Complete Prospective of *Lawsonia inermis* Linn- Review

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Abstract

*Lawsonia inermis* Linn is known for centuries as medicinal and cosmetic plant. Different parts of this, especially leaves are cultivated for variety of purposes. Besides, other parts of the plant has also been used. The plant is reported to contain many important components which are responsible for their extensive biological activities. The dyeing pigment, lawsone, make it a good candidate to be used in commercial dyeing industry. This review gives an insight on major aspects of this plant.

1. Introduction

The use of plants for the healing purposes cited around 3000 B.C, in China, Egypt and subcontinent. The first known doctors were Schen Nung and Sekhet Enanach in China [1] and Egypt [2] respectively. It is to mention here that Schen Nung was the emperor of China about 4500 years ago discovered a large number of medicines through extensive experimentation. He reported his findings in Pen Tsao, which contained uses of many plants in medicines, including creation, opium and quinine, which are still base of many herbal and allopathic practices [3].

In the subcontinent, the herbal medical system is very popular which dates about 800 B.C. The Ayurveda and Yunnan, which made use of extract of plants for the curing of diseases. The old civilization of the Indus valley, Meon Jo Darrow had contributed a great deal in the field of herbal medications. The enormous amount of knowledge had been provided by Muslim scientist, who contributed in the field of medicines. The writings and monograms of father of medicinal chemistry Bu Ali Sina, served as the textbook of medicines till the 17th century A.D. and is even considered as the fundamental of basic medicinal field. Since the number of the century, there has been a great deal of work performed in the area of medicine leading to enormous progress made by humans in the playing area of scientific and medical techniques leading towards great cultural accomplishments. This opened a track for the revival of communities’ healing tradition in the herbal and Greek ancient medicinal practices.

The origin of *Lawsonia inermis* Linn, is obscure. The linguistic evidence supports an origin in the area of Baluchistan (Iran/Pakistan) to western India, where it can still be found rising in the beast. From there it would have spread eastward to the rest of India and Indonesia, and westward to the Middle East, where it became one of the significant plants of Islam. It was, however, already mentioned in the Bible for its perfume (‘cover’) and in Ancient Egypt (‘kwpr’). It later followed Islamic armies and traders from Arabia reaching as far as Spain, northern Africa, Madagascar, the Moluccas, Indo-China and Japan [4].

Which is present in dry leaves at a concentration of 0.5–2%. It attaches itself strongly to proteins, and as a result the dye is really tight. Other components in henna such as flavonoids and Gallic acid contribute as organic mordants to the coloring process; carbohydrates give the henna paste a suitable consistency to attach to hair and possibly they too take on a purpose in the penetration of Lawsone into the hair and other tissues [5]. *Lawsonia inermis* Linn showed anti-inflammatory, analgesic and antipyretic effects, simply it may cause side-effects such as hemolytic anemia in cases of glucose-6-phosphate dehydrogenase enzyme deficiency. Its leaf extract showed antitumor and tuberculostatic effects. It represented a broad fungus toxic spectrum when tested
against various ringworm fungi, which was attributed to Lawsone.

The present review analyses chemical (components isolated, recognized and characterized from different parts), biological (benefited to organisms) and dyeing (cosmetic) aspect of *Lawsonia inermis* Linn.

**Figure 1.1.** *Lawsonia inermis* Linn Plant

2. Chemical Review

**Phytochemical screening of *Lawsonia inermis* Linn**

Singh et al in 2014 investigated *Lawsonia inermis* Linn for the presence of alkaloids, glycosides, flavonoids, tannins, sugars and protein correlation with its TLC profile and discovered that various curative properties of *Lawsonia inermis* Linn was due to the comportment of these secondary metabolites [6].

**Chemical components of *Lawsonia inermis* Linn**

Secondary metabolites play a critical function in the genetics of plant and understanding the plant problem such as the constitutions of the metabolic pathways. The secondary metabolites of plants include alkaloids, flavonoids (flavones), terpinoids, and phenolic compounds.

**Hennatannic acid and Lawsone**

Written reports on chemical constituents of *Lawsonia inermis* Linn were first reported in 1886 by M. A. Harraory, who reported hennatannic acid as coloring pigment of *Lawsonia inermis* Linn, then after around 26 years Tommasi in 1920 reported that 2-hydroxy-1,4-naphthoquinone [7].

**α- ionone and β- ionone**

Anita and kaushal in 1950 confirmed the presence of α- ionone and β- ionone in the essential oil extracted from flowers of *Lawsonia inermis* Linn while working on its flowers [8].

