Nirma Univ J Pharm Sci; 2020, 7(1) 37-48

ISSN 2348 –4012

REVIEW ARTICLE

POTENTIAL IMPORTANCE OF *JUGLANS REGIA* LINN: NUTRITIONAL PROFILE AND HEALTH BENEFITS

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ABSTRACT

Food containing good amount of nutritional value is the most important parameter for maintaining human health and complete physical well-being. Number of plants are available with good source of vitamins and minerals and having other nutritional composition. Juglans regia Linn. (Family-Juglandaceae), commonly known as walnut has substantial benefits as dietary supplement. It possesses remarkable edible and nutritive values, with ease of processing and food manufacturing. It is widely spread and cultivated in various parts of world because of its valuable kernels. Dietician and other health workers of developing countries should give due attention in promoting the research work and projects for studying the medicinal importance, processing of walnut fruit and shell, manufacturing, improvement in nutritive values and potential health benefits of the walnut fruit to promote their utilization as food in respective countries. Many researchers have proved the therapeutic potential of the Juglans regia. It is one of the most important non-timber forest products. The nutritional importance of walnut is related to its seed or kernel. The aim of the present review is to provide the benefits of the walnut with respect to its nutritional profile and therapeutic as well as pharmacological importance as an antioxidant, hypolipidemic, antidiabetic, antimicrobial, antihypertensive and hepatoprotective activity.

Key Words: *Juglans regia*, walnut, nutritional profile, Juglone, antioxidant

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1. Introduction:

The discovery of plants having medicinal effects has been discovered since decades. They have been used in the traditional systems of medicines since ancient times. There are hundreds of chemical and biochemical compounds in plants having functions including defense against various insects, diseases, etc. Number of phytochemical have been discovered in plants. However a single plant also contains numerous phytochemicals which makes the whole plant having one or the other potential medicinal or nutritional effects. Many pharmacologically active substances have been discovered through ethno-botanical studies. The nutritional rich food is the most important parameter for maintaining human health and complete physical well-being. For development and maximization of human genetic potential, nutritional food is necessary [1]. Malnutrition problem can be solved by taking dietary food and supplements for maintaining overall human health and fitness. Expansion of food production must be supported at both national and household level with increasing yields and household techniques [2].

In modern years, plant-based materials, and especially nuts, became short of interest. Walnut is widely used since ancient times due to its nutritional values. Its scientific or biological name is *Juglan regia* Linn. It belongs to family Juglandaceae. Of the total walnut produced in the world, about 90% is utilized in the developing countries and about two-thirds of plant produced are consumed as food. It is grown in temperate region and extensively used by Persia (now Iran) for trading with other countries so known as Persian nut [3]. When taken to Rome, it was named Jovis Glans. Later it was named in Latin as *Juglans regia* - meaning the Royal nut. It is now grown in Central Asia, the Himalayan chain, Kyrgyzstan, and also cultivated in some parts of Europe and USA. Some common names of walnut are Mocker nut hickory, Jupiter's nut, kurup, ramakrot. Similarly walnut has some Ayurvedic names like Akshoda, Akshodaka, Akshota, Shailbhava, Pilu, Vrantphala, etc. [4,5] Walnut is known by different names throughout the world. Akhrot in Hindi, Doon in Kashmiri, Gardgani in Unani, Charmarghz (four brains) in Afghanistan and Karyon by Greek. There are 15 different varieties of walnut. Some known ones are English/Persian Walnut (*Juglans regia*), Black Walnut (*Juglans nigra*) and White Walnut/Butternut (*Juglans cinera*) [6,7]

Figure: 1- Shell of *Juglans regia* Linn

Figure 2(a) - Walnut seed Kernel

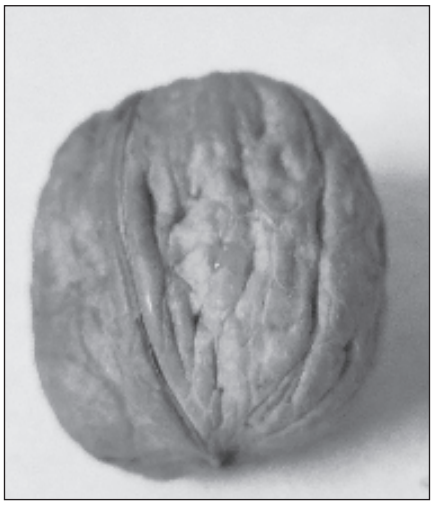

Figure 2(b) - Ripe fruit of *Juglans regia* Linn

2. Phytochemical composition of Walnut:

Walnut contains large amount of mono-unsaturated fatty acids. It is an ideal supply of Omega-3 fatty acids and arachidonic acid. It contains higher amount of omega-3 and omega-6 PUFA, considered as an essential dietary fatty acids. It has been proven through clinical studies that omega-3 PUFA have a major protective role in coronary heart disease [9]. The shape of walnut is similar to human brain, so it is used as brain nutrient. Walnut having many

