Iranian Journal of Basic Medical Sciences
Vol. 14, No. 4, July-Aug 2011, 295-307
Received: Nov 22, 2010; Accepted: May 10, 2011

IJBMS

Review article

Pharmacological Effects of *Rosa Damascena*

*[1]Mohammad Hossein Boskabady, [1]Mohammad Naser Shafei, [1]Zahra Saberi, [2]Somayeh Amini

Abstract

Rosa damascena mill L., known as Gole Mohammadi in Iran is one of the most important species of Rosaceae family flowers. *R. damascena* is an ornamental plant and beside perfuming effect, several pharmacological properties including anti-HIV, antibacterial, antioxidant, antitussive, hypnotic, antidiabetic, and relaxant effect on tracheal chains have been reported for this plant. This article is a comprehensive review on pharmacological effects of *R. damascena*.

Online literature searches were performed using Medline, Pubmed, Iran medex, Scopus, and Google Scholar websites backed to 1972 to identify researches about *R. damascena*. Searches also were done by going through the author's files and the bibliographies of all located papers.

Keywords: Damask Rose, Essential oil, Pharmacological properties, *Rosa damascena*, Rose water

1- Department of Physiology, School of Medicine and Pharmaceutical Research Centre, Mashhad University of Medical Sciences, Mashhad, Iran
*Corresponding author: Tel: +98- 511- 8828565; Fax: +98- 511- 8828564; email: boskabadymh@mums.ac.ir
2- Department of Horticulture, College of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran

Introduction

Rosa damascena mill L, commonly known as Damask rose (1), is known as Gole Mohammadi in Iran (2). It is one of the most important species of Rosaceae family. Rosaceae are well-known ornamental plants and have been referred to as the king of flowers (3, 4). At present time, over 200 rose species and more than 18000 cultivars form of the plant have been identified (5). Apart from the use of *R. damascena* as ornamental plants in parks, gardens, and houses, they are principally cultivated for using in perfume, medicine and food industry (6). However, *R. damascena* is mainly known for its perfuming effects (7). The rose water were scattered at weddings to ensure a happy marriage and are symbol of love and purity and are also used to aid meditation and prayer.

There is a strong bond between Iranians and this plant. Its popularity is not only because of the medicinal effects but also is due to holy beliefs about it. People call this plant Flower of Prophet Mohammed (Gole mohammadi), because they believe its nice aroma reminds them of prophet Mohammad (8).

At the present time, this plant is cultivated in Iran (especially in Kashan) for preparing rose water and essential oil (9, 10). Because of the low oil content in *R. damascena* and the lack of natural and synthetic substitutes, essential rose oil of this plant is one of the most expensive ones in the world markets (11).

The *R. damascena* has also been used for medicinal purposes (12). Various products and isolated constituents from flowers, petals and hips (seed-pot) of this plant have been studied in a variety of *in vivo* and *in vitro* studies. However, there are not any reviews to collect pharmacological effects of *R. damascena* in the present time. Therefore, in this review we collect and discuss important pharmacological effects of *R. damascena* that recently have been published in numerous studies.

Morphology

R. damascena is a perennial bushy shrub reaching approximately 1 to 2 meters in height with large, showy and colorful flowers. The leaves are imparipinnate and compound with 5-7 leaflets (13, 14) (Figure 1).

Figure1.The plant of R. *damascena*

Its life span is up to 50 and economic period is about 25 years. Gestation period is three years for attaining economic production level. Its propagation is mostly by cutting and using Suckers but micropropagation is a developing propagation method for this plant in Iran (8).

History

There are evidences that Rosaceae family is an ancient plant (8, 9, 15). Some fossils of rose are found in America that are 30 million years old (15). The origin of Damask rose is the Middle East and some evidences indicate that the origin of rose water is Iran, but the origin of its fragrant oil and extracts is Greece (16). This plant is cultivated in all over the world including Iran, Europe, Bulgaria, Turkey and India (17). The major cultivation areas of *R. damascena* in Iran are Kashan, Fars and Azerbaijan, among them Kashan is the most famous one (8).