**Carboxylic acids**

S. R. Agarwal et al. in 1959 extracted fixed oil from seeds of *Lawsonia inermis* Linn reported its yield 10-11% and determined arachidic acid, behemic acid, linoleic acid, palmitic acid and steric acid as its main components [9].

**Gallic acid and Glucose**

B. N. Sastri et al. in 1962 reported gallic acid and glucose from Leaves and whole parts of *Lawsonia inermis* Linn respectively [10].

**Flavone Glicysides**


**Auto- Oxidation of Lawsone**

Later on Afzal et al in 1984 he further suggested that Lawsone is present in the leaves in reduced configuration and is auto- oxidized to Lawsone during alkaline extraction [12].

**Coumarins and Xanthones**

D.K. Bhardwaj et al. In 1976 reported a compound 5- alloxyl-7- acetoxy coumarin from the ethanolic extract of *Lawsonia inermis* Linn [13] and in 1977 he further extracted 1,3- dihydroxy-6,7- dimethoxyxanthone and 1-hydroxy-3,6- diacetoxy-7- methoxyxanthone [14]. The structure of 1-hydroxy-3,6- diacetoxy-7-methoxyxanthone was later on confirmed in 1980 [15] and in 1978 reported 1-hydroxy-3,7- dimethoxy-6-acetoxyxanthone from *Lawsonia inermis* Linn [16].

**D- Mannitol**


**Alcohol**

S. Gupta et al. In 1992 extracted 3- methylnonacosan-1-ol from bark of *Lawsonia inermis* Linn [18].

**Naphthoquinone**

S. Gupta et al. In 1993 extracted a compound from the bark of *Lawsonia inermis* Linn and determined its structure as 2-methyl-8-hydroxy-1,4- naphthoquinone [19].

**Diols**

S. Gupta et al. In 1994 reported a new compound from roots of *Lawsonia inermis* Linn and on
spectroscopic measurements determined its structure as β-ethylcholest-5-en-3β, 8β-diol [20].

### 2- Phenylethanol, β- ionone and its Derivatives
In 1995 K.C. Wong et al. extracted volatile components from yellow and red flowers of *Lawsonia inermis* Linn and carried out its analysis through GC and GC/MS. The components determined were 2- phenylethanol, β- ionone and its derivatives [21].

#### Saponin
In 1996 khan et al. Reported antiviral Saponin from fruit of *Lawsonia inermis* Linn [22].

#### Larnermis acid
G. Handa et al. in 1997 isolated Lawnermis acid from seeds of *Lawsonia inermis* Linn [23].

#### Triterpinoids
Siddiqui et al. in 2001 reported two pentacyclic triterpinoids from aerial parts of *Lawsonia inermis* Linn [24].

#### Anthraquinones
In 2007 M. A. Abdulmoneim Saadabi, prepared crude extracts of leaves of *Lawsonia inermis* Linn in water, methanol and chloroform reported that anthraquinones as major constituent in leaves and water crude extract inhibit the growth of pathogens in antimicrobial assay more than methanol and chloroform crude extracts [25].

#### Phenolic Glycosides
Hsouna et al. in 2010 reported five phenolic glycosides from n- butanol extract of leaves of *Lawsonia inermis* Linn [26].

#### Components of essential oil of leaves
Adebola O.Oyedeji et al. in 2005 isolated essential oil from leaves of *Lawsonia inermis* Linn and reported 47 components in the essential oil of leaves of *Lawsonia inermis* Linn through GC and GC/MS analyses out of which 36 components were identified which constitute 80.4% of the oil. The major components were Ethyl hexadecanoate, (E)- methyl cinnamate, isocaryophyllene, (E)-β-ionone and methyl linolenate [27].

Kebede et al. in 2013 identified 28 components in the essential oil of *Lawsonia inermis* Linn [28].

#### Extraction of Lawsone
Mehrdad Mahkam et al. in 2014 extracted Lawsone by soxhlet extraction technique using methanol solvent. The merit of this method is to extract large amount of Lawsone (720mg from 40 grams of henna powder) using small quantity of methanol. The extracted Lawsone was optimized using UV-Vis, FT-IR and NMR analysis [29].

Ashnagarl et al. in 2011 isolated Lawsone from leaves of *Lawsonia inermis* Linn due to their curative and traditional applications through maceration and soxhlet extraction in different polar and non-polar solvents. The extracted Lawsone was optimized using FT-IR and thin layer chromatography (TLC) The yield was 30mg [30].