phytochemical constituents, some of them have antioxidant activity examples such as melatonin, ellagic acid, vitamin E, carotenoids and polyphenols etc. having capacity fitness outcomes towards: getting old, cancers, inflammations and neurologic ailments [1]. Walnut is rich in alpha-linolenic acid. One ounce of walnut can provide 2.5 grams of ALA. There are 3 types of omega-3 fatty acids: alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), as shown in figure 3. EPA and DHA are obtained from fishes like salmon, trout and mackerel [2]. From *J. mandshurica* Maxim (green husk) around 27 naphthoquinones and their derivatives, including 4 new naphthalenyl glucosides and 23 other known compounds, have been isolated [10]. Walnut husk contains two hydrolysable tannins: Ellagic acid and tannic acid. Tetralones is another type of phytochemical group found to be present in the plants belonging to the family Juglandaceae. [11]. 3,4-dihydroxy-benzoic acid and 2,3-dihydroxy-benzoic acid were also isolated from the husk extract of *J. mandshurica* Maxim. [12]. Other chemical constituents and their structures are shown in the figure 4.

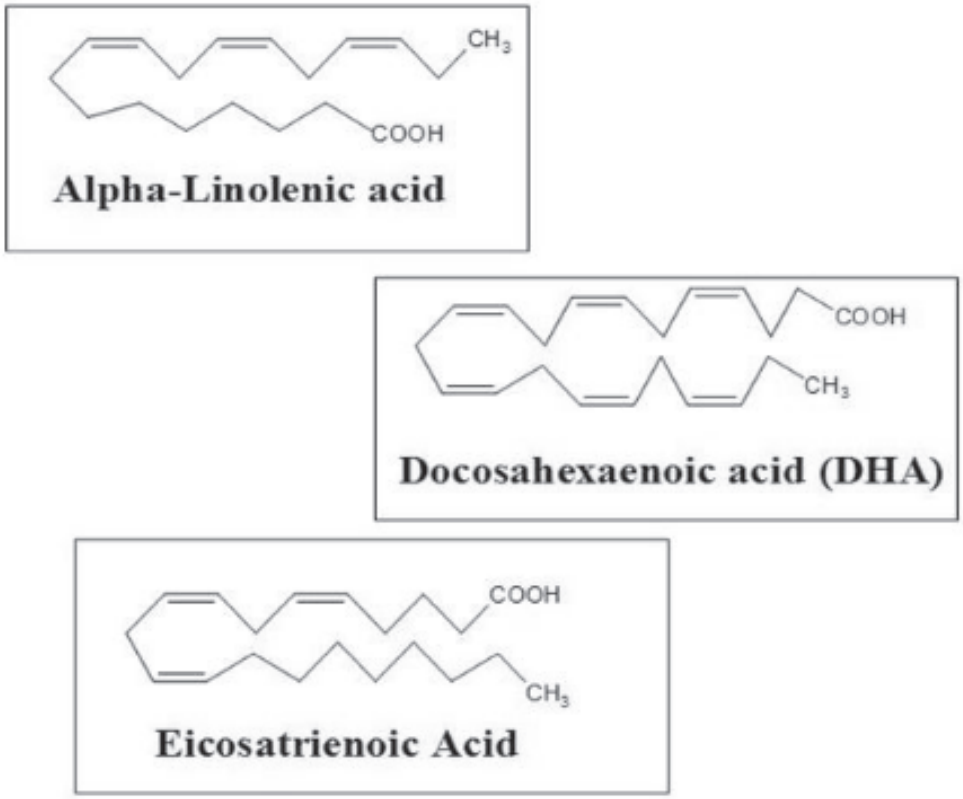