There are many evidences that cultivation and consumption of *R. damascena* in Iran has a long history and Iran is one of its origins (18). It is believed that the crude distillation of roses for the oil was originated from Persia in the late 7th century AD, and spread to the provinces of Ottoman Empire later in 14th century. Iran was the main producer of rose oil until the 16th century and exported it to all around the world (19-21).

Traditional uses

The most therapeutic effects of *R. damascena* in ancient medicine are including treatment of

abdominal and chest pain, strengthening the heart (22), treatment of menstrual bleeding and digestive problems (23), and reduction of inflammation, especially of the neck (24). North American Indian tribes used a decoction of the root of *R. damascena* plant as a cough remedy to ease children's cough (13). This plant is also used as a gentle laxative (16). Rose oil heals depression, grief, nervous stress and tension. It helps in the reduction of thirst, healing old caugh, special complaints of women, wound healing, and skin health. Vapor therapy of rose oil is helpful for some allergies, headaches, and migraine (16, 25).

Products

There are different products from *R. damascena* in the world. The major products are as below.

Rose water

It is an abundant product of *R. damascena* in Iran which contains 10-50% rose oil. The most usage of Rose water is in religious ceremonies. It is used in mosques especially at mourning ceremonies, to calm and relax people. The highest quality rose water is produced in Kashan. Kaaba (God House) in Mecca, Saudi Arabia, is washed yearly by unique and special rose water of Kashan. Rose water is also of high value in the food industry and some special foods are prepared using this product (8).

Rose oil

It is a volatile oil obtained by distillation of the fresh flowers of *R. damascena*. The chief producing countries are Bulgaria, Turkey, and Morocco, but not a major product in Iran. The oil is prepared in copper alembic stills by the peasant or in large factories under careful scientific control. Some 3000 parts of flowers yields only one part of oil. The oil is very expensive and very liable to adulteration. The oil is, pale, yellow, and semisolid. The portion which is solid at ordinary temperatures forms about 15-20% and consists of odourless stearoptene containing principally saturated aliphatic hydrocarbons (C14-C23 normal paraffins) (8, 26). Because of the low oil content in *R. damascena* and the lack of natural and synthetic substitutes, essential rose oil is one of the most expensive ones in the world markets (11).

Dried flowers

Two kinds of dried flowers are produced in Iran. A) Dried bud which is mostly for export. B) Dried petals for different purposes; its major use is for eating, as it can solve problems with digestive system. Some Iranians eat it with yogurt. Another reason for drying petals is to store them when distilleries cannot accept the whole produced flower anymore. They use them later for distillation (8, 16).

Hips

Both dried and fresh hips of *R. damascena* processed or not processed, are used in Iran (8).

Other products

Other different products are including hydrosol, absolute, ethanolic, aqueous, and chloroformic extractions from flowers, petals, and hips (seed-pot) of this plant. In comparison with rose oil, hydrosol and absolute are less expensive. The ethanolic, aqueous, and chloroform extracts are also prepared for research purposes (10).

Chemical composition

Several components were isolated from flowers, petals and hips (seed-pot) of *R. damascena* including terpenes, glycosides, flavonoids, and anthocyanins (27-30). This plant contains carboxylic acid (31), myrcene (32), vitamin C (13), kaempferol and quarcetin (33). Flowers also contain a bitter principle, tanning matter, fatty oil and organic acids (34). Loghmani-Khouzani *et al* (2007) found more than 95 macro- and micro-components in the essential oil of *R. damascena* from the Kashan regions of Iran. Among them, eighteen compounds represented more than 95% of the total oil. The identified compounds were; β-citronellol (14.5-47.5%), nonadecane (10.5-40.5%), geraniol (5.5-18%), and nerol and kaempferol were the major components of the oil (2). Analyses of rose absolute showed that phenyl ethylalcohol (78.38%), citrenellol (9.91%), nonadecane (4.35%) and geraniol

(3.71%) ethanol (0.00-13.43%), and heneicosane were the major compounds (35). In another study, the composition of rose was phenyl ethylalcohol (72.73–73.80%), citrenellol (10.62–11.26%), nerol (2.42–2.47%), and geranial (5.58–5.65%) (36). Hydrosol was also found to contain four constituents; geraniol was the major compound (30.74%) followed by citrenellol (29.44%), phenyl ethylalcohol (23.74%), and nerol (16.12%) (9, 35).

