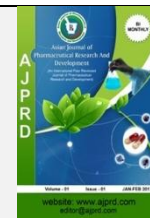


Available online on 15.06.2020 at <http://ajprd.com>

Asian Journal of Pharmaceutical Research and Development

Open Access to Pharmaceutical and Medical Research

© 2013-20, publisher and licensee AJPRD, This is an Open Access article which permits unrestricted non-commercial use, provided the original work is properly cited



Open Access

Review Article

A Scientific Update on *Juglans Regia* Linn.

Gunjan Verma *, Vandana Sharma

Arya College of Pharmacy, Jaipur, Rajasthan, India

ABSTRACT

Medicinal herbs having a great role in human health care and welfare services. These herbs widely used in Ayurveda, Homeopathic and Allopathic system having various therapeutic properties. Walnut (*Juglans regia* L.) are the plants belonging to the family *Juglandaceae* commonly known as Akhrot. It is widely distributed in China, United State, Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh, Uttarakhand. It has different varieties such as Black walnut, English/Persian walnut, butternut/white walnut. *J.regia* L. have many marketed formulations such as Topical formulations like Walnut oil, Face wash, Exfoliating scrub, Soap, Shampoo, Hair color and Oral formulations like capsules, tinctures, dilutions, shell powder. Chemical study reveals that *J.regia* L. contains Juglone, Alkaloids, Flavonoids, Saponins, Polyphenols, Polyunsaturated fatty acids, Oleic acids, Linoleic acids, Proteins, Napthaquinones, Ascorbic acid, Sitosterol, Tannins. Walnut contains different nutritional components like Carbohydrates, Proteins, Dietary fibres, Iron, Phosphorus, vitamin E & C. This plant possess beneficial effects include Antimicrobial, Antioxidant, Anticancer, Antidiabetic, Anthelmintic, Antiinflammatory, Antidepressant, Hepatoprotective, Antiulcer, Antiaging and Hypocholestermic activity and other therapeutic activities. It is believed to be used in Dental plaque, Gingivitis, Oral hygiene, Eczema, Hemorrhoids, Burns, Blood Purifier, Dyeing or Colorant, Antiseptic and Astringent. In the present study, Pharmacognostic and Pharmacological properties of *J.regia* L. have been discussed. This review highlights the various Ethanobotanical and traditional uses as well as Pharmacognostic and Pharmacological report on *J.regia* L.

Key words: Anti diabetic, *Juglans regia* L. Juglone, Polyphenols, Nutritional value.

ARTICLE INFO: Received 03 April 2020; Review Completed 27 May 2020; Accepted 05 June 2020; Available online 15 June. 2020



Cite this article as:

Verma G, Sharma V, A Scientific Update on *Juglans Regia* Linn, Asian Journal of Pharmaceutical Research and Development. 2020; 8(3):166-175.DOI: <http://dx.doi.org/10.22270/ajprd.v8i3.741>

***Address for Correspondence:**

Gunjan Verma, Arya College of Pharmacy, Jaipur

INTRODUCTION

The system of medicine organized in India and absorbed in to the Indian culture. Indian medicinal practice includes AYUSH, Ayurveda, Unani, Siddha, Yoga, Naturopathy and Homeopathy. The word Ayurveda is made up of the two Sanskrit words “Ayur” means life and “Veda” means knowledge and “It is the science of life”. Ayurveda is the part of Adharveda, nature and science. Indian traditional medicine plays a great role in human health care and welfare services. In India, the history of traditional medicines have before 5000 years BCE. In ancient literature, there are different medicinal manuscripts like Arthaveda (enlisted use of 290 medicinal plants, 1200 B.C), Rigveda (contains therapeutic uses of 67 plants, 1700-1100 B.C), Yajurveda (enlisted use of 81 plants, 1400-1000), Sushruta samhita (enlisted use of 395 plants, 660 B.C), Charakha samhita (describe use of 341 plants, 990 B.C), Dhanwantari nigantu (contains many

medicinal plants). It is noticed that the method mentioned in Adharveda is more beneficial in humans than mentioned in different Vedas. Charakha and Sushruta samhita are the compendium of Ayurveda. Charakha samhita includes the knowledge of medicines and Sushruta samhita includes detail on surgery than medicines¹⁻³. In the Global Market, there are several medicinal plants which having therapeutic activity and it is the good source for the treatment of minor to major problems like Cold, Cough, Skin rashes, Bacterial and Fungal infections, Diabetes, Cancer, Arthritis, Tuberculosis etc⁴. Different parts of plants like root, bark, fruit, flower, seed, leaves, stem etc and their secondary product like gum, resin show biological activity. This plant contains active constituents such as vitamins, minerals, enzymes and trace elements which having a great role in Pharmaceutical formulations⁵.

In the present study we have gone through a comprehensive review of common walnut, *Juglans regia* Linn. (*J.regia* L.),

belonging to the family Juglandaceae. It is also known as English walnut, Persian walnut, common walnut Akhrot, Aksoda, Aksota. It is widely distributed in Southern Europe, Western Asia, Central Asia, Kashmir, Tajikistan, Kyrgyzstan, China, United State, Turkey, India, Australia, New Zealand. This plant can live over a duration of 100-200years and some species for 1000 years⁶. All parts of *J.regia* L. such as leaves, bark, green husk, shell, seed, fruit have pharmacological activities⁷. *J.regia* L. is a source of Vitamin E, monounsaturated fatty acids, omega 3 fatty acids and arachidonic acids⁸. *J.regia* L. is an ayurvedic traditional plant and it is used as an ingredient of many marketed formulations mentioned below in table no. 6. China is the largest and United State is the second largest producer of walnut in the world⁹. According to Indian scenario it is mainly cultivated in Jammu&Kashmir, Arunachal pradesh, Himachal pradesh and Uttarakhand¹⁰. In

the world, there are different varieties of walnut such as black walnut (*Juglans nigra*), English or Persian walnut (*J.regia* L.), Butter or white walnut (*Juglans cinerea*). English walnut not too hard to crack than black or white walnut¹¹.