Hikmatullah Jan et al.in 2011 extracted Lawsone from leaves of *Lawsonia inermis* Linn with clove oil, ethyl acetate, water and stained angiosperm stem of Zea mays Linn and Helianthus annuus Linn (parenchyma and sclerenchyma tissues). However, the staining intensity depends upon the solvent used. Water and ethyl acetate extract gave significant intensity of color in parenchyma and sclerenchyma tissues of both species. This study revealed that method of extraction and solvent has direct effect on the staining property of dyeing agent on botanical materials [31].

#### Estimation of Lawsone through HP-TLC
Maunang M. Patel et al. in 2013 Proposed high performance thin layer chromatography (HP-TLC) for the estimation of Lawsone in poly herbal dye Trichup Herbal Hair Powder (THHP) and good resolution was achieved with mobile phase containing toluene, ethyl acetate and glacial acetic acid in the ratio of 8:1:1. The Rf value of 0.46±0.05 was obtained densitometrically at 277nm. Yield of Lawsone obtained was 0.322±0.014% in THHP. This study showed that this method is accurate and cost- effective for routine analysis of Lawsone in polyherbal dyes [32].

#### Reactivity of Lawsone
Lamoureuxa. H. et al.In 2008 Explained the reactivity of Lawsone on the basis of Lawsone acetate as an active ester. It has been reported that Lawsone can be thermodynamically activated. A mechanism is proposed for the transfer of acyl group of the Lawsone in the presence of a catalyst [33].

Density functional theory (DFT) explains the reactivity of Lawsone during alkylation that the enolate anion act as nucleophile with various reactive sites. The oxygen at position 2 can act selectively under polar conditions in ionic solvents, explained by atomic charge and Fukui function [34].

### 3. Biological Review

#### Anti-bacterial and antifungal activity
Bhuvaneswari K. et al. In 2002 Tested fresh suspension and dried powder of leaves of *Lawsonia inermis* Linn against the pathogens Escherichia coli, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumoniae,
Staphylococcus aureus causing urinary tract infection. The measured inhibition zones were 18mm for Escherichia coli, 17mm for Staphylococcus aureus with fresh leaves suspension and 17mm for Escherichia coli, and 10mm for Staphylococcus aureus with dried leaves powder. The dried leaves powder has significant effect on the microbial concentration than fresh leaves suspension [35].

Fatima et al, 2013 investigated three medicinally important plants; Lawsonia inermis Linn, Lantana camara and Swertia angustifolia for antifungal and antibacterial activities. Amongst them Lawsonia inermis Linn showed maximum zone of inhibition against six bacterial strains (staphylococcus aureus 16mm, E. coil 14.1mm, M. luteus 14mm E. aerogenase 11mm, S. Setubal 10.5mm and Klebsiella pneumonia 15.6mm) and three fungal strains Fusarium solani, Alternaria and Mucor. The percent inhibitions were 78.8, 65.3 and 71.1 per cent respectively. These results concluded that extracts of Lawsonia inermis Linn can participate in the antibacterial and antifungal drugs positively [36].

Analgesic activity
Shah et al, 1989, Seed oil of Lawsonia inermis Linn was tested on isolated tissue and failed to show CNS effects because it possess analgesic activity [37].

Antibacterial activity
Wasim Raja et al. in 2014 investigated phytochemical constituents of Lawsonia inermis Linn and evaluate its antibacterial activity. In this study antibacterial activity was correlated with the presence of phytochemical components (flavonoids and glycosides). The antibacterial activity of Lawsonia inermis Linn was determined in the concentrations of 25, 50, 75, and 100mg/mL against B. cereus, S. aureus, E. coli, Kleb. pneumoniae, Ps. pseudoalcaligenes bacteria with the inhibition zones of 8mm-14mm, 7.5mm-9.9mm, 7mm-16mm, 7mm-10.2mm and 6mm-10mm respectively [38].

Anthemantic activity
Sarojini et al. in 2012 reported that ethanolic and methanolic extract of leaves of Lawsonia inermis Linn obtained through maceration method of extraction showed anthemantic activity performed using Indian earthworm Pheritima posthuma . The results were evaluated using SEM technique, the ethanolic extract showed more anthemantic activity showing time of paralysis 35±1.15min-57±0.57min and time of death 40±1.15min-63±1.15min than the positive control used. The anthemantic activity is probably due to the presence of alkaloids, glycosides, terpinoids and flavonoids in Lawsonia inermis Linn [39].

Anti-parasitic activity
Okpekon T. et al, in 2004 showed that Lawsonia inermis Linn possesses significant trypanocidal activity during study of 17 plants that were used in the Ivory Coast. Various polar, non-polar and alkaloidal extracts of their species were tested for antiparasitic activity in-vitro against antiparasitic drug [40]. Okpekon et al. in 2004, isolated Acetyl derivative of Lawsonicin constituent of Lawsonia inermis Linn showed cent percent inhibition to the growth of Mycobacterium tuberculosis [41].

