Modulatory effect of Henna leaf (*Lawsonia inermis*) on drug metabolising phase I and phase II enzymes antioxidant enzymes lipid peroxidation and chemically induced skin and forestomach papillomagenesis in mice. *Molecular and Cellular Biochemistry* **245**:11-22. DOI: 10.1023/A:1022853007710
- Dikshit V, Dikshit J, Saraf M, Thakur V and Sainis K (2000) Immunomodulatory activity of naphthoquinone fraction of *Lawsonia inermis* Linn. *Phytomedicine (Jena)* **7**:102-103
- Endrini S, Rahamat A, Ismail P and Yun Hin TY (2002) Anticarcinogenic properties and Antioxidant effect of Henna (*Lawsonia Inermis*). *J Med Sci* **2(4)**: 194-197. DOI: 10.3923/jms.2002.194.197
- Gogte VM (2000) *Ayurvedic Pharmacology and Therapeutic uses of Medicinal plants. (Dravyagunavignyan)* 686-687
- Goyal BR, Goyal RK and Mehta AA (2008) Phyto-Pharmacognosy of *Archyranthes aspera*: A Review *Pharmacog Rev***1(1)**:143- 150
- Gupta S, Ali M, Alam M and Sarwar (1992) 24 β -Ethylcholest-4-en-3 β -ol from the roots of *Lawsonia inermis* *Phytochemistry* **31**: 2558-2560
- Habbal OA, Ai-Jabri AA, El-Hag AH, Al-Mahrooqi ZH and Al-Hashmi NA (2005) *In-vitro* antimicrobial activity of *Lawsonia inermis* Linn (henna) - A pilot study on the Omani henna *Saudi Medical Journal* **26**:69-72
- Handa G, Kapil and Sharma A (1997) Lawnermis acid: a new anticomplementary triterpenoid from *Lawsonia inermis* seeds *Indian Journal of Chemistry* **28**: 252-256
- Jallad KN and Jallad CE (2008) Lead exposure from the use of *Lawsonia inermis* (Henna) in temporary paint-on-tattooing and hair dying *Science of the Total Environment* **397**:244-250. DOI: 10.1016/j.scitotenv.2008.02.055
- Kasture SB, Une HD, Sarveiyal VP, Pal SC and Kasture VS (2001) Nootropic and anxiolytic activity of saponins of *Albizzia lebbek* leaves *Pharmacology Biochemistry and Behavior* **69**:439-444. DOI: 10.1016/S0091-3057(01)00516-0
- Khan ZS and Nasreen S (2010) Phytochemical analysis antifungal activity and mode of action of methanol extracts from plants against pathogens *J Agric Technol* **6**: 793-805
- Khare CP (2007) *Indian Medicinal Plants: An Illustrated Dictionary Springer reference* 366
- Kirkland D and Marzin D (2003) An assessment of the genotoxicity of 2- hydroxy-1 4-naphthoquinone the natural dye ingredient of Henna *Mutat Res* **537(2)**:183-199
- Kirtikar KR and Basu BD (2005) *Indian Medicinal Plants* Second edition International book distributors Dehradun **2**: 1076-1086
- Lavhate MS and Mishra SH (2007) A review: nutritional and therapeutic potential of *Ailanthus excelsa* *Pharmacog Rev* **1(1)**:105-113
- Malekzadeh F (1968) Antimicrobial activity of *Lawsonia inermis* *L Appl Microbiol* **16**:663-664
- Mikhaeil BR, Badria FA, Maatooq GT and Amer MMA (2004) Antioxidant and immunomodulatory constituents of henna leaves *Zeitschrift fuer Naturforschung Section C Journal of Biosciences* **59**:468-476
- Misra SK and KC Sahu (1977) Screening of some indigenous plants for antifungal activity against dermatophytes *Indian J Pharmacology*, **9**:269-272