J.regia L. contains various type of chemical constituents such as Juglone, polyphenols, Flavonoids, Terpenoids, Steroids, Ascorbic acid, Gallic acid, Sitosterol, Quercetin and Omega 3 Fatty acid¹²⁻¹⁴. *J.regia* L. is reported to use as Antiinflammatory, Diuretic, Anticancer, Laxatives, Antidiabetic, Antiatherogenic, Antimutagenic, Antifungal, Antioxidant, Antiseptic, Antibacterial, Antiallergic, Astringent, and Antiulcer. It is useful in traditional medicines for the treatment of Cardiac diseases, Dental plaque, reduces Cholesterol level, Blood purifier, regulate Immune system. The nut of *J.regia* L. is used in Cosmetic, Food and Pharmaceutical industry¹⁵.

Table: 1 A common name of *J.regia* L. in the various region of India

S.no	Country	Languages	Common Names	References
1.	India	Hindi	Akhrot	[16]
2.	India	Kashmiri	Doon	*
3.	India	Unani	Gardgani	[16]
4.	India	Sanskrit	Akschota	[11]
5.	India	Tamil	Akhrottu	[11]
6.	India	Telgu	Akroot kaya	[11]
7.	India	Gujarati	Akharot	*
8.	India	Urdu	Akhhroot	[11]
9.	India	Bengali	Bosnian	*
10.	India	Marathi	Akrod	[11]

Table 2: A common name of *J. regia* in other countries

S.no	Countries	Common names	References
1.	China	Long zhu guo	[11]
2.	Japan	Kusa-tokeiso	*
3.	Singapore	Timun hutan	*
4.	Sri Lanka	Kodimathulai	*
5.	Mexico	Clavellin blanco	*
6.	Hawai	Scarlet fruited passion flower	[11]

Taxonomical Classification-¹¹

Kingdom- Plantae
 Division- Magnoliophyta
 Class – Magnoliopsida
 Order – Fagales
 Family – Juglandaceae
 Genus – Juglans L.
 Species – *Juglans regia* L.

Cultivation & Collection: ^{9,11,16,17}

Walnut is grown in deep, fertile, loamy soil, free from alkali. Seed is sown about 4-10 cm deep in soil. Seed germinates in 1-2 weeks after planting. Nitrogen, Potassium, Phosphorus are the common elements must be available in the soil for germination of seed. The climate should be sunny because it is intolerant in wet or rainy climate. The main problem of this plant is that on heavy rainfall deterioration will start which reduces the number of flowers. The pH of soil should be 6-8. Plant should be protected from vermin by covering them from the net. The Plantation of *J.regia* L occurs in spring season. Flowering is done in the month of April and Pruning occurs between June and December. Harvesting of plant occurs in the month of September and it continued till November. Walnuts are ready to harvest when green husk is split and nut is falling from the tree. Harvesting occurs via shaking the tree by hands or using long poles. Delaying in harvesting reduce the quality of nuts and kernels. Dried nut stored at room temperature for 4-5 months and freeze for 1-2 years. For packaging, Green husk of fruit removes by wet scrubber and nut dried for 24 hrs to remove moisture.

Proper drying of walnuts improves the quality and life of nuts.

Morphology: ^{6, 11, 18}

J.regia L. is a large deciduous tree having height 25-35m and diameter 2 m. Bark is silver-grey in color having smooth and wide fissures. The color of the sap wood is creamy-white and heart wood is dark chocolate. Leaves are arranged in alternate and imparipinnate manner. It is Yellowish green in color having aromatic odour and Astringent taste. It is 20-35cm in length and 5-15cm in width. It has ovate and lanceolate shape.

Flowers are monoecious, small yellowish green in colour. The male flowers are arranged in the manner of pendulous slender catkins and female flowers are in 1-3 flower terminal catkins which born in the form of clusters. The male and female reproductive organs exist on the same plant so for the pollination some trees grow near to each other. *J.regia* L. fruit is 5cm long with leathery, wrinkled exocarp and hard endocarp having 4 lobes. Fruits are born in the form of clusters. Seeds are edible. Nuts are round in shape, having size 1.5-2 inches.

Figure: 1 *J.regia* L. treeFigure: 2 Leaves of *J.regia* L.Figure: 3 Bark of *J.regia* L.Figure: 4 Fruit Nut of *J.regia* L.Figure: 5 Bud of *J.regia* L.Figure: 6 Fruit of *J.regia* L.



Figure: 7 Stem & Root of *J. regia* L.



Figure: 8 Male catkin of *J. regia* L.



Figure: 9 Female Flower of *J. regia* L.

Medicinal uses :¹⁹

J. regia L. is a traditional medicine, has been used in different Ayurvedic formulations since a long ago.

Different part of *J. regia* L. like bark, leaves, fruit, flower, seed, pericarp found various medicinal uses. Some of the medicinal uses of *J. regia* L. have been mentioned in table 3 given below:

Table: 3 The medicinal use of various parts of *J. regia* L.

