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RHUS CORIARIA LINN, A PLANT OF MEDICINAL, NUTRITIONAL AND INDUSTRIAL IMPORTANCE: A REVIEW

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ABSTRACT

Rhus coriaria Linn. (Anacardiacea), commonly known as sumac, has been used as a spice, condiment, appetizer, and as a souring agent for centuries. A broad range of nutritionally and medicinally significant phytochemical components have been identified from various parts of sumac such as tannins, flavonoids, anthocyanins, organic acids, flavones, proteins, fiber, volatile oils, nitrates, and nitrites. The plant also possesses minerals which are beneficial in the treatment of different disorders and contribute to various biological processes. In traditional system of medicine, this plant has been used in the treatment of diarrhea, dysentery, ulcer, hemorrhoids, hemorrhage, wound healing, hematemesis, hemoptysis, leucorrhea, sore throat, ophthalmia, conjunctivitis, diuresis, animal bites, poison, pain, and liver disease. Traditional practitioners have also prescribed this plant as antimicrobial, abortifacient, and stomach tonic. *Rhus coriaria* is known to possess DNA protective, non-mutagenic, chondroprotective, antifungal, antibacterial, antioxidant, anti-ischemic, vasorelaxant, hypoglycemic, xanthine oxidase inhibition, vascular smooth muscle cell migration inhibition, and hepatoprotective properties, supporting its traditional uses. The role of plant in leather and textile industry as tanning agent and as a coloring agent is significant. It also prevents wood decay and has considerable potential for future research.

Key Words: *Rhus coriaria*; phytochemistry; antioxidant; antibacterial; sumac.

INTRODUCTION

Since prehistoric times, plants have been used as drugs (Palevitch, 1978). When man became familiar with the nutritious value of edible plants, he also noticed that other plants and sometimes edible plants themselves have medicinal properties (Yaniv, 1982). *Rhus coriaria* Linn. (Anacardiacea) is commonly known as sumac, the name is originated from “sumaga”, meaning red in Syriac (Wetherilt and Pala, 1994; Kossah *et al*., 2009). The plant has both nutritional qualities and medicinal values as it is used as a spice by crushing and mixing the dried fruits with salt, and is commonly used as a medicinal herb in the Persia (Saeed, 1972), Mediterranean and Middle East (Sezik *et al*., 1991), Turkey (Sezik *et al*., 2001; Tuzlacı and Aymaz, 2001), Palestinian population, Golan Heights, Israel (Said *et al*., 2002), Jordan (Lev and Amar, 2002), Medieval and Ottomon al-Sham region (Lev, 2002), Cyprus during island’s Ottomon period (Lardos, 2006), and in the Jewish community of Medieval Cairo (Lev, 2007).

Rhus coriaria is a 1-3 m high shrub or small tree. The leaves are imparipinnate with 9-15 leaflets. The inflorescence is a compact and erect panicle, the flowers are small and greenish white, and the fruit is a villose, reddish, 1-seeded drupe (Davis, 1967). This plant is reported to posses hydrolysable tannins (Mavlyanov *et al*., 1997) gallotannins, volatile oil, flavonoids, anthocyanin (Güvenç and Koyuncu, 1994), gallic acid (El Sissi *et al*., 1972), flavones, such as, myricetin, quercetin and kaempferol (Mehrdad *et al*., 2009), nitrate and nitrite contents (Özcan and Akbulut, 2007), moisture, oil, protein, fiber, and ash (Özcan and Haciseferogullari, 2004). Malic, palmitic, stearic, oleic, and linoleic acids are found as the major components of sumac oil (Kizil and Turk, 2010). Minerals present in plant are K, P, Si, Br, Al, Cu, S, Cl, Pb, Ti, Ca, Mn, Fe, Zn, Sr, Mg, Ba, Cr, Li, N, and V (Barakat *et al*., 2003; Özcans, 2004).