The medicinal functions of Rosaceae are partly attributed to their abundance of phenolics compound. Phenolics possess a wide range of pharmacological activities, such as antioxidants, free-radical scavengers, anticancer, anti-inflammatory, antimutagenic, and antidepressant (12, 38-42).

Pharmacological studies

Different pharmacological effects of *R. damascena* are as follows (Table 1).

Neuropharmacolgical effects

Several Pharmacological studies have been performed on *R. damascena* to evaluate their effects on the central nervous system (CNS). The effects of this plant on CNS are extensive.

Ethanolic extract of the flowering tops of *R. damascena* has been shown to possess a potent depressant activity on CNS in mice (34). Some of these effects that evaluated are hypnotic, anticonvulsant, anti-depressant, anti-anxiety, analgesic effects, and nerve growth that are discussed below.

Hypnotic effect

One of the effects of *R. damascena* on central nervous system is its hypnotic effect. The ethanolic, aqueous and chloroformic extracts from *R. damascena* were used for hypnotic effect in mice. The ethanolic and aqueous extracts in doses of 500 and 1000 mg/kg significantly increased the pentobarbital induced sleeping time in mice which was comparable to diazepam. However, the chloroformic extract has not shown to have hypnotic effect (43, 44).

In another study, the hypnotic effects of three fractions (ethyl acetate, aqueous and n-butanol fractions) of this plant were evaluated. It has been shown pentobarbital induced sleeping time increased by these fractions. Among these fractions, the ethyl acetate fraction has the best hypnotic effect. The ethanol crude extract of *R. damascena* and its fractions were also investigated in mice. It was shown that they can prolong the pentobarbital induced sleeping time comparable to diazepam (45). Although the hypnotic effect of the extracts and fractions of *R. damascena* have been shown but the mechanism(s) of hypnotic effect of this plant was (were) not clarified. *R. damascena* contains several components such as flavonoids and terpenes (13, 46). There are evidences that these compounds have hypnotic effect (44, 47). Therefore, it is suggested that these compounds may be responsible for the hypnotic effect of *R. damascena*. Flavonoids have been shown to have anxiolytic and/or antidepressant activity in numerous studies (18, 43, 44). It can be suggested that flavonoids of the *R. damascena* contribute to the hypnotic effect. This effect has been ascribed to their affinity for the central benzodiazepine receptors (44). Noguerira and Vassilieff have shown that the other genuses of Rosaceae family exert their hypnotic effect through GABAergic system (48). Therefore, this system is probably another mechanism involved in the hypnotic effect of *R. damascena*.

The analgesic effect

The analgesic effect of *R. damascena* is also reported. In a study, the effect of aqueous, ethanolic and chlorphormic extracts in mice on hot plate and tail flick was evaluated and only ethanolic extract showed analgesic effect (49). The analgesic activity of hydroalcoholic extract and essential oil of *R. damascene* in acetic acid formalin and tail flick tests in mice demonstrated that essential oil of the plant failed to show any analgesic effect. However, hydroalcoholic extract has a potent analgesic effect in acetic acid and formalin tests and no effect on tail flick test (50).

Based on analgesic effect of hydroalcoholic and ethanolic extracts, it is suggested that ingredients of the plant that are not soluble in

water may be responsible for observed analgesic effect. Therefore, it is suggested quercetin and kaempferol which are not soluble in water may be responsible for this effect (49, 51).

Recently, it has been reported that antioxidants reduce pain in formalin test (52). It has been reported that *R. damascena* contains flavonoid (2, 53, 54). Therefore, it seems that these compounds have some role in the analgesic effect of the plant. In tail flick test, essential oil and hydroalcoholic extract could not exert any antinociceptive activity but ethanolic extract could affect tail flick test. The mechanisms of these effects are not completely known and further studies are needed to find out the exact mechanism.

Protective effects on neuritic atrophy

R. damascena has beneficial effects on the brain function such as treatment of dementia. Awale *et al* (2009) showed neurite outgrowth activity of rose extract (55). They found that the chloroformic extract of the *R. damascena* significantly induced the neurite outgrowth activity and inhibited the amyloid β (Aβ) (55). Aβ is thought to be a major pathological cause of Alzheimer. Aβ (25-35) is major fragment of full peptide of Aβ and can be produced in the brains of Alzheimer's patients. Aβ (25-35) caused neural cell death, neuritic atrophy, synaptic loss, and memory impairment (56-61).