S.no.	Parts	Medicinal uses	References
1.	Bark	Oralcavity hygiene, Gingivitis, Dental plaque, Cleaning of teeth, Antiinflammatory, Diuretic, Laxative, Blood purifier, as colorant for dyeing or coloring the lips.	[12]
2.	Leaves	Hyperglycemia, Eczema, Hemorrhoids, Diabetes, Hypercholesterolemia, Urinarytract infection, Antibacterial, Antioxidant, Anti ulcer, Anthelmintic	[21-23]
3.	Fruit and green husk	Goitre, Diabetes, Hepatic and Renal disease, Myocardial infraction, burns, Mental retardation, Galactagogue, oral contraceptives, Textile or Dyeing industry.	[24,25]
4.	Flower	Skin inflammation, Antiulcer, Antidiarrhoeal, Antiseptic, Astringent	[26]
5.	Seed	Antiatherogenic, Antimutagenic, Breast and Colon cancer.	[27]
6.	Pellicle	Antioxidant, Antiinflammatory, Anti atherogenic, Antimicrobial, liver protective, Antidiabetic.	[28]
7.	Walnut oil	Inflammation, Diabetes, Diabetic neuropathy, Immunomodulatory, Cardiovascular disease.	[14,29]

Nutritional Value:^{31,32}

J. regia L. is an important food source from an ancient time. It has various nutritional components like Starch, Protein, Phosphorus, Iron, Alkaloids, Vitamin E & C.

J. regia L. is the best source of Iron, Phosphorus, Carbohydrate and Protein. It has fat and dietary supplements which help in lowering the blood cholesterol level, lipids, LDL and HDL.

Table: 4 Nutritional values of various components of *J.regia* L.

Substance	Value
Carbohydrate	13.7%
Dietary fiber	31-52 gm/kg
Total proteins	15.7%
Iron	40 mg%
Phosphorus	340 mg%
Unsaturated fatty acid	63-90%
Vitamin C	40%
Vitamin E	24.5%

Chemical Constituents:

J.regia L. is a rich source of various types of chemical compounds. It plays a great role in the ayurvedic and homeopathic system of medicine³³. It contains different biologically active substances like Polyphenols, Flavonoids, Steroids, Phospholipids, Triterpenes, Quinines, Fatty acids, Tannins like Gallic Acid and Ellagic Acid. Ellagic acid is responsible for anticancer property and immunization. The active constituent of *J.regia* L. is Juglone (quinone)^[11]. *J.regia* L. bark contain higher polyphenolic compounds which are responsible for antioxidant and antibacterial activities^{12,34}. The leaves of *J.regia* L. is highly rich in

alkaloids, saponins, flavonoids which exhibits antidiabetic effect²¹. walnut oil contains omega 3 and omega 6 polyunsaturated fatty acid, mono,di,tri acylglycerol, free fatty acids, oleic and linoleic acid which is helpful in heart disease, lowering the blood cholesterol and sugar level^{31,35}.

The green husk shell contains juglone and polyphenols which are used in textile dyeing industries. *J.regia* L. plant contains monoterpenes, sesquiterpenes, juglone, sterols, tocopherols, proteins, dietary fibres, melatonin, folate. This study has found that *J.regia* L. contains varieties of chemical constituents containing different biological activities²⁵.

Table: 4 Chemical components present in different parts of *J.regia* L.:

Part of plant	Chemical components
Leaves	Alkaloid , Saponin, Flavonoids, Napthaquinones
Green walnut shell	Juglone, polyphenols, Naphthols, Tannins
Walnut oil	Poly Unsaturated Fatty Acids, Monoacylglycerol, Diacylglycerol, Triacylglycerol, Oleic and Linoleic Acid
Bark	Polyphenols
Seed	Protein
Stem	Juglone, Sitosterol, Ascorbic Acid, Quercetin-3-Larabioside, Phenols, Flavonoids, Naphthquinones
Flower	Gallic acid, Coumarin, Quercetin, Polyphenols, Flavonoids, Sterols, Fat , Protein, Vitamin, Minerals

Previous Findings:**Table: 5** Therapeutic activities of various parts of *J.regia* L.:

Therapeutic activity	Extract used	Part used	References
Antimicrobial activity	Aqueous/Ethanol	Bark	[12,20,22]
Antimycobacterial activity	Hexane/Methanol/Aqueous/Ethanol	Bark, Leaves	[36]
Antidiabetic effect	Ethanol /Aqueous	Leaves, Septum	[14,21,35]
Antioxidant activity	Methanol / Aqueous	Pericarp (Green Husk), Bark	[30,34]
Antifungal activity	Alcohol /Methanol	Stem Bark, Leaves	[23,37,38]
Antidepressant, antihypoxic, anti-inflammatory	Methanol	Flower	[26]
Platelet aggregation, bleeding time, plasma coagulation	Aqueous	Root Bark	[39]
Thyroid hormone enhancing activity	Aqueous	Fruit	[24]

Antinociceptive and antiinflammatory activity	Ethyl Acetate	Walnut Oil, Kernel	[29]
Anticancer	Peptide	Seed	[27,40]
Gastro-protective activity	Aqueous	Leaves	[41]
Hepato-protective activity	Ethanol:Water	Leaves	[42]
Hypocholesteremic activity	Powder	Leaves	[43]
Anti ageing activity	Aqueous	Leaves	[44]
Anthelmintic activity	Aqueous, Methanolic, Petroleum Ether Extract	Leaves	[45]