Sumac is documented to possess antibacterial (Adwen *et al*., 2010; Gündüz *et al*., 2010), hepatoprotective (Pourahmad *et al*., 2010), antifungal (Hashem and Alamri, 2010), antioxidant, anti-inflammatory/chondroprotective (Panico *et al*., 2009), DNA protective (Chakraborty *et al*., 2009), anti-ischemic, vasorelaxant (Baretta *et al*., 2009), vascular smooth muscle cell migration inhibition (Zargham and Zargham, 2008), hypoglycemic (Giancarlo *et al*., 2006; Mohammadi *et al*., 2010), xanthine oxidase inhibition (Candan, 2003), and non-mutagenic properties (Barakat *et al*., 2003).

From an industrial point of view, sumac contains coloring matter and tannins which are used in dying and tanning fine leather. Leaves are also exported for this purpose (Saeed, 1972; Baytop, 1984). Protein based textile materials such as silk, goat wool, Angora rabbit wool, and sheep wool could be dyed evenly with washing fastnesses and high light by using sumac as a natural dye (Kumbasar *et al*., 2009). It has a high fixation, retention and fungal resistance properties, and is significantly effective against wood decay (Sen *et al*., 2009).

In this review, a comprehensive account of its medicinal importance from both traditional and pharmacological point of view is presented along with phytochemical components which are nutritionally as well as medicinally significant. This review also encircles the role of plant in industry in view of many recent findings and its potential for future research.

Phytochemistry: In view of the importance of sumac in traditional system of medicine, in industry and as a spice, systematic physical and chemical examinations have been carried out by several groups of researchers. The flavonols quercetin, myricetin, and kaempferol were identified from ethyl acetate and methanol extracts of *Rhus coriaria* leaves by paper chromatography together with gallic acid, methyl gallate, *m*-digallic acid, and ellagic acid as a part of tannins present in sumac. Phenolic components were confirmed by ultraviolet spectrophotometric measurements (El Sissi *et al*., 1966). Further detailed investigations were provided by assigning structure of an octa- or nona-galloylated glucose to isolated gallotanins from sumac leaves through paper chromatography, UV, and IR measurements (El Sissi *et al*., 1971). Presence of flavonoid glycosides was proved through adsorption column chromatography while methyl gallate was identified in aqueous acetone extract of sumac leaves (El Sissi *et al*., 1972). Dimeric flavonoids amenthoflavone, agathisflavone, hinokiflavone, and sumaflavone have also been separated from sumac leaves by liquid chromatography (Van loo *et al*., 1988). The steam volatile constituents of the dry fruits were investigated by GC and GC–MS. Main constituents determined were, aliphatic aldehydes, farnesyl acetone, hexahydrofarnesylacetone as well as oxygenated terpenes such as β-caryophyllene alcohol, α-terpineol, and carvacrol. Terpene hydrocarbons such as cembrene, α-pinene, and β-caryophyllene were also found as major constituents (Brunke *et al*., 1993). The aqueous extract constituents were examined using normal phase high-performance liquid chromatography (HPLC) and extract was found to possess penta-, hexa-, hepta-, octa-, nona-, deca-, undeca- and dodecagallolyl glucose derivatives. Water at 45˚C during 60 min without agitation has been established as the best tannin extraction procedure for sumac leaves (Zalacain *et al*., 2003). The use of monolithic column with reversed phase HPLC has been validated for the separation and quantification of flavonol aglycones in *Rhus coriaria*, it reduced the separation time to less than one minute without sacrificing column selectivity and efficiency (Mehrdad *et al*., 2009).