- Mudi SY, Ibrahim H and Bala MS (2011) Acute toxicity studies of the aqueous root extract of *Lawsonia inermis* Linn in rats *J Med Plant Res* **35**: 5123-5126
- Muhammad HS and Muhammad S (2005) The use of *Lawsonia inermis* Linn (Henna) in the management of burn wound infection *African Journal of Biotechnology* **4**: 934-937
- Nadkarni KM (1982) *Indian Materia Medica* Popular Book Depot Bombay India **1**:730-73
- Natarajan V PV Venugopal and T Menon (2003) Effect of *Azadirachta indica* (neem) on the growth pattern of dermatophytes *Indian J Med Microbiology*, **21**: 98-101
- Nayak BS Isitor G Davis EM Pillai GK (2007) The evidence based wound healing activity of *Lawsonia inermis* Linn *Phytotherapy Research*, **21(9)**:827-831. DOI: 10.1002/ptr.2181
- Nayak BS, Isitor G, Davis EM and Pillai GK (2007) The evidence based wound healing activity of *Lawsonia inermis* Linn *Phytotherapy Research* **21**: 827-831. DOI: 10.1002/ptr.2181
- Padma TV (2005) India Ayurveda. *Nature* **436(7050)**: 436-486.
- Philip JP, Madhumitha G and Mary SA (2011) Free radical scavenging and reducing power of *Lawsonia inermis* L seeds *Asian Pac J Trop Med* **4**: 457-461. DOI: 10.1016/S1995-7645(11)60125-9
- Prakasha HM Krishnappa M Krishnamurthy YL Poornima SV (2010) Folk medicine of NR PuraTaluk in Chikamagalur district of Karnatka *Indian Journal of Traditional Knowledge*, **9(1)**:55-60
- Priya R, Ilavenil S, Kaleeswaran B Srigopalram S and Ravikumar S (2011) Effect of *Lawsonia inermis* on tumor expression

- induced by Dalton's lymphoma ascites in Swiss albino mice Saudi J Biol Sci 18: 353-359. DOI: 10.1016/j.sjbs.2011.04.001
- Reddy KR (1988) Folk medicine from Chittoor District Andhra Pradesh India used in the treatment of jaundice International Journal of Crude Drug Research 26(3):137-140. DOI: 10.3109/13880208809053907
- Saadabi MAA (2007) Evaluation of *Lawsonia inermis* L (Sudanese Henna) Leaf extracts as an antimicrobial agent Res J Bio Sci 2(4):419-423
- Sharma VK (1990) Tuberculostatic activity of henna *Lawsonia inermis* Linn Tubercle, 71(4):293-296
- Sukh D (2006) A selection of prime Ayurvedic Plant Drugs Ancient- modern concordance Anamaya Publishers New Delhi 276-279
- Syamsudin I and Winarno H (2008) The effects of Inai (*Lawsonia inermis*) leave extract on blood sugar level: An Experimental Study Res J Pharmacol 2(2):20-23
- Tadesse E and Mirutse G (2009) In vitro anthelmintic activity of three medicinal plants against *Haemonchus contortus* Int J Green Pharm 3: 29-34
- Tapas AR, Sakarkar DM and Kakde RB (2008) Flavonoids as nutraceuticals: A review Trop J Pharm Res 7: 1089-1099
- Tommasi G (1920) Henna (*Lawsonia inermis*) Chemical constitution of lawsone II - Gazzetta Chimica Italiana 50:263-272
- Wurochekke AU, Chechet G and Nok AJ (2004) In-vitro and in-vivo anti trypanosomal activity of the leaf of *Lawsonia inermis* against *Trypanosoma brucei* infection in mice J Medical Sci 4: 236-239
- Zumrutdal ME, Ozaslan M, Tuzcu M, Kalender ME and Daglioglu K (2008) Effect of *Lawsonia inermis* treatment on mice with sarcoma Afr J Biotechnol 7: 2781-2786.