Anti fungal activity: ^{23,37,38}

Anti fungal activity was performed on the alcoholic extract of *J.regia* L. stem bark. It was estimated by in vitro method against three isolates of fungi (*Rhizoctonia solani*) isolated from cauliflower, tomato and egg. The *J.regia* L. extract reduce the radial growth of fungus and the inhibition of radial growth was 3.5cm at 5% concentration of plant extract and decrease gradually 0.4cm at 20% concentration of plant extract. *J.regia* L. 20% concentration of extract show high inhibition of fungus *Rhizoctonia solani* and this method was studied by *Mohammed Nadeem Kasim Hantoosh et al.* (2018) and *Emira noumi et al.* (2011). Juglone, sitosterol, ascorbic acid, quercetin-3-larabinoside, polyphenols, flavonoids are the main constituents of *J.regia* L stem bark. Antifungal activity was also performed on the different extract of *J.regia* L. leaves effective against *Candida albicans* studied by *Hubert sytykiewicz et al.* (2015)

Bleeding time, Plasmatic Coagulation, Platelet aggregation: ³⁹

Bleeding time, Plasmatic coagulation, Platelet aggregation activities was studied in aqueous extract of root bark of *J.regia* L. It exhibited the platelet aggregation and anticoagulant activity. Activated partial thromboplastin time, prothrombin, thrombin time and fibrinogen dosage are the clotting parameters. *J.regia* L. extract inhibited the platelet aggregation induced by ADP, thrombin and collagen and it was correlated via $ADP \geq thrombin \geq collagen$. This method was studied by *A.amirou et al.*(2018). The aqueous extract represented the significant in vitro anti aggregation activity observed by the ADP induced aggregation method having inhibition up to 90%. Aqueous extract increased the bleeding time in animals hence it exhibited potent anti thrombotic activity.

Anti Nociceptive and Anti Inflammatory Activity: ²⁹

Anti inflammatory and Anti nociceptive activity was studied on ethyl acetate extract of *J.regia* L. kernels and oil. Linoleic acid was responsible for the reduction of inflammation, pain and blood sugar level. It increased the level of serum insulin and normalise the glycated haemoglobin level. The ethyl acetate extract of kernels reduced the blood sugar level and increased the insulin level. This method was evaluated by *Karim Rafat* (2018) and Phytochemical analysis was done on the basis of GC-MS, GC-FID, RP-HPLC. *J.regia* L. oil and kernel show high anti nociceptive effect.

Anti ageing activity: ⁴⁴

In vitro anti ageing activity was studied on leaves extract of *J.regia* L. The extract was prepared from undamaged *J.regia* L. kernels with pellicles using the solvent as water. The total phenolic and protein content were examined by using UV spectrophotometer hence the result showed that due to the phenolic compounds present in the extract of *J.regia* L. it exhibits the anti ageing effect and this activity was studied by *Przekora et al.* (2018). It was concluded that the extract concentration 5µg/ml was potential to use in cosmetic preparations prepared for sensitive skin.

Anti Cancer Activity: ^{27,40}

Anti cancer activity was performed on *J.regia* L. which is effected against the survival of human breast and colon cancer cells. 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay was used to detect the viability of cancer cells. Walnut protein hydrolysates were used against breast and colon cancer cell lines. Chymotrypsin show good anticancer activity. Chymotrypsin hydrolysate has potency to inhibit MDA-MB 231 breast and HT-29 a colon cancer cell line. The peptide fraction shows cell growth inhibition $63 \pm 1.73\%$ for breast cancer and $51 \pm 1.45\%$ for colon cancer cells and this method was studied by *Rahelah Jahanbani et al.*(2016). *J.regia* L. exhibited the antitumor effect on ovarian cancer cells was studied by *Fang Fang et al.* (2015).

Anti Depressant, Anti Hypoxic, Anti Inflammatory: ²⁶

Anti Depressant, Anti Hypoxic and Anti Inflammatory activity were studied in the methanolic extract of *J.regia* L. flower. The anti inflammatory effect was determined by Carageenan induced hind paw edema. Antihypoxic activity was determined by haemic hypoxia, circulatory hypoxia and antidepressant activity was determined by using swimming test, Tail suspension methods. These activities were studied through *Seyed Fazel Nabavi et al.*(2014). Gallic acid, Coumarin, Quercetin, Polyphenols, Flavanoid compounds show an important role in this activity. Phenol compound inhibited the edema induced by Carageenan, so it has significant anti inflammatory activity. Flavonoids increase the cerebral blood flow and extract of flower having a good biological activity due to high content of Phenol, Flavanoid specially Quercetin.

Anti Microbial Activity: ^{12,20,22}

Anti microbial activity was performed on various species of oral bacteria such as *Streptococcus salivarius*, *Streptococcus mutans*, *Streptococcus aureus*, *Streptococcus*

sanguis. The Iranian bark of the Juglone shows antimicrobial effect against the oral bacteria. This activity was studied by *Faramarz zakavi et al.* (2013). The aqueous and ethanol extract were evaluated by using disk diffusion method. The result showed that sanguis and mutans species of streptococcus were most resistant to ethanol and aqueous extract respectively. The ethanol extract having significant anti-bacterial activity against all tested bacteria. In vitro antimicrobial activity of green husk and leaves of *J.regia L.* was studied by *Dilek keskin et al.* (2012) and *Bennacer amel et al.* (2017). Anti-microbial activity was also studied on the fruit extract of *J.regia L.* by *Afaf H. Al-Nadaf et al.* (2018) hence it is used as a natural antimicrobial agent for oral hygiene.