There are more than 20 chemical elements (often called minerals) necessary for humans. Minerals that have a function in the body must be supplied in the diet. When the intake is insufficient, deficiency symptoms may arise (Bender and Mayes, 2003). Pallets of *Rhus coriaria* from Jordan were analyzed through X-ray fluorescence which showed the presence of Ti, Cu, Fe, Al, Cl, P, K, Mn, Ca, Zn, Si, Br, S, and Sr in different quantities (Barakat *et al*., 2003). Fruits of sumac from Turkey were dried, ground, and incinerated in oven after adding pure HNO_3. Inductively coupled plasma atomic emission spectrometry revealed the presence of many minerals along with Mg, Ba, Cr, Li, N, Pb, and V (Özcan, 2004). Potassium, Calcium, Magnesium, and Phosphorous were found to be predominant elements in Sumac fruits (Barakat *et al*., 2003; Özcan and Haciseferogullari, 2004; Özcan and Akbulut, 2007; Kizil and Turk, 2010).

The oil was extracted from sumac using cold ether extraction. Gas chromatography showed that major fatty acids present in sumac were palmitic ($C_{16:0}$), oleic ($C_{18:1}$), and linoleic ($C_{18:2}$) acids. Polyunsaturated fatty acid (18:2 +18:3) contents of the total fatty acids were ranged from 34.84 to 37.36% (Dogan and Akgul, 2005). Fruits of the sumac were subjected to petroleum ether extraction and the extract was analyzed by Gas chromatography-Mass spectroscopy technique. *Rhus coriaria* was found to possess fatty acids such as malic acid, linoleic acid, azelaic acid, tetradecanoic acid, 7-hexadecenoic acid, ethyl octadecenoate, palmitic acid, oleic acid, elaidic acid, stearic acid, 11,13-eicosadienoic acid, 11-eicosenoic acid, arachidic acid, behenic acid, and tetracosanoic acid. It was confirmed that oleic, linoleic, and palmitic acids are the major fatty acids in sumac fruits. Fruits from the Mercin region, Turkey, also contain 2.3% proteins and 1.5% ash (Kizil and Turk, 2010). Nitrite and nitrate components were determined by diazotisation and phenoldisulphonic acid method of the American Public Health Association using hot distilled water extract of sumac fruits. Concentration of nitrate and nitrite were found as 162.28 mg/kg and 36.60 mg/kg, respectively (Özcan and Akbulut, 2007).

Some physical properties such as weight, length, volume, geometric mean diameter, sphericity, and thickness of sumac fruits were found as 0.018 g, 4.72 mm, 19.49 mm^3, 3.64 mm, 0.773, and 2.64 mm, respectively, at 4.79% moisture content level. At the same moisture content level, porosity, static friction, bulk density, terminal velocity, and projected area of sumac fruits were evaluated as 68.52%, 0.482-0.675, 304.25 kg/m^3, 3.52 m/s, and 0.164 cm^3, respectively (Özcan and Haciseferogullari, 2004).

Use in traditional medicine: Sumac has been used traditionally in the treatment of diarrhea (Saeed, 1972; Usmanghani *et al*., 1997; Sezik *et al*., 2001; Said *et al*., 2002; Lev and Amar, 2002, 2008; Lev, 2007), ulcer (Tuzlacı & Aymaz, 2001), hemorrhoids (Saeed, 1972; Lev, 2002), liver disease (Said *et al*., 2002), animal bites, pain (Lev, 2002), dysentery, diuresis, hemorrhage, hematemesis, hemoptysis, ophthalmia, conjunctivitis, leucorrhea, and stomach tonic (Saeed,1972; Usmanghani *et al*., 1997). Traditional medical practitioners have also used sumac for cholesterol reduction (Lev and Ammar, 2002), in the treatment of sore throat, and as an abortifacient (Lev, 2007; Lev and Amar, 2008). Other reports also indicate its use in wound healing and as an antimicrobial (Rayne and Mazza, 2007).

Different parts of the plant have been used in diverse preparations in traditional system of medicine. Powder of its bark is effective for cleaning the teeth. Bark infusion is useful in beginning of viral eye infections. Bark is bruised in water and applied on the forehead for the first-aid treatment of epistaxis (Usmanghani *et al*., 1997). Powdered fruits are sprinkled on boiled egg and eaten for the treatment of diarrhea (Sezik *et al*., 2001). A decoction of fruits is prepared and administered orally (150 cc) for the treatment of liver disease, diarrhea and urinary system disorders. Decoction is taken three times per day until improvement occurs (Said *et al*., 2002).

