

Folk Medicine and Biological Activities

Rhus coriaria has been used as a spice, condiment, appetizer, and as a souring agent for centuries. In traditional medicine, the 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 (Shabbir, 2012).

Fruits of *Rhus coriaria* are traditionally used as a table spice and are highly recommended for diabetic patients (Mohamadi *et al.*, 2010; Sharma and Arya, 2011). The tannins of the plant have been found to be effective at 0.4% in killing worms (*Allolobophora foetida*) (Tkabladze, 1959). The changes of the carbohydrate tolerance of organisms (rabbits) during the parallel administration of an aqueous extract of ripe fruits have been studied and its effect on reducing the blood sugar was proved (Karaev *et al.*, 1954). The results obtained by Giancarlo *et al.* (2005) revealed that sumac may have interest in the treatment and prevention of hyperglycemia, diabetes and obesity, with an IC₅₀ value of 28.7 µg mL⁻¹. Also, the results obtained by Mohammadi (2010) confirmed that the fruits can be utilized as useful herb for alleviation of the diabetes complications.

The methanolic extract of the leaf showed antimicrobial activity (Iauk *et al.*, 1998). Nasar-Abbas and Halkman (2004) studied the antimicrobial effect of water extracts of sumac (*Rhus coriaria*) on the growth of 12 bacterial strains (six Gram positive strains and six Gram negative strains), mostly food borne including pathogens. It was found to be effective against all the test organisms with Gram positive strains being more sensitive than Gram-negative strains. Significant differences ($P < 0.01$) were found among the bacteria and between the non-neutralized and neutralized extracts with non-neutralized being more effective against all the bacteria. Among the Gram positive organisms, *Bacillus* species (*Bacillus cereus*, *Bacillus megaterium*, *Bacillus subtilis*, and *Bacillus thuringiensis*) were found to be the most sensitive showing MICs of 0.25-0.32% (after 24 h incubation) followed by *Staphylococcus aureus* (0.49%), while *Listeria monocytogenes* was found to be the least sensitive demonstrating a

MIC of 0.67%. Of the Gram negative organisms, *Salmonella enteritidis* was found to be the most resistant with a MIC of 0.67% followed by *Escherichia coli* Type I, *E. coli* O157:H7, *Proteus vulgaris* and *Hafnia alvei* having MICs of 0.63%, 0.60%, 0.55% and 0.45%, respectively; whereas *Citrobacter freundii* was found to be the least resistant surviving up to 0.42 (Nasar-Abbas and Halkman, 2004). The ethanolic extract of *Rhus coriaria* has been found to increase the inhibition zones of oxytetracyclin HCl, gentamicin sulfate and sulfadimethoxin (Adwan *et al.*, 2009). The antimicrobial efficacy of the aqueous extract of the plant suggested its use to enhance microbial safety of tomatoes without loss in quality attributes (Gunduz *et al.*, 2010). The antifungal activity of xanthenes, naphthalene and anthracene derivatives, isolated from the seeds has been reported (Singh *et al.*, 2011a,b). The fruits showed strong antibacterial and antifungal activities (Diğrak *et al.*, 2001).

The sumac (*Rhus coriaria*) extracts generally inhibited the formation of hydroperoxide, as did butylated hydroxyanisole, in peanut oil (Ozcan *et al.*, 2003a,b). The study of Candan (2003) provides evidence that a crude extract of *Rhus coriaria* exhibits interesting antioxidant properties, expressed either by the capacity to scavenge superoxide radical or to uncompetitively inhibit xanthine oxidase. The methanolic extract has considerable antioxidant activity against free radicals and lipid peroxidation (Candan and Sokmen, 2004). The findings of Kosar *et al.* (2007) demonstrated that sumac can be used as a natural antioxidant. The antioxidant activity of *Rhus coriaria* extracts or some of its constituents (mainly phenolic compounds) have been reported by Panico *et al.* (2009) and Unver *et al.* (2009).

Gallotannins extracted from sumac showed antitumor-promoting effects in mouse skin (Gali *et al.*, 1993). The ethanolic extract of the plant has DNA-protective effects on human and rat lymphocytes. The animal experiments showed that sumac also causes protection in inner organs (Chakraborty *et al.*, 2009). The aqueous extract showed a hepatoprotective activity less than gallic acid against oxidative stress cytotoxicity (Pourahmad *et al.*, 2010).

The cardio-protective activity of hydrolyzable gallotannins from *Rhus coriaria* leaves extract (RCLE) was studied in isolated rabbit heart preparations submitted to low-flow ischemia/reperfusion damage. RCLE induces a dose-dependent normalization of coronary perfusion pressure, reducing left ventricular contracture during ischemia, and improving left ventricular developed pressure and the maximum rate of rise and fall of left ventricular pressure at reperfusion. Creatinine kinase and lactate dehydrogenase outflow were significantly reduced during reperfusion. In parallel there was a rise in the release of the cytoprotective 6-ketoprostaglandin F₁ α and a decrease of tumor necrosis factor- α (Beretta *et al.*, 2009).

The hypoglycemic (Giancarlo *et al.*, 2006) and the antioxidant (Serteser *et al.*, 2009; Bursal and Köksal, 2011; Capcarova *et al.*, 2012) activities of the plant have been reported. The study of Zavaragh (2011) showed that using sumac and garlic powder have positive effects on performance, carcass traits and blood biochemical parameters of Japanese quails. *Rhus coriaria* administration in feed, decreased cholesterol level in rabbits (Capcarova *et al.*, 2012).

The results reported by Zargham and Zargham (2008) showed that sumac may have potential for the prevention or treatment of atherosclerosis and its clinical manifestations.

An interferon-inducing tannin extract was prepared from the leaf of *Rhus coriaria*, *Rhus glabra* or *Rhus typhina* with increased activity and reduced toxicity (Islambekov *et al.*, 1992). Some pharmacological effects of *Rhus coriaria* have been reported (Altinkurt and Heper, 1970).

Gulmez and Vatansever (2006) reported that water extract of *Rhus coriaria* may be important for poultry processors and for consumers. The antifeedent growth and toxic effects

of the plant extract on larvae of *Leptinotarsa decemlineata* have been reported (Erturk and Uslu, 2007).

Using *Rhus coriaria* in broiler chicken feeds have significant effects on performance, carcass traits and blood biochemistry without having any significant effect on immunity parameters (Mansoub, 2011). Also, sumac powder significantly improved feed conversion ratio during growth period (Mohammadi *et al.*, 2011).