Hepato-Protective Activity:⁴²

Hepato-protective activity was studied in *J.regia L.* leaves extract. *Akram eidi et al.* (2013) studied the liver damage in animals which was induced by using carbon tetrachloride (CCl₄). Animals were divided into seven groups. After 28 days of treatment, animals were sacrificed and liver damage was examined by using various parameters such as serum biochemical parameters and histopathological observations. *J.regia L.* leaves extract exhibited a significant decrease in serum parameters and an increase in antioxidant enzymes. Histopathological examination showed that leaves extract decrease fatty acid degeneration from carbon tetrachloride-treated rats. It was concluded that *J.regia L.* leaves extract exhibits hepato-protective activity.

Gastro-Protective Activity:⁴¹

Gastroprotective activity was monitored in the leaves extract of *J.regia L.* on albino rats. It was responsible for anti-ulcer activity against pylorus ligation method. The chemical agents like aspirin and ethanol induced gastric ulcers in animals at 500mg/kg body weight. This method was summarized by *Kumaraswamy dabburu et al.* (2012). Animals were divided into 3 groups: control, standard and test. In pylorus ligation method *J.regia L.* extract showed a significant decrease in ulcer index. It was affected against ethanol and aspirin-induced gastric ulcer. The gastro-protective effect was evaluated by histopathological examinations, hence *J.regia L.* leaves extract exhibited a potent gastro-protective activity.

Hypocholesteremic effect:⁴³

This study monitored the activity of *J.regia L.* leaves in hypercholesterolemic rats. The antioxidant activity played an important role to overcome the hypercholesterolemic problems. Fifty albino rats were divided into 5 groups of 8. *J.regia L.* leaves powder mixed with food at different concentrations 1%, 2% and 5%. After 40 days of treatment, the blood sample was collected and examined the various biochemical parameters such as triglycerides, cholesterol, LDL, HDL etc. The result showed that *J.regia L.* leaves powder reduced the cholesterol, LDL-C, triglycerides and increased the HDL-C level. This method was studied by *Mahmoodi et al.* (2011) and it was concluded that walnut leaves powder had a potent effect on cholesterol and lipid profile and helpful in reducing cardiovascular disease.

Anti Diabetic Activity:^{14, 21, 35}

Anti-diabetic activity was studied in ethanol extract of leaves in streptozotocin-induced diabetic models. This anti-diabetic activity was studied by *Jamshid Mohammadi et al.* (2010). Animals were divided into four groups. Group 1 fed with normal diet and groups 2, 3, 4 treated with streptozotocin. Then groups 3 & 4 treated with *J.regia L.* leaves extract at different concentrations e.g. 200mg/kg and 400 mg/kg for 28 days. The alcoholic extract of *J.regia L.* had a significant effect in lowering the triglyceride level. On increasing the concentration of leaves extract, insulin level also increased but the HDL level was not changed in any group study. The cholesterol, LDL, VLDL level reduced significantly when compared from diabetes-inducing groups. The anti-diabetic activity of the different parts of *J.regia L.* via alloxan-induced diabetic animals was studied by *Parivash Rahimi et al.* (2011) and *Susankhosroyar et al.* (2017).

Anthelmintic Activity:⁴⁵

In vitro Anthelmintic activity was studied in different extracts of *J.regia L.* leaves by using an Indian earthworm (*Pheritima Posthuma*). This in vitro activity was studied by *R.Das et al.* (2011). Leaves were extracted by using different solvents like petroleum ether, methanol and water (maceration method). On phytochemical screening of different extracts of leaves revealed that it contains alkaloids, saponins, flavonoids, tannins. Earthworms were divided into five groups. Each group contains six earthworms. Extract was administered at different concentrations and piperazine citrate used as standard. Observation was done by calculating the time of paralysis and death of earthworm. Water extract had significant activity than petroleum ether extract.

Anti mycobacterial activity:³⁶

Anti-mycobacterial activity was studied on various extracts of bark and leaves of *J.regia L.* by *Delia Elva Cruz-Vega et al.* (2008). Leaves contain Monoterpenes, Sesquiterpenes and Bark contains Juglone, Regiolone, Sterol, Flavanoid. The minimal inhibitory concentration (MIC) was exhibited by hexane bark and methanol leaf extract. The aqueous and ethanol extract of bark and leaves had not show any anti-mycobacterial activity.

Antioxidant activity:^{30,34}

Antioxidant activity on various extracts of bark and green husk of *J.regia L.* was performed by *Kanchan Bhatia et al.* (2006) and *Ksenija kojicic et al.* (2018) respectively. They analysed DPPH scavenging effect and Cyclophosphamide-induced urotoxicity in mice. On increasing the concentration of extract, radical scavenging activity also enhanced. It was analysed on research that all parts of walnut like husk, leaf, seed, fruit, shell, pellicle, kernels show anti-oxidant activity. All methanol extract show higher antioxidant activity than petroleum ether extract.

Thyroid hormone enhancing activity:²⁴

Thyroid hormone enhancing activity was studied on fruit extract of *J.regia L.* This activity was performed by *Y.Ozturk et al.* (1994) by preparing fresh juice from plant

material or extraction by boiling with distilled water. Aqueous extract was used as an oral contraceptive and show anti implantation activity. The extract of *J.regia* L. increases the thyroid hormone level in mice.