Anti-inflammatory activity
Ali B.H. et al. in 1995 butanol and chloroform extract of Lawsonia inermis Linn showed significant anti-inflammatory activity as compared to the ethanolic extract in the concentration dependent fashion [42]. Malek et al, 2014 evaluated antioxidant activity of aqueous extracts of various parts of Lawsonia inermis Linn through free radical scavenging capacity (ABTS, DPPH, hydroxyl, superoxide, nitricoxide), total antioxidant by ammonium molybdate reduction method, the IC50 value was calculated for ability of extract to prevent lecithin liposomes peroxidation the results was compared with the already reported results. Seeds and leaf extracts of Lawsonia inermis Linn showed maximum antioxidant activity, seed extract were involved in the iron chelating activity while the leaves extracts were involved in the anti-inflammatory activity [43].

Anti-oxidant activity
Khodaparast et al. 2007 reported antioxidant activity of water and methanalol leaf extract of Lawsonia inermis Linn by rancimat method on refined soybean oil and compared with the induction period of synthetic antioxidants; BHA, BHT and TBHQ. The phenolic extracts of leaves of Lawsonia inermis Linn were extracted by solvent and ultrasound- assisted methods. Out of which sonication gave better yield of phenolic compounds and showed maximum antioxidant activity than solvent extraction. The methanolic extract of Lawsonia inermis Linn has shown better antioxidant activity than water extract [44].

Anti-cancer activity
Babili et al. in 2013 obtained antioxidant activity of ethanolic extract of leaves of Lawsonia inermis Linn with an IC50 value of 6.9±0.1mg/L,petroleum ether extract showed antimalarial activity. Extracts, ethyl acetate and petroleum ether, showed activity against MCF7 (human breast cancer cells) 27mg/L and 22mg/L respectively [45].

Hepatoprotective activity
Asmah Rehmat et al. in 2006 investigated essential oil of Strobilanthes crispus and Lawsonia inermis Linn for their chemical constituents, antioxidant activity and cytotoxic effects. Essential oils of both species were evaluated against cancerous and normal cells. The GC/ MS analysis of their essential oil revealed 28 components of Strobilanthes crispus and 23 components of Lawsonia
inermis Linn. They reported that Essential oil from Lawsonia inermis Linn showed maximum cytotoxic effect on liver cancer cells (HepG2) with IC50 value of 24µg/mL while essential oil from Strobilanthus crispus showed no anti-cancer activity [46].

Protein Glycation Inhibitory Activity
Sultana N. et al. in 2009 reported that ethanolic extract of Lawsonia inermis Linn showed significant protein glycation inhibitory activity with IC50 value of 82±0.13µg/mL [47].

Tuberculostatic activity
Sharma V.K. et al in 1990 reported that extract of Lawsonia inermis Linn inhibited the growth of Mycobacterium tuberculosis H37Rv in the concentration of 6µg/mL [48].

Antiviral activity
Khan M. M. A. A. et al. in 1991 reported that the ethanolic extract of fruits of Lawsonia inermis Linn showed highly inhibiting activity against Sembiki forest virus (SFV) present in Swiss models of mice and chicken embryos. That was evaluated after 10-25 days of virus attack [49].

Antifertility activity
Munshi et al. 1977, reported that the leaves powder of Lawsonia inermis Linn when introduced into the diet of rat effects the fertility of rats. It was further investigated that the infertility induced was permanent [50].

Anti Nematicidal activity
Korayem et al. in 1992 reported that Lawsonia inermis Linn has an inhibited effect on the growth of Meloidogyne incognita. When tomato and Lawsonia inermis Linn were grown simultaneously in the soil, it inhibited the growth of nematodes. It was analysed that when Lawsonia inermis Linn grown alone reduction in the growth of nematodes was observed up to 99% [51].

Enzyme inhibitory activity
Choudhary et al. In 2009 showed that Methanolic extract of leaves of Lawsonia inermis Linn showed immune-stimulant action in the as low concentration of as 1mg/mL as indicated by stimulation of T-lymphocyte proliferative action [52].

Immunomodulatory activity
Dixit V. et al. in 2000 reported that the naphthoquinone obtained from leaves of Lawsonia inermis Linn showed optimum immunomodulatory activity [53].