PHARMACOLOGICAL PROPERTIES

Antioxidant Property: Sumac prevented autoxidation of peanut oil. Antioxidant activity was determined by the measurement of peroxide value (Özcan, 2003). Many diseases such as carcinogenesis, mutagenesis, heart disease, stroke, aging, and emphysema is caused due to lipid peroxidation. Ethyl acetate fraction of methanol:water (80:20) extract showed significant antiradical activity on 2,2-diphenyl-1-picrylhydrazyl (DPPH). It also exhibited antioxidant activity on the Fe^{+2} induced linoleic acid peroxidation (Bozan *et al*., 2003). Anthocyanin and hydrolysable tannins derivatives are responsible for inhibition of lipid peroxidation and scavenging activity on DPPH radical as determined by HPLC-MS system (Kosar *et al*., 2007). It is commonly believed that free radicals damage nucleic acids, lipids, proteins, and carbohydrates. Methanol extracts of *Rhus coriaria* fruits inhibited the degradation of deoxyribose mediated by hydroxyl radical produced from the Fe^{+3}/ascorbate/EDTA/H_2O_2 system. The same extract exhibited superoxide radical scavenging activity produced from the xanthine/xanthine oxidase method thus, showed antioxidant activity *in vitro*. The production of lipid peroxidase by Fe^{+2}-ascorbate in rat liver homogenates also appears to be prevented by *Rhus coriaria* (Candan and Sökmen, 2004). Inflammatory cytokines, nitric oxide, and reactive oxygen species progressively damage the articular cartilaginous tissue which possibly leads to osteoarthritis. Lyophilized hydroalcoholic crude extract of sumac leaves reduced inflammation, chondrodegeneration, and oxidative stress. It reduced the production of reactive oxygen species (ROS), nitric oxide, and prostaglandins E_2 induced by interleukin-1β, and increased the synthesis of glycosaminoglycans. Polyphenolic active constituents of sumac can partially be responsible for these actions (Panico *et al*., 2009). Oxidative stress plays significant part in the initiation and development of various liver disorders. Aqueous extract of *Rhus coriaria* fruits prevented oxidative stress toxicity stimulated by cumene hydroperoxide in isolated rat hepatocytes. It markedly protected the hepatocytes against, glutathione depletion, lysosomal membrane oxidative damage, ROS generation, lipid peroxidation, cellular proteolysis, and mitochondrial membrane potential decrease. Gallic acid, one of the chief constituents of plant, also showed similar kind of protection (Pourahmad, 2010).