Marketed Formulations Containing *J.regia* L. as main ingredient:

Table: 6 Marketed formulations of *J.regia* L. with their indications:

S.no.	Product name	Manufacturer	Indications
1.	Walnut herbal extract Capsules	Shudhanta Herbal Product	Memory booster, Dietary Supplement, Improve brain function, makes bones stronger.
2.	Walnut oil	KS essentials, Park Daniel	As hair oil, Paint thinner, wood oil, skin care, emollient.
3.	Exfoliating Walnut Face scrub	Bipha Ayurveda, Bajaj Nomarks, Biocare, Himalaya, Biotique, Sri Sri tattva	Skin cleaner, Remove impurities and improve skin tone, remove dead skin cells.
4.	Herbal Hair Color walnut red brown	Logana Naturkosmetik	Radiant color, shine and brown hair.
5.	Body language face wash	The Elite	Cleansing skin and remove impurities.
6.	<i>J.regia</i> L. Gemmae bud	Unda Gemmo	Dietary Supplement
7.	Gemmotherapy G75 <i>J. regia</i>	Herbal Gem	Dietary supplement
8.	Walnut shell powder	Herbal ingredient experts.	Manufacturing of skin care products.
9.	Walnut bark Volumizing Shampoo	Biotique	For fine and thinning hair
10.	Walnut 1:20 (concentrated embryonic plant extract).	Plant Stem cells (PSC)	Dietary supplement
11.	Herbal walnut & Goat milk Soap	Old tree	Remove impurities and purify the skin.
12.	<i>J.regia</i> L. liquid dilutions	Bjain pharmaceutical pvt limited.	Constipation, epigastric pain, useful in menstruation.
13.	ADEL <i>J.regia</i> L. Dilutions 200 CH	Adel Pekana Germany	Brain tonic, headache, acne, eczema, flatulence & bloating of abdomen.
14.	SBL <i>J.regia</i> L. mother tincture Q.	SBL pvt limited	Jaundice, gall bladder stone, Skin eruptions, Headache, acidity.
15.	<i>J.regia</i> L. globules 3X	Bjain Pharmaceutical pvt limited.	Acne, jaundice, gall bladder stone, skin inflammation, acidity, back pain.

Future Prospects:

J.regia L. is very important traditional medicine used for treatment of several diseases. This review tells that various types of studies done on plant *J.regia* L. and it is concluded that various types of Pharmacological studies proved on parts of *J.regia* L. The well known research on plant *J.regia* L. is not up to mark. It is possible that if we isolate a particular chemical compound from the extract of *J.regia* L. so it will easy to identify that which type of chemical compound responsible for particular activity. So the isolation of chemical compounds of *J.regia* by using chromatography methods like TLC, HPLC, GC-MS etc will be important for future aspects.

CONCLUSION:

In the present review we are trying to mention all information available on *J.regia* L. like Description, Nutritional Aspects, Phytochemical and Pharmacological Studies, Marketed Formulations. *J.regia* L. commonly known as Akhrot found in various countries of the world. *J.regia* L. is most commonly used in the indian system of medicine. It has various pharmacological activities on different parts of plant such as Antidiabetic, Anticancer, Antimicrobial, Antioxidant, Anthelmintic, Antiinflammatory, Antiageing, Hepatoprotective, Gastroprotective, Antifungal, Antimycobacterial and Antidepressant activity. It also having many marketed

formulations mention in above table no.6. This literature review that *J.regia* L. have an important role in various chronic diseases like diabetes, cancer, hypertension, depression but some parts of *J.regia* L. are untouched for

various pharmacological studies. This updated review of this plant will help to many researchers who will carry the investigation on this medicinal plant.

REFERENCES:

- Partha Pradip Adhikari, Satya Bhusan Paul, History of Indian Traditional Medicine: A Medical Inheritance, Asian Journal of Pharmaceutical And Clinical Research, 2018; 11(1):421-426.
- Abdurahiman. P.A "Problems and Prospects of Ayurvedic Medicine Manufacturing Units in the Northern Region of Kerala with Special Reference to Marketing" Thesis. Department of Commerce and Management Studies, University of Calicut, 2004
- Kokate C.K, Purohit A.P, Gokhale S.B, Pharmacognosy, Nirali Prakashan, 2018
- Anita Surendra Patil , Bipin Deochand Lade And Hariprasad Madhukarrao Paikrao, A Scientific Update on Passiflora Foetida, European Journal of Medicinal Plants, 2015; 5(2):145-155.
- Asma Nisar, Awang Soh Mamat, Md Irfan Hatim, Muhammad Shahzad Aslam, Muhammad Syarhabil Ahmad, An Updated Review On Catharanthus Roseus: Phytochemical And Pharmacological Analysis, Indian Research Journal of Pharmacy and Science, 2016; 3(2):631-653.
- D.De Rigo, C.M Enescu, T. Houston Durrant, W. Tinner, G. Caudullo, Juglans Regia In Europe: Distribution, Habitat, Usage And Threats, European Atlas of Forest Tree Species.
- Singh Deeksha, Tanwar Asmita, Agrawal Parul, an Overview on Coriander, JBPRAU, 2015; 4(2):67-70.
- Seyit Mehmet Sen, Turan Karadeniz , The Nutritional Value of Walnut, Journal of Hygienic Engineering and Design, 68-71.
- Walnuts Presented By FDA, Western Institute for Food Safety and Security, 1-5.
- Thakur Monika, Singh karuna, Walnut (Juglan Regia L.) A Complete Health and Brain Food, Asian Journal of Bio Science, 2013; 8(2):276-288.
- Parle Milind, Khanna Deepa, Walnut: Not A Hard Nut To Crack, IRJP, 2011; 2(5):8-17.
- Faramarz Zakavi, Leila Golpasand Hagh, Arash Daraeighadikolaei, Ahmad Farajzadeh Sheikh, Arsham Daraeighadikolaei, Zahra Leilavi Shoostari, Antibacterial Effect of Juglans Regia Bark against Oral Pathologic Bacteria, International Journal of Dentistry, 2013;1-5.
- Tuqa Aldawood, Alaa Alyousef, Shima Alyousef, Nora Aldosari, Sara Hussam , Alalhadad , Fikrat Bhaian, Dalia Sharaf Eldeen , Nishanth Sayed Abdul, Antibacterial Effect of Juglans Regia L. Bark Extract at Different Concentrations against Human Salivary Microflora, Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology, 2017; 3(4):214-217.
- Susankhosroyar, Shima Ghofranpour, The Effect Of Walnut Oil, Septum and Leaves Aqueous Extract in Alloxan-Induced Diabetic Rats, International Journal of Chemtech Research, 2017; (10):46-54.
- Jaiswal Bhagat Singh, Tailang Mukul, Juglans Regia: A Review of Its Traditional Uses Phytochemistry and Pharmacology, Indo American Journal of Pharmaceutical Research, 2017; 7(9):390-398.
- Ahmad N., Singh S R, Rashid Megna, Hidayatullah Mir, Walnut, Fruit Production of India, 2018; 660-672.
- Ali Jahanban-Esfahlan , Alireza Ostadrahimi, Mahnaz Tabibiazar And Ryszard Amarowicz, A Comparative Review on the Extraction, Antioxidant Content and Antioxidant Potential of Different Parts Of Walnut (Juglans Regia L.) Fruit And Tree, MDPI, 2019 ;(24):1-40.
- Arya Vaidya Sala, Indian Medicinal Plants, A Compendium Of 500 Species, Orient Longman Private Limited, 2004; (3).
- Sharma Pankaj, Tomar Lokeshwar, Bachwani Mukesh, Bansal Vishnu, Review On Neem: Thousand Problems One Solution, IRJP, 2011; 2(12):97-102.
- Dilek Keskin, Nur Ceyhan, Aysel Ugur, Chemical Composition And In Vitro Antimicrobial Activity of Walnut (Juglans Regia) Green Husks and Leaves From West Anatolia, Journal of Pure And Applied Microbiology, 2012; 6(2) :583-588.
- Jamshid Mohammadi, Khalil Saadipour, Hamdollah Delaviz, Bahram Mohammadi, Anti-Diabetic Effects of an Alcoholic Extract Of Juglans Regia in an Animal Model, Turk J Med Sci 2011; 41 (4): 685-691.
- Bennacer Amel, Cherif Hamida Saida, Contribution to the Ethnobotanical, Phytochemical, Antimicrobial and Antioxidant Study of the Leaves Aqueous Extract of the Common Walnut "Juglans Regia L., International Journal Of Pharmacology, Phytochemistry and Ethnomedicine, 2016; 7:41-52.
- Hubert Sytykiewicz, Grzegorz Chrzanowski, Anti Fungal Activity of Juglans Regia Leaf Extract Against Candida Albicans Isolates, Pol.J.Environ. Stud. 2015; 24(3):1339-1348.
- Y. Ozturk, S. Aydm And R. Arslan, K. H. C. Bwr And N. Kurtar-Ozturk, Thyroid Hormone Enhancing Activity Of the Fruits of Juglans Regia L. In Mice, Phytotherapy Research, 1994; 8:308-310.
- Mohammad Mirjalili And Loghman Karimi, Extraction And Characterization Of Natural Dye From Green Walnut Shells and Its Use in Dyeing Polyamide: Focus On Antibacterial Properties, Hindawi Publishing Corporation Journal of Chemistry 2013; 1-9.
- Seyed Fazel Nabavi, Mohammad Ali Ebrahimzadeh, Seyed Mohammad Nabavi, Mitra Mahmoudi, Shabnam Keyvani Rad, Biological Activities of Juglans Regia Flowers, Brazilian Journal of Pharmacognosy 2011; 21(3):465-470.
- Raheleh Jahanbani, S.Mahmood Ghaffari, Maryam Salami, Kourosh Vahdati ,Houri Sepehri, Nazanin Namazi Sarvestani, Nader Sheibani ,Ali Akbar Moosavi-Movahedi, Antioxidant and Anticancer Activities of Walnut (Juglans Regia L.) Protein Hydrolysates Using Different Proteases, Plant Foods Hum Nutr 2016; 71:402-409.
- Rosaria Acquaviva, Floriana D'Angeli, Giuseppe Antonio Malfa, Simone Ronsisvalle, Adriana Garozzo, Aldo Stivala, Salvatore Ragusa, Daria Nicolosi, Mario Salmeri & Carlo Genovese, Antibacterial And Anti-Biofilm Activities Of Walnut Pellicle Extract (Juglans Regia L.) Against Coagulase-Negative Staphylococci, Natural Product Research, 2019; 1-5.
- Karim Raafat, Phytochemical Analysis of Juglans Regia Oil and Kernel Exploring their Antinociceptive and Anti-Inflammatory Potentials Utilizing Combined Bio-Guided GC-FID, GC-MS And HPLC Analyses, Brazilian Journal of Pharmacognosy 2018; 358-368.
- Ksenija Kojicic, Vanja Tadic, Miroslav Sovrlic, Snezana Cupara, Antioxidant Activity of Juglans Regia L., Juglandaceae Pericarp Originated From Sumadija Region, Pons Med J 2019; 16(1):3-8.
- G.P. Savage and D.L. Mcneil, P.C. Dutta, Some Nutritional Advantages of Walnuts, Proc. IV Int. Walnut Symp. Ed. E. Germain, D. Calvi Acta Hort. 557-563.
- Raja G., Ivvala Anand Shaker, Inampudi Sailaja, Swaminathan R., Kondaveeti Suresh Babu, S. Saleem Basha, Nutritional Analysis of Nuts Extract of Juglans Regia L, International Journal Of Bioassays, 2012; 68-73.
- Gajendra Mahor, Sharique A Ali, Recent Update on the Medicinal Properties and Use of Aloe Vera in the Treatment of Various Ailments, Biosci. Biotech. Res. Comm. 2016; 9(2):273-288.
- Kanchan Bhatia, Shakilur Rahman, Mehboob Ali & Sheikh Raisuddin, In Vitro Antioxidant Activity of Juglans Regia L. Bark Extract and Its Protective Effect On Cyclophosphamide-Induced Urotoxicity In Mice, Redox Report 2006; 11:274-279.
- Parivash Rahimi, Najmeh Kabiri, Sedigheh Asgary And Mahbubeh Setorki, Anti-Diabetic Effects Of Walnut Oil on Alloxan-Induced