Figure 3: Chemical structures of omega 3-fatty acids present in Walnut

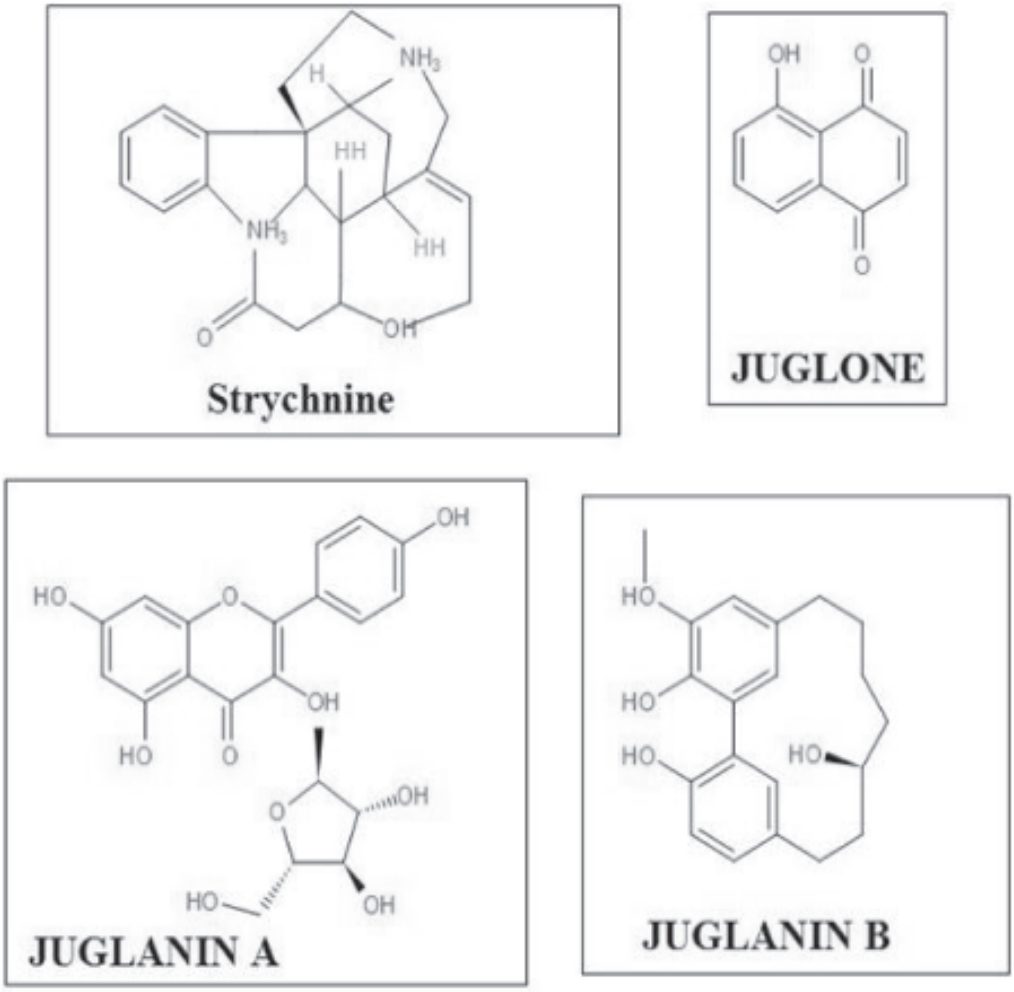

Figure 4 : Chemical structures of Phytoconstituents present in Walnut

2.1 Nutritional composition of Walnut

2.1.1 Source of Vitamins:

Walnut is an excellent source of tocotrienols. It contains two forms of tocotrienols: alpha and gamma. About 21 mg gamma tocotrienols is present in 100 gram of Walnut, and this quantity meets 140% of daily need. Vitamin E is a fat-soluble antioxidant, required to shield the mucus pores and skin cell membranes to reduce the dangerous effects of unfastened free-radicals and to hold its solidarity [13]. Walnut consists of critical nutrition systems together with: Vit B2, nicotinic acid, Vit B1, pantothenic acid, vitamin B6, and folate/B9. It has a preventive role against irritation, also reduces the risk of high blood strain and prevents from mind stroke, chest illnesses, cancer etc. [14]

2.1.2 Source of proteins, fats and carbohydrates:

Walnut contains significant quantities of mono and poly-unsaturated fatty acids. Three-forth portion of the energy in walnut is due to fat[4].The nutritional composition of walnut is shown below in table 1. [15]

Table-1: Nutritional composition of Walnut.