Antibacterial Property: Methanol extract of *Rhus coriaria* leaves demonstrated high inhibitory activity against different strains of both Gram negative and Gram positive bacteria. MICs and MBCs were calculated by a broth microdilution assay in microlitre plates using Mueller–Hinton medium and by plating 0.01 mL samples from clear 1 mL tubes onto agar plates, respectively**.** Sumac showed highest activity against *Escherichia coli* ATCC 30213 at 156 mg/L among all other Gram negative strains. It also inhibited *Bacillus subtilis* strain at 78 mg/L, and both clinical and standard isolates of *Staphylococcus aureus* strains at 312 and 156 mg/L (Iauk *et al*., 1998). Chloroform, ethyl acetate, and *n*-butanol extracts of *Rhus coriaria* fruits specifically inhibited *Branhamella catarrhalis*. Among them ethyl acetate extract was the most active with MIC = 125 µg/ml and showed widest zone of inhibiton, while aqueous part did not show any activity (Sökmen *et al*., 1999). Chloroform extract of fruits showed strong antibacterial effect with an inhibition zone of 35-51 mm in disk diffusion method against *Escherichia coli, Bacillus megaterium, Bacillus bravis, Bacillus cereus, Enterobacter aerogenes, Listeria monocytogenes, Micrococcus luteus,* and *Pseudomonas aeruginosa* (Dığrak *et al*., 2001). Methanol crude extract of fruits resolved in absolute alcohol in a ratio of 1:5 w/v extract/absolute alcohol inhibited fifteen lactobacillus species namely *Lactobacillus plantarum* C27*, L. plantarum* C32*, L. plantarum* C39*, L. plantarum* P33*, L. plantarum* P51*, L. plantarum* P53*, L. fermentum* C47*, L. fermentum* P37*, L. fermentum* P38*, L. fermentum* P46*, L. fermentum* P54*, L. coryniformis* subsp. *torquens* C33*, L. animalis* C26*, L. acidophilus* P49, and *Lactobacillus* sp. C4. The plant extract showed zone of inhibition ranging from 13 mm to 22 mm (Sağdiç *et al*., 2003). Fruits of sumac were dried and methanol extract was prepared. The observed diameter for inhibition zone was >15 mm against *klebsiella pneumonia, Bordetella bronchiseptica, Staphylococcus epidermidis* and *Bacillus pumilus* using agar well-diffusion method. Extract showed same activity 18 months later (Bonjar, 2004). Anti yeast effect was not demonstrated by ethanol extract of *Rhus coriaria* fruits but it was effective against *Proteus vulgaris* and

Mycobacterium smegmatis exhibiting inhibition zone of 25 mm and 38 mm, respectively, which includes 6 mm diameter of disc (Dulger and Gonuz, 2004). Gram positive bacteria are more sensitive to inhibitory effect of alcoholic extract of sumac than Gram negative bacteria. MIC and the cup method were applied. MIC for each test organism was examined by observing their development on nutrient agar containing the sumac extract at different incremental levels equivalent to 100-5000 mg/L. *Bacillus* species (*B. megaterium, B. cereus, B. thuringiensis,* and *B. subtilis*) survived up to only 500 mg/L of the sumac, followed by *Staphylococcus aureus* (1000 mg/L), and *Listeria monocytogenes* (1500 mg/L). Among the Gram negatives, *Citrobacter freundii, Proteus vulgaris, Hafnia alvei,* and *E. coli* O157:H7 servived upto 1000 mg/mL, 1500 mg/mL, 2000 mg/mL, and 2500 mg/mL, resepctively. *Escherichia coli* type I and *Salmonella enteritidis* presented more resistance, surviving up to 3000 mg/L. Extract of ripened sumac (brown red) was more effective than unripened (greenish) sumac (Nasar-Abbas *et al*., 2004). Ethanol and methanol extracts of sumac fruits inhibited clinical bacterial strains, such as, *Klebsiella pneumonia,* multi-drug resistant *Pseudomonas aeruginosa*, enterohemorrhagic *Escherichia coli* O157 (EHEC), *P. aeroginosa, Proteus vulgaris,* and Methicillin-resistant *Staphylococcus aureus* but no effects were detected for water extract against *P. aeruginosa, P. vulgaris,* and *Klebsiella pneumonia.* Well diffusion and micro-dilution techniques were applied. *B. subtilis* were used as reference strain and results were compared with tetracycline antibiotic. The MIC of ethanol extract was 0.156 mg/ml against *B. subtilis,* while 1.25 mg/ml against MRSA, EHEC, *P. aeruginosa,* and *Proteus vulgaris* (Abu-Shanab *et al*., 2005). 80% v/v aqueous alcohol was used to make hydroalcoholic extract of *Rhus coriaria* by percolation method. It was found active against *Salmonella typhi* and *shigella flexneri* showing MIC of 0.20% for each bacterium, and MBC of 0.80% and 0.40%, respectively (Fazeli *et al*., 2007). Synergistic interaction was found between 80% ethanol extract of sumac seeds and antimicrobial agents such as enrofloxacin, cephalexin, penicillin G, oxytetracycline HCl, and sulfadimethoxine as sodium. This combination can be useful in fighting emerging drug-resistance *P. aeruginosa* (Adwan *et al*., 2010). Water extract of sumac caused significant reduction of nalidixic acid resistant strain of *Salmonella typhimurium* inoculated to tomatoes and can be used as natural alternative to chlorine for the inhibition of bacteria. The plant extract can be helpful to increase microbial safety of tomatoes without loss in quality features (Gündüz *et al*., 2010).