- Diabetic Rats, African Journal of Pharmacy and Pharmacology 2011; 5(24):2655-2661.
35. Delia Elva Cruz-Vega, Maria Julia Verde-Star, Noe Salinas-Gonzalez , Bibiana Rosales Hernandez, Iris Estrada-Garcí, Patricia Mendez-Aragon, Pilar Carranza-Rosales, Maria Teresa Gonzalez-Garza And Jorge Castro-Garza, Antimycobacterial Activity of Juglans Regia, Juglans Mollis, Carya Illinoensis and Bocconia Frutescens, Phytotherapy Research 2008; 22:557–559.
36. Emira Noumi, Mejdi Snoussi, Najla Trabelsi, Hafedh Hajlaoui, Riadh Ksouri, Eulogio Valentin, Amina Bakhrouf, Antibacterial, Anticandidal and Antioxidant Activities of *Salvadora Persica* and *Juglans Regia L.* Extracts, Journal of Medicinal Plants Research, 2011; 5(17):4138-4146.
37. Mohammed Nadeem Kasim Hantoosh, Hussein Ali Salim, Emad Adnan Mahdi, Hassan Ali Majid, Mohammed Abdalrahem Jalal, Antifungal Activity of Alcoholic Extract of *Juglans Regia* Against Phytopathogenic *Rhizoctonia Solani*, Chemistry Research Journal, 2018; 3(4):105-109.
- A. Amirou, M. Bnouham , A. Legssyer, A. Ziyat , M. Aziz , M. Berrabah, H. Mekhfi, Effects of *Juglans Regia* Root Bark Extract On Platelet Aggregation, Bleeding Time and Plasmatic Coagulation: In Vitro And Ex Vivo Experiments, Hindawi Evidence-Based Complementary and Alternative Medicine, 2018; 1-7.
38. Fang Fang ,Yingxin Qin , Ling Qi ,Qing Fang, Liangzhong Zhao, Shuang Chen, Qiang Li, Duo Zhang, Ligu Wang, Juglone Exerts Antitumor Effect In Ovarian Cancer Cells , Iranian Journal of Basic Medical Sciences, 2015; 18:544-548.
39. Kumaraswamy Dabburu, Suresh Babu Kondaveeti, Sarath Babu.K, Evaluation of Gastro-Protective Effect Of The Hydro-Alcoholic Extract of *Juglans Regia L.* Leaves in Experimental Animals, Journal of Applied Pharmaceutical Science, 2012; 2(11):079-083.
40. Akram Eidi, Jalal Zarringhalam Moghadam, Pejman Mortazavi, Shamsali Rezaeadeh & Somayeh Olamafar, Hepatoprotective Effects Of *Juglans Regia* Extract against CCl_4 -Induced Oxidative Damage in Rats, Pharm Biol, 2013; 51(5):558–565.
41. Mehdi Mahmoodi, Hadis Eghbali, Seyed-Mostafa Hosseini-Zijoud, Ahmad Pourrashidi, Alireza Mohamadi, Majid Borhani, Gholamhossein Hassanshahi , Mohsen Rezaeian, Study of the Effects of Walnut Leaf on Some Blood Biochemical Parameters in Hypercholesterolemic Rats, Biochem & Anal Biochem, 2011; 1:1-4.
42. Agata Przekora, Anna Belcarz, Katarzyna Kowalczyk, Michal Wojcik , Katarzyna Wojciechowska and Graoyna Ginalska, Uv Protective, Anti-Aging and Anti-Inflammatory Properties of Aqueous Extract of Walnut, Acta Poloniae Pharmaceutical Drug Research, 2018;75(5) :1167-1176.
43. Das R., Mehta D. K. and Gupta A., In Vitro Anthelmintic Activity of Leaves of *Juglans Regia L.* against *Pheretima Posthuma*, Sci. Revs. Chem. Commun.: 2011; 1(1):78-82.