An active constituent of chloroform extract of *R. damascena* was isolated which is a very long polyunsaturated fatty acid (VLFA) having molecular formula $C_{37}H_{64}O_2$. This isolated compound protected atrophy induced by Aβ (25-35) and displayed strong neurite outgrowth activity. The effect of this compound on length of dendrite in the treated cells was comparable to those of nerve growth factor (NGF) (55). Therefore *R. damascena* may have beneficial effect in patients suffering from dementia.

Anticonvulsant effect

The essential oil of *R. damascena* in acute pentylenetetrazole (PTZ)-induced seizure in rats, delays the start of epileptic seizures and decrease the duration of tonic-clonic seizures (stage 4) (62, 63). In chronic model of PTZ-induced seizure, this plant also caused prolongation of latent periods before tonic-clonic generalized seizures (62).

Injection of essential oil 30 min before amygdale electrical kindling also reduced appearance of 1st, 2nd, 3rd, 4th, and 5th stages of seizure and could reduce the time after discharge duration. It is suggested that essential oil of *R. damascena* retarded the development of behavioral seizures in amygdale electrical kindling and possesses the ability to counteract kindling acquisition (63).

The mechanism(s) of these effects of *R. damascena* cannot be explained by the observed results. However, authors suggested that the flavonoieds maybe involved in this effect. It is reported that flavonoieds act on GABAergic system in the brain. Flavonoieds can also enhance the effect of benzodiazepines on GABA receptors (62). Other components of essential oil of *R. damascena* such as geraniol and eugenol have been shown to have antiepileptic effect (65). However, the exact mechanistic effect of these compounds is unknown.

The effects of the essential oil of *R. damascena* as an adjunct in treatment of children with refractory seizures were also studied and showed a significant reduction in the mean frequency of seizures in patients using essential oil of the plant. Therefore, the essential oil of *R. damascena* has beneficial antiepileptic effect in children with refractory seizures (64).

Effect on respiratory system

Research about respiratory effect of *R. damascena* is sparse and only our laboratory evaluated this effect. We showed that the ethanolic and aqueous extracts of this plant significantly reduce number of coughs induced by citric acid, in guinea pigs (46). In another study the effect of ethanolic extract and essential oil on tracheal smooth muscle of guinea pigs contracted by KCl and methacholine were studied. The results showed a potent relaxant effect of extract and essential oil that was comparable to that of theophylline (66). The

exact mechanism(s) of antitussive effect of *R. damascena* is (are) not clarified. However, this effect of *R. damascena* might be due to its possible tachykinin inhibitory substance(s) content mediating both bronchodilatory and antitussive effects (67).

The mechanism(s) of relaxant effect of *R. damascenea* on tracheal smooth muscle of guinea pigs is (are) unknown. This effect may be produced by several different mechanisms. Because the relaxant effect of adrenoceptors on guinea pig airway and bronchodilatory effect of H_1 blocking drugs have been shown previously (68-69), we suggested that some components of this plant can stimulate β-adrenergic receptors or inhibit histamine (H_1) receptors. In fact, the extract and essential oil from *R. damascene* did not show any significant relaxant effect on incubated tracheal chains with β-adrenergic and H_1 receptors antagonists. These results indicated a stimulator effect for this plant on β-adrenoceptors and/or histamine (H_1) receptors blocking effect. Based on bronchodilatory effect of calcium channel blockers, an inhibitory effect of this plant on calcium channels of guinea pig tracheal chain also suggested (46, 66).

The aqueous, ethyl acetate and n-butanol fractions of *R. damascena* also showed relaxant effect on tracheal smooth muscle of guinea pigs (70). The results of this study also showed more potent relaxation effect of ethyl acetate fraction on tracheal smooth muscle compared to theophylline, while effect of aqueous and n-butanol fraction was relatively weak. The greater relaxant effect of ethyl acetate fraction compared to the other two fractions suggests that lipid soluble (non-polar) constituents of this plant are mainly responsible for its relaxant effect on tracheal smooth muscle. The results also suggest an inhibitory effect of aqueous and acetyl acetate fractions on muscarinic receptors (70). The effect of essential oil, extracts and fractions of the plant are summarized on Table 2.