Principle	Value per 100g
Vitamins (USDA)	
Niacin	1.125 mg
Pantothenic acid	0.570 mg
Pyridoxine	0.537 mg
Riboflavin	0.150 mg
Thiamin	0.541 mg
Vitamin A	20 IU
Vitamin C	1.3 mg
Vitamin E-y	20.83 mg
Vitamin K	207 mcg
Folates	98 mcg
Minerals	
Potassium	441 mg
Phosphorous	346 mg
Magnesium	158 mg
Calcium	98 mg
Manganese	3.8 mg
Zinc	3.09 mg
Iron	2.9 mg
Sodium	2 mg
Copper	1.5 mg
Aluminum	0.58 mg

Fatty Acids	
Unsaturated fatty acids	
Linoleic acid C18:2	57.10
Oleic acid C18:1	25.26
Total MUFA	22.37
Linelic acid C18:3	10.34
Total PUFA	4.29
Palmitoleic acid C16:1	0.77
Gadoleic acid C20:1	0.05
Saturated fatty acids	
PUFA/SFA	9.91
Total SFA	7.21
Palmitic acid C16:0	4.28
Stearic acid C18:0	1.85
Myristic acid C14:0	0.24
Arachidic acid C20:0	0.19

3. Medicinal importance of *Juglans regia* Linn.

3.1 Ethnomedicinal uses:

It has been observed from some of the articles that the plant can be used in many different ways, either alone or in combination with other medicinal plants, or with olive oil or honey. [6]. In Iran, the kernel of *J. regia* has been used for the curing inflammatory bowel disease. In Palestine, it is used for remedy of diabetes and asthma and to deal with prostate and vascular disturbance. [16]

The plant is used as a topical remedy for dermal infection and excessive perspiration of the palms and feet. The topical use of plant leaves cures dandruff and scalp itching, superficial burns and sunburn. It is used as emollient for pores and skin disorders. It also has excessive anti-atherogenic capacity and osteoblastic activity that shows its potential use in cardioprotection and bone loss. The branches, barks and exocarp of the immature fruit is used to treat gastric, liver and lung cancer in China. In northeastern Mexico, it is used a traditional healer for protection against liver harm. [6]

The bark is used as miswaks for enamel cleansing. The bark paste is applied at different places and beneficial in pores, arthritis and skin diseases, toothache, and hair boom in Nepal [17]. Seed coat is used for healing wounds. *Juglans regia* shell is used as Calabria folk remedy to heal malaria in Italy [6].

3.2 Anti-oxidant potential:

The walnut contains antioxidant substances having 15 instances extra results compared to natural vitamin E. Anti-oxidants defend the cells towards the deterioration resulting from harmful substance called as free-radicals. [18] It has the property to reduce oxidative stress due to lose radicals, LDL cholesterol, and inflammations that harm fitness [19].

3.3 Anti-microbial and anti-fungal activity:

Juglone is used widely in pharmaceutical for anti-microbial activity. Walnut leaf extract along with its anti-oxidant property, inhibits the growth of bacteria – *Bacillus cereus* [20]. It is also useful against bacteria that are the cause of human gastrointestinal infections [21] .Walnut husks inhibit the growth of various pathogenic bacteria. [4]

3.4 Anti-diabetic activity:

Polyphenolic components such as Tellimagradin II, Casuarictin and Tellimagradin I present in walnut have been shown to have a robust inhibitory effect on distinct enzymes like glycosidase, maltase sucrose, glycosidase, and amylase. Researchers additionally noticed that walnut, due to its polyphenol content, has triglyceride decreasing impact and peroxide urine reducing effect in genetically inherited Type II diabetes mellitus. Significant inhibition was observed in α-glucosidase effect *in vitro* for both maltase and sucrase enzymes using the plant extract and showed no adjustments in the insulin and glut-4 gene expression [22].

3.5 Anthelmintic activity:

The methanol, ethanol and benzene extracts of stem bark of *Juglans regia* on adult Indian earthworm, Pheretimaposthuma shows full-size anthelmintic effect corresponding to popular drug Piperazine citrate. The ethanolic, ethyl acetate and petroleum ether extract of walnut hull have anti-feedant effect on small vegetable moth and army worms [17].