Non-mutagenic Property: *Salmonella typhimurium* strains TA97a, TAg8, TAI00, and TAI02 were used for mutagenic studies. Plate incorporation test showed that sumac has no base pair substitution mutagenic activity (Barakat *et al*., 2003).

Hypoglycemic property: Methanol extract of *Rhus coriaria* fruits demonstrated 48.3% inhibition of α-amylase while ethyl acetate and *n*-hexane extracts demonstrated 91.9% and 44% inhibition, respectively, at a concentration of 100 µg/mL. Thus sumac may improve glucose tolerance in diabetic patients especially ethyl acetate extract with an IC_{50} value of 28.7 µg/mL (Giancarlo *et al*., 2006). Ethanol extract of *Rhus coriaria* fruits showed significant hypoglycemic property in alloxan induced diabetic rats. 24% blood glucose reduction (at 400 mg/kg dose) was found at 5 hrs after single dose administration. In long term test, 26% decrease in blood glucose level was measured at 21st day compared to diabetic control group. A significant reduction in blood glucose level was measured (at 200 and 400 mg/kg doses) in oral glucose tolerance test at the 60 minutes time after administration of carbohydrate solution. Intestinal maltase and sucrase activities (44.33% and 25.38% respectively) were also reduced significantly by ethanol extract (Mohammadi *et al*., 2010).

Anti-migratory property: Dry sumac was ground and tannins were extracted. Cultured rat carotid vascular smooth muscle cells were treated with tannins. Transmembrane migration assay was used to measure vascular smooth muscle cells migratory activity in response to platelet-derived growth factor-BB. Sumac significantly reduced vascular smooth cell migration by 62%, thus possesses potent anti-migratory activity, and may possibly have atheroprotective effect (Zargham and Zargham, 2008).

Anti-ischemic property: Sumac leaves extract demonstrated cardiovascular protective effect. This property was investigated by using isolated rabbit heart and thoracic aorta preparations. Different factors such as free radical and ROS scavenging, tissue necrosis factor (TNF)-α inhibition, cycloxygenase pathway activation, and endothelial nitric oxide synthase activation were found to be responsible for cardiovascular protective effect. Sumac leaves contain hydrolysable gallotanins which are mainly responsible for anti-ischemic property (Baretta *et al*., 2009).

DNA protective effect: Sumac strongly reduced DNA-migration after treatment of the cells with H_2O_2 by 30%. DNA-migration due to endogenous production of oxidized pyrimidines and purines was also significantly decreased by 36% and 52%, respectively. The most significant decrease in damage due to oxidation of purines and pyrimidines was found in liver and in lymphocytes. Supplementation of drinking water clearly decreased comet formation due to oxidized DNA bases. Cells sensitivity towards anti-benzo[a]pyrene-7,8-dihydro-diol-9,10-epoxide (BPDE) were also changed as

BPDE-induced comet formation was markedly reduced by 69%. Overall glutathione *S*-transferase (GST) activity in plasma and the two isoenzymes GST–π and GST-α were clearly enhanced by 40%, 26%, and 52%, respectively, suggesting that sumac protects against genotoxic carcinogens which are degraded by these enzymes (Chakraborty *et al*., 2009).

Antifungal property: Candidia albicans was susceptible at 625 mg/L MIC to methanol extract of *Rhus coriaria* leaves (Iauk *et al*. 1998). Dilution method was used to determine total fungal counts in spice samples. Three different nutritive media were chosen such as potato dextrose agar, coke rose, and czapek dox agar. Sumac showed very low affinity to be contaminated with moulds thus demonstrated antifungal effect (Hashem and Alamri, 2010).