.

Table 1. Pharmacological effects of flowers from *Rosa damascena*

Type of solution	Effect	Method of study	Reference
Extract(ethanolic , aqueous) Fraction(ethyl acetate, aqueous, n-butanol)	Hypnotic	Pentobarbital-induced sleep time	43, 44
Extract (Hydroalcoholic , ethanolic)	Analgesic	Hot plate , tail flick, acetic acid and formalin tests	49, 50
Essential oil	Anticonvulsant	Pentylenetetrazole and kindling methods	62, 63
Ethanolic and aqueous extracts	Antitussive	Citric acid method	46
Ethanolic extract , essential oil Fraction(ethyl acetate, aqueous , n-butanol)	Bronchodilatory	Tracheal chains	66, 70
Aqueous-ethanolic extract	Potentiation of HR and contractility	Isolated heart (Langendorff mode)	71
Compounds purified from the methanol extract	Anti-HIV	Effect on C8166 and H9 cells infected with HIV	33
Essential oil and absolute extract	Antibacterial	Disk method, well-diffusion , microdilution method	33, 77, 78
Methanol extract	Anti-diabetic	Measurement of α-glucosidase activity	73
Extract (hydroalcohlic, ethanolic, fresh flower, spent flower),essential oil	Antioxidant	Measurement of free-radical-scavenging activity	76, 83, 84
Boiled extract	Laxative and prokinetic	Frequency of defecation, Intestinal transit time	78
Hydroalcoholic extract	Anti-inflammatory	Rat paw edema induced by carrageenan	85

Table 2. Relaxant effect of extract, essential oil and fractions from *Rosa damascena* in comparison with negative control (saline) and positive control (theophylline) in group 1 experiments (KCl) (66, 67, 70).

Different Solution	Concentration	G1	G2	G3
Ethanolic extract	0.25	5.60±2.42	1.62±1.16	0.00±0.00
	0.50	11.60±4.95	17.12±4.06	0.00±0.00
	0.75	20.00±9.12	43.25±6.32	4.00±3.00
	1.0	41.60±11.95	60.37±6.98	9.00±5.00
Essential oil	0.25	22.80±6.38	15.19±1.57	0.00±0.00
	0.50	32.40±7.36	38.50±4.25	2.00±2.00
	0.75	53.80±7.91	59.13±7.47	0.00±0.00
	1.0	82.40±7.92	67.88±6.27	8.00±5.00
Aqueous F.	0.1	-3.50±1.17	18.25±2.40	-
	0.2	-6.30±0.50	26.75. ±3.32	-
	0.4	-6.60±0.98	34.88±4.37	-
Ethyl acetate F.	0.1	33.80±2.13	21.50±5.37	-
	0.2	48.20±3.50	44.81±11.55	-
	0.4	68.42±4.48	77.89±9.14	-
N-buthanol F.	0.1	3.48±1.20	1.56±0.87	-
	0.2	6.20±0.46	3.50±0.87	-
	0.4	24.00±3.77	5.00±1.17	-
Theophylline	0.25	-4.36±2.44	-1.92±0.27	-
	0.50	17.81±7.44	12.43±1.63	-
	0.75	50.40±6.86	33.26±3.02	-
	1.0	88.20±7.28	73.81±4.53	-

Values are presented as mean±SEM. The unit of concentration for essential oil was vol%, for extract and fractions was g%, and for theophylline was mM. Group 1 (G1); KCl induced contraction on non - incubated tracheal chains (n= 5), Group 2 (G2); methacholine induced contraction on non - incubated tracheal chains (n= 8) and Group 3 (G3); methacholine induced contraction on incubated tracheal chains of guinea pig with propranolol and chlorpheniramine (n= 5).

Effect on cardiovascular

The research on the cardiovascular effect of *R. damascena* is little. In one study aqueous-ethanolic extract from *R. damascena* potentially increased heart rate and contractility in isolated guinea pig heart. The mechanisms of these effects are unknown. However, a possible stimulatory effect of the plant on β-adrenoceptor of isolated guinea pig heart is suggested (71).