3.6 Anti-inflammatory activity:

Central and peripheral antinociceptive effects has been observed using aqueous and ethanolic extracts of *Juglans regia.* It was again notified that this effect is due to inhibition of cyclo-oxygenase enzyme and through non-opioid receptors. These extracts also showed activity against acute and especially chronic inflammatory condition. Various flavonoids like quercetin, hesperidin and luteolin shows antinociceptive and/or anti-inflammatory activities. So, it can be concluded that

water and ethanolic extract of *Juglans regia* leaves show antinociceptive activity, and suggest a promising anti-inflammatory and analgesic agents against diseases together with rheumatoid arthritis. [23]

3.7 Dermatological activity:

For treating pores and skin pigmentation, the components like ellagic acid in plant leaves extract of *Juglans regia* were found to be powerful. The ethanolic extract of walnut leaves have potential to become new asset of pores and skin-whitening marketers. [14]

3.8 Hepatoprotective activity:

The oral administration (200 g/kg) of walnut containing polyphenols from the kernel pellicle showed reducing effect in glutamyl pyruvic transaminase (GOT) and glutamyl oxaloacetic transaminase (GPT) in carbon tetrachloride (CCl4) precipitated harms to liver in mice model. Results indicated that walnut polyphenols are superior to Curcumin polyphenols which are normally used as hepatoprotective. Polyphenolic components, rugosin C, tellimagrandins I and II and casuarictin have been discovered as main components with hepatoprotective activity against oxidative damage. [24]

3.9 Hypo tri-glyceridemic activity:

Hypotriglyceridemic activity is observed due to polyphenolic - rich extract through enhancement of peroxisomal fatty acid β-oxidation in the liver. [9]

3.10 Effects of walnut leaf on hypercholesterolemic rats:

One of the major risk factors for cardiovascular diseases is hypercholesterolemia. A research on hypercholesterolemic rats was done. They were given 1%, 2% and 5% of walnut leaf powder in their diet daily and was carried out till 40 days. Blood samples from eyes were collected and various biochemical parameters like triglycerides, LDL-C, HDL-C, etc. were tested. The result showed that the cholesterol and the triglycerides level decreased while the HDL-C level increased. The best results were seen in the rats with 5% of powder in the diet. Thus, it can be concluded that walnut leaf can be used due to its anti-oxidant property in cardiovascular diseases (CVD). [25]

3.11 Walnut as an Anti-cancer agent:

Juglone inhibits intestinal carcinogenesis in rats and also acts as chemopreventive agent in human intestinal neoplasia. Juglone also has strong cytotoxic action *in vitro* in human tumor mobile traces, which includes HCT-15 (human colon carcinoma) cells, HL-60R (doxorubicin-resistant human leukemia) cells and (HL-60) human leukemia cells. In a latest observation, Juglone inhibited 180 SGC-7901 cell-line isolated from metastasis of untreated gastric adenocarcinoma and also the apoptosis of sarcoma *in vivo*. [26]

3.12 Effect of walnut on brain health:

English walnut *(J. regia*) is highly rich in antioxidants. Consumption of walnut in daily diet reduces the oxidative and inflammatory load on the brain cells. This leads to improvement in inter-neuronal signaling, increase in neurogenesis, etc. [19]

3.13 Uses of walnut in Cosmetics and other beauty products:

Walnut oil is high in vitamins and proteins and is beneficial for skin. They are rich in omega-3, fiber and other vital minerals. Since 17th century, walnut oil has been used to treat wrinkles and helps the skin look younger. The oil is a bit greasy but can be applied on the skin. Walnut oil is used to treat fungal infections by applying the oil topically to the affected area. [27]. Walnut shell powder is widely used as a scrubbing agent in cosmetic industry [26].

4. Conclusion

The present review highlights the active constituents of *Juglans regia* Linn. and its traditional uses in a wide array of diseases and for its nutritional value. Due to presence of various antioxidants, it may lead to decrease in LDL cholesterol. Walnut can be taken on a daily basis in order to improve the human health. It not only provides major nutrients like carbohydrate, protein, fat etc. but also provides ample of vitamins and minerals. In developing countries, due to circumstances of malnutrition and various health problems like cancer, diabetes, cardiovascular disease, obesity, celiac disease, various skin problems, etc. are most prominent because of mal-nutrition consumption and improper life style. This review explores the benefits of Walnut which can be used as a "Nutritional medicine". Walnut is an excellent source of antioxidants such as phenolic acids which can be characterized to be potential supplement and can enhance the viability of dietary and nutraceutical products along with potential health benefits.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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