Anti-diabetic activity
Syamsudim et al. in 2008 reported that 70% ethanolic extract of leaves of Lawsonia inermis when introduced orally in alloxan induced diabetic mice showed strong hypolipidaemic and hypoglycaemic activities [54].

Antitrypanosomal effect
Wurochekke A. U. et al. in 2004 reported that Methanolic extract of leaves of Lawsonia inermis Linn inhibited Trypanosoma brucei at a concentration of 8µg/mL of blood in mice [55].

Molluscicidal activity
Wurochekke A. U. et al. in 2004 reported that the extracts of leaf, bark and seeds of Lawsonia inermis Linn were evaluated against Lymnaea acuminata and Indoplanorbis exustus. Seed extracts were found more potent than bark and leaf extracts against Indoplanorbis exustus [56].

Antidermatophytic effect
Natarajan V. et al. in 2000 reported that Ethanolic, hexane and ethyl acetate extract of Lawsonia inermis Linn showed optimum Antidermatophytic effect against five strains of Tinea rubrum and Tinea mentagrophytes [57].

Wound healing activity
D. M. Sakarkar et al. in 2004 evaluated ethanolic extract of Lawsonia inermis Linn and isolated Lawsone for wound healing effect [58].

ROS inhibitory activity
S. M. Ghuzfran Saeed et al.in 2013 purified Lawsone from leaves of Lawsonia inermis Linn through calcium ion Flash and Disc Counter Current Chromatography and found its inhibitory activity on the oxidative burst response of blood cells, polymorphonuclear cells and Mononuclear cells with IC50 values of 13±1.6µg/mL, 11±2.7 µg/mL and 10±4.2 µg/mL respectively [59].

Anti-sickling activity
Chang et al. in 1982 reported that aqueous extract of leaves of Lawsonia inermis Linn was found to increase the oxygen affinity of HbSS blood and to reduce the illness effects [60].

Mosquito repellent activity
Datti Y. et al. in 2014 reported that chloroform extract of Lawsonia inermis Linn has the ability to repel Anopheles gambiae 2014 Bakhshi et al. determined larvicidal activity property of Lawsonia inermis Linn against anopheles stephensi, the main cause of malaria in Iran. The concentrations of 4000ppm and 4ppm were used for four larval stages. The IC50 and IC90 values were found as 413.8, 3366.3, 696.9 and 3927.7 for four stages respectively [61].

4. Dye Review

Dye formulations from Lawsonia nermis Linn
In 2013 Naishadham et al. formulated natural hair dye combinations using 6 plants including Lawsonia inermis Linn and reported these formulations have no adverse effects on human scalp and are better than synthetic hair dyes [62]. Vadivel et al. in 2014 designed 17 hair formulations using Lawsonia inermis Linn, indigo and ratanjot, characterized them through pH study and
microscopic study. This study confirmed that there is no damage to human hairs using herbal formulations [63]. In 2015 Mahabub Hassan et al. isolated and purified Lawsons from leaves of Lawsonia inermis Linn and checked its coloring properties on cotton by using different mordants including potassium aluminum sulphate, copper sulphate and tartaric acid. This study reveals that coloring property of Lawsons can be enhanced by using different mordants and natural Lawsons can be used in textile industries for dyeing of silk and cotton fabrics [64].

5. Conclusion

This review highlighted that phytochemical constituents (secondary metabolites) play very important role in the eco-physiology of animals. Lawsonia inermis Linn has high antioxidant activity which is due to the presence of these secondary metabolites. Phenolic compounds mainly Flavonoids are called are nutraceuticals with its six subclasses flavones, flavonols, flavanones, flavonols, anthocyanines and isoflavones [65]. Alkaloids, glycosides, terpenoids, steroids and Saponins which are also responsible for fragrance [66]. Essential oil of Lawsonia inermis Linn has high antioxidant and antimicrobial activity which makes it a good ingredient to be use in the future drugs against various diseases. The Lawsons of Lawsonia inermis Linn was evaluated for antioxidant activity, antibacterial activity and its coloring effect on leather. Based on the dyeing method and selection of the mordants variety of shades can be obtained. Diversity in the topology causes introduction of different metals in the plants which have both adverse and curative effects on organisms as well as on environment. Lawsonia inermis Linn can further use for its medicinal values and coloring properties. Projects can be developed and designed for detail investigation of its carcinogenic activity and can be incorporated for treatment of many types of cancer, renal failure, and other fatal diseases. Moreover, its coloring property can be toned and altered to obtain desired shades and could be used safely as dyeing agent for hairs and palms without any hazards besides, it can be used in the textiles industry and leather industry that are caused by synthetic coloring agents.

6. References

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