Recently, a new compound named cyanidin-3-O-β-glucoside was isolated from the buds of *R. damascenea.* This compound can significantly suppressed angiotensin I-converting enzyme (ACE) activity. Because ACE is a key enzyme in production of angiotensin II, *R. damascena* may be effective to improve the cardiovascular function (72).

Anti-HIV effects

The effect of water and methanol extracts of *R. damascena* on HIV infection were studied *in vitro* (33). In this study, anti-HIV activities of the nine compounds including a new compound 2-phenylethanol-O-(6-O-galloyl)-β-D-glucopyranoside which were purified from the methanol extract were

evaluated on C8166 human T lymphoblastoid cells infected with HIV-1MN and H9 human T-cell lymphoma cells chronically infected with HIV-1IIIB. Kaempferol 1 and its 3-O-β-D-glucopyranosides 3 and 6 exhibited the greatest activity against HIV infection of C8166 cells, whereas kaempferol-7-O-β-D-glucopyranoside showed no effect. Similarly, quercetin-7-O-β-D-glucopyranoside was inactive compared to quercetin 2. Compound 8, a new natural product exhibited some anti-HIV activity, presumably due to the presence of the galloyl moiety since 2-phenylethanol-O-β-D-glucopyranoside was inactive. In this study, authors compared the anti-HIV activities of the nine compounds and showed that the activity of the crude extract is due to the combined effects of different compounds acting additively against different stages of virus replication (33).

Anti- diabetic effect

It has been found that *R. damascena* exert an anti-diabetic effect. Oral administration of the methanol extract of this plant significantly decreased blood glucose after maltose loading in normal and diabetic rats in a dose-dependent manner. In addition, its methanol extract inhibited postprandial hyperglycemia similar to of acarbose. It was found that *R. damascena* is a potent inhibitor of α-glucosidase enzyme (73). Therefore, anti-diabetic effect of this plant maybe mediated by inhibition of α-glucosidase that suppressed carbohydrate absorption from the small intestine and can reduce the postprandial glucose level (74).

Antimicrobial effects

It has been shown that *R. damascena* has wide spectrum antimicrobial activities. Essential oil, absolute and hydrosol are important products that showed these effects.

Ulusoy *et al* (2009) showed that essential oil and absolute have strong antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *B. subtilis*, *Staph. aureus*, *Chromobacterium violaceum* and *Erwinia carotovora* strains. The *C. violaceum* was the most sensitive microorganism against rose essential oil and absolute. *E. coli* was also sensitive against rose essential. However, hydrosol had no antimicrobial activity against any of the microorganisms (35). Rose absolute also showed antibacterial activity against both gram-negative and gram-positive bacteria (35).

In other study, the essential oil of *R. damascena* petals was evaluated for its antibacterial effects against three strains of *Xanthomonas axonopodis* spp. vesicatoria. The essential oil of *R. damascena* flower remarkably inhibited the growth of the tested strains of *X. axonopodis* vesicatoria (75). Antibacterial activity of the both fresh flower (FF) and spent flower (SF) extracts of *R. damascena* flower against 15 species of bacteria: *Aeromonas hydrophila, B. cereus, Enterobacter aerogenes, Enterococcus feacalis, E. coli, Klebsiella pneumoniae, Mycobacterium smegmatis, Proteus vulgaris, Ps. aeruginosa, Ps. fluorescens, Salmonella enteritidis, Salmonella typhimurium, Staph. aureus, and Yersinia enterocolitica* were studied. Both extracts were effective against all the bacteria except *E. coli*, although the FF extract was more effective than the SF extract. FF and SF extracts showed the strongest effects against *S. enteritidis* and *M. smegmatis*, respectively (76).

The *in vitro* antibacterial activities of essential oil from *R. damasce* were also shown by disk diffusion testing *against E. coli, Staph. aureus and Ps. aeruginosa. R. damascena* showed antimicrobial activity against *Staph. aureus* in this study (77).

The interaction between water extracts of *Psidium guajava*, *Rosmarinus officinalis*, *Salvia fruticosa*, *Majorana syriaca*, *Ocimum basilucum, Syzygium aromaticum*, *Laurus nobilis,* and *R. damascena* using both well-diffusion and microdilution methods against five *Staph. aureus* isolates; one