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Systematic Review

Juglans Regia (Walnut Tree) Bark in Dentistry

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ABSTRACT

Juglans regia, commonly known as the Walnut tree, is a type of a deciduous tree. The tree has many important parts, the seed, bark, husk, leaves, oil, shell of the fruit and the kernel.The plant has been used in its crude form since ages. The kernel holds nutritional value. The leaves contain an essential oil which is extracted and used. The husk contains steroids and vitamins amongst other useful compounds. The leaves are used topically as antipyretic, analgesic, antidandruff and to heal burns. The bark is tough and has been used for mechanical tooth cleaning due to its tough fibrous texture. It contains Juglone as its main and most important constituent. Juglone works as an anti-viral,anti-parasitic, anti-fungal, anti-bacterial, anti-inflammatory, and anti-cancerous agent. In dentistry it poses as an effective anti-plaque, anti-fungal, anti-bacterial, anti-cariogenic and tooth whitening material. It was concluded thatin recent years, scientists and researchers have shown increasing interest towards the in depth understanding of the chemicals and compounds of the bark and its utilization in dental products towards improving dental treatment.

INTRODUCTION

Juglans regia, commonly known as the Walnut tree, is a type of a deciduous tree growing in temperate regions such as India, Iran, Kashmir and the Baluchistan province of Pakistan [1]. It belongs to the Juglandaceae family and the Juglans genus [2]. This article aims towards studying the dental uses of the bark of the plant. Articles were studied using PubMed and Google Scholar. The gatheredinformation was compiled. The tree has many important parts; the seed, bark, husk, leaves, oil, shell of the fruit and the kernel itself [3, 4]. All of these have individual benefits in many respects and have been used widely in folk herbal medicine[5, 6].The plant has been used in its crude form since ages. But in recent years, as scientists have shown growing interest in natural medicine, the benefits of J. regia have been in the spotlight. Scientists and researchers have worked towards the in depth understanding of the chemicals and compounds of the bark and their utilization in dental products.

Composition: Understanding the composition of J. regia is an important topic because every part of the plant contains valuable compounds which have various benefits. Walnuts are mainly cultivated in order to obtain the kernels, but other parts of fruit such as the husk and bark do not go to waste [4].

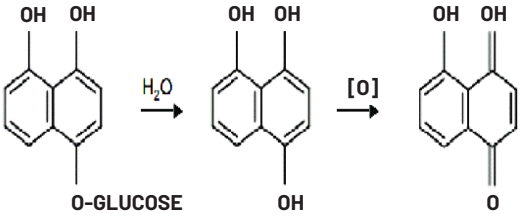

Figure 1: Chemical structure of Juglone-$C_{10}H_6O_3$ (5-hydroxy-1,4, -naphthoquinone).

It is formed from glucoside by hydrolysis followed by oxidation[4].

Kernel:

The kernel of J. regia holds the most nutrients. Nutritional analysis stated that it contains carbohydrates, starch,

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sugars, fibre, and mostly fat (saturated, mono-unsaturated and poly-unsaturated), protein, vitamins (folates, niacin, pantothenic acid, pyridoxine, riboflavin, thiamine, vitamins A, C, E and K)and minerals(potassium, phosphorus, calcium, magnesium, sodium, iron, copper, manganese, zinc and aluminium) [4].The main constituent of the fruit is fat [4].The starch content is very low at 2.8% [7]. The mineral content is also high as it contains high concentrations of Potassium, Calcium, Sodium, Magnesium, Iron, Copper, Zinc and Phosphorous [6].

Leaves:

The leaves of J.regia are beneficial as an essential oil can be extracted from them [8]. The oil from the leaves of J. regia growing in Kashmir was studied. A total of 38 compounds representing 92.7% of the oil, were identified. The major components were 15.5% α-piene , 30.5% β-piene, 15.5% β-caryophyllene, 14.4% germacrene D and 3.6% limonene [8].