Conclusion: Over the years scientists have confirmed many of the traditional uses of sumac that continue to be significant natural therapy for various diseases. From medicinal point of view sumac possesses antibacterial, hepatoprotective, antifungal, antioxidant, anti-inflammatory/chondroprotective, anti-ischemic, vasorelaxant, anti-migratory, hypoglycemic, xanthine oxidase inhibition, DNA protective, and non-mutagenic properties. From nutritional point of view, it is much admired condiment used as a major souring agent. It is used as an appetizer by blending with freshly cut onion. Turkish fast food especially döner kebab is sometimes flavored with sumac powder. It is also rubbed on kebabs, chicken or fish (Baytop, 1984). Sumac possesses minerals such as Ti, Cu, Fe, Al, Cl, P, K, Mn, Ca, Zn, Si, Br, S, Sr along with Mg, Pb, Cr, Li, N, Ba, and V. Iron is a vital element for human body and takes part in electron and oxygen transfer. It is essential for the synthesis of haemoglobin (Dalziel, 1936; Kaya and Incekara, 2000). Calcium is the major element of bone and helps in teeth growth (Anke *et al*., 1984). Zinc and copper are important for our diet because they perform a broad range of biological roles such as parts of enzymatic and redox reactions (McLaughlin *et al*., 1999). Human and animal studies demonstrated that optimal intakes of minerals such as magnesium, calcium, potassium, zinc, copper, and manganese could decrease individual risk factors associated to cardiovascular disease (Mertz, 1982; Brody, 1994; Sanchez-Castillo *et al*., 1998). Mg, P, and Fe levels are also essential. Other inorganic elements such as lead, bromine, and barium contribute to the biological processes, but have not been established as essential (Macrae *et al*., 1993a). Lithium is another mineral with valuable pharmacological properties; it is effective in the treatment of manic depressive disorders (Macrae *et al*., 1993b).

Rhus coriaria has an important role in leather industry as a tanning agent such as Morocco leather was originally tanned with sumac, as well as, processing of goatskin with sumac produced the highest quality of bookbinding leather. Benefits of plant as a coloring agent in textile industry especially for dying protein based textile materials and as a preventer of wood decay are significant.

Sumac has marked potential for future research. It has been used in the treatment of diarrhea and as stomach tonic in traditional medicine for centuries (Usmanghani *et al*., 1997; Lev, 2007; Lev and Amar, 2008). The phytochemical screening revealed the presence of tannins and flavonoids, which are known to possess the spasmolytic and antidiarrheal activities (Di Carlo *et al*., 1993; Palombo, 2006). Furthermore, the plant is also documented to possess antibacterial activity which can offer additional benefit for its use in the management of different types of diarrhea including infectious diarrhea so *in vivo* antidiarrheal and *in vitro* spasmolytic activities should be conducted. *Rhus coriaria* has shown anti-ischemic and hepatoprotective properties *in vitro* which require *in vivo* studies in animals to be confirmed. *Rhus coriaria* is also reported to possess nitrates and nitrites, both cause vasodilation through relaxation of vascular smooth muscles (Katzung and Chatterjee, 2003). Vasodilators reduce hypertension by decreasing peripheral vascular resistance (Benowitz, 2003). Flavonoids are known to possess Ca^{++} channel blocking activity (Revuelta *et al*., 1997; Gilani *et al*., 2007). Ca^{++} channel blockers reduce hypertension by negative ionotropic effect, as well as, by vasodilation (Seth, 2009). On this basis, it is suggested that plant might have antihypertensive property so *in vivo* and *in vitro* activities should be conducted for evaluation. To what degree the results about pharmacological activities are of potential clinical relevance is uncertain due to deficiency of clinical data. Thus there remains significant research gap for scientists and they can serve mankind through future research.

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