Husk:

The Husk of J. regia contains several useful compounds. Hydrolysable tannins, Naphthoquinones, Naphthoquinone Glycosides, Naphthalene's, α-Tetra-lone, α-Tetra-lone Glycosides, and α-tetra-lone dimers, hydroxy benzoic acids, hydroxyl cinnamic acids, Flavonoids, Diarylheptanoid's, Ceramides, Alkanes, Steroids and Vitamins are amongst them. Other compounds such as octa decanoic acid, rhodopsin and cyclo-deca siloxane are also reported to be present in the extract of the husk[3].

Bark:

The bark of J. regia contains reducing sugars[4]. This means that the sugars in them contain an aldehyde group or a free hemiacetal group with an open chain. They oxidize themselves while reducing another compound [4]. Another constituent are alkaloids [4]. They contain one nitrogen atom and have a neutral pH. Tannins present in the J. regia bark give the material a reddish brown stain and help in precipitation of proteins [4]. Some volatile phenols and phenolic acids like gallic acid, and saponins which areresponsible for the soapy texture and bitter taste are also present [4]. It also contains ash and has a mild abrasive effect as is tough and fibrous [3]. One of the most important compounds in the J. regia bark is the organic compound called juglone[9]. Juglone is formed from glucose and has a distinct phenyl group (image 1)[9].It is due to this compound that the bark of this plant holds multiple medicinal benefits. It acts as an antifungal, antibacterial, antiviral, antiparasitic, antioxidant, and antitumour agent [1, 8-16].

General Uses of J. Regia Plant:

Every part of the plant has numerous uses. The fruit, rip or unripe, is used as food due to the rich flavour and multiple health benefits. It is famous for its high nutritional value as it helps in lowering blood pressure, cholesterol and inflammation [4]. It improves memory and helps is weight loss. It is also known to reduce risk of prostate cancer in males [4].The hard, abrasive nut shell is used as a commercial cleaner and filtering agent [17]. It is also incorporated in jet engine cleaners and helps in oil well drilling and water filtration [17]. It is also burnt as a biofuel [18].The seeds contain fatty acids which are used as protective coating, cosmetics, soaps and as stabilizers in plastic formulation[19].The pigment from the plant acts as a colouring agent and tonic for dark hair [5, 6]. It has also been used as a lip and cheek stain by females [20]. The extract from the leaves holds potent growth inhibitory effects against human prostate cancer cell by inducing apoptosis and is also effective in treating uneven skin pigmentation [21]. In Turkish folk medicine, they are used topically as antipyretic and analgesic in rheumatism and to treat itchy scalp, dandruff, sunburns, and superficial burns in Palestine [5, 6]. The bark of J. regia has been used in many ways since ancient times. It has a light odour, bitter taste and it leaves a reddish stain [5, 6]. It serves many benefits, not only generally, but to the oral cavity and dentition as well[22].

Uses In General:

The wood from *J. regia* is used for making household items like cabinets, shelves, and other handicrafts. It is also burnt for domestic heating[20]. Cleaning of jewellery can also be carried out with it [20].

Uses In Human Body:

J. regia is used as a topical home remedy for dermal inflammation and excessive perspiration of the palms and soles [23]. It is also a common home remedy of the treatment of eczema and scrofula [21]. The extract is consumed to heal inflammatory bowel disease in Iranian traditional medicine[23]. Ethanolic extract found in it gives it excellent antioxidant properties [9]. Some parasitic infections have also been cured with the help of J. regia bark extracts [9]. A study done on cancer cells resulted in decreased proliferation of tumours due to the compounds found in the bark of *J. regia* [9]

Uses In Dentistry:

J. regia bark has many mechanical and chemical uses. In some countries, it is used as an alternate to toothbrushes due to the light abrasive properties of the fibrous bark (Image 1)[24]. It is effective in improving oral hygiene as it has showed maximum antiplaque activity [25]. It acts against the oral pathogenic bacteria very effectively due to its antimicrobial properties. This prevents caries and periodontal diseases [26]. Aqueous extract of *miswak (S. persica)* and *dandasa (J. regia)* were compared in one study [27]. The *J. regia* bark extract showed greater performance in enhancing the growth of fibroblast and inhibiting the growth of cariogenic bacteria [27]. It has anti-biofilm activity against *streptococcus sangius* [28]. The ethanolic extract of the bark inhibits the growth of Staphylococcus, *E.*

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coli, Enterobacter, and Pseudomonas at high concentrations[27]. Another study concluded that acetone extracts of *J. regia* are much more effective compared to aqueous extracts on salivary microbial flora samples from patients with dental caries [22].

Figure 2: A toothbrush made out of *J. Regia* bark twigs, locally known as '*dandasa*' in Pakistan [29].

Anti-fungal properties of *J. regia* against oral candida species make it useful for the treatment of oral fungal infections[30]. *J. regia* has anti-viral properties so it is used against herpes simplex virus with success [31]. It has also proved to be a salivary stimulant [1]. Due to this action it relieves xerostomia, and stabilizes the oral pH [1].The extract has also been successful in improving the corrosion resistance of Ni-Cr alloy dental appliances[1]. Effective and natural teeth whitening is another important benefit of the twigs and their extract [13, 32]. Though it actually does whiten teeth by removing stains, the effect is amplified as the red staining of the gingiva after its use [33].

Extraction and Synthesis: The bark of *J. regia* has long been used in its natural, raw, unprocessed form effectively. But modern studies have aimed at extracting specific products which are then added with other constituents into products [34]. The bark is cut into pieces and dried under the sun for a few days. After it is completely dry, it is ground into fine particles[35]. This material is then macerated with several solvents like benzene, ethyl alcohol, petroleum ether and most commonly, chloroform [34, 36]. It is then distilled or evaporated for the desired products respectively [35]. The factor that is most important in controlling yield is temperature. Yield is higher when temperatures are low[34, 36].The extracted compounds are then incorporated into the dental products that they are needed in[36]. Juglone is known to degrade under alkaline conditions and in saline water [36]. Therefore care needs to be taken when selecting solvents for this compound[36].Juglone can be synthesised by oxidation of 1,5-dihydroxynaphthalene [36].

Incorporation into Dental Products: The powder of the dried bark can easily be added into clinically used tooth polishing pastes and tooth brushing pastes which are used at home[27]. This is to utilize the teeth whitening, antiplaque and stain removal properties[27]. The powdered bark itself or other useful chemicals from the bark like tannins, reducing sugars and specifically juglone, can be incorporated into mouth rinses, topical oral ointments and even pit and fissure sealants due to their anti-bacterial, anti-fungal, anti-viral, anti-inflammatory and anti-cariogenic properties[14-16, 37]. The products can also be mixed with intra-canal medicaments and used in between RCT visits. Mixing with cavity liners and pulp capping agents can also prove to diversify the utilization of these products [14-16, 37]. The anti-cancer action of the chemicals present in the *J. Regia* bark can be utilized by incorporating it into mouth rinses, ointments or sprays prescribed to patients suffering from chronic ulcers or oral cancers [9]. The extract is incorporated into artificial saliva because of its numerous benefits [9]. Mouth freshener sprays can be improved by incorporation of the bark extract of *J. Regia* and have added benefits [38-41].

CONCLUSIONS

Juglans Regia has countless benefits, and it can work wonders in the field of medicine. It is used since ancient times topically and orally for numerous health benefits due to its anti-fungal, anti-bacterial, anti-viral, anti-parasitic, anti-helminthic, anti-inflammatory, anti-oxidant, anti-plaque, and anti-tumour action. With improving research in the field of conventional, herbal medicine, and with the growing demand of going back to natural healing methods, countless benefits of J. Regia bark for the oral cavity have been discovered. The data available is still limited and there is dire need and heavy potential for further research in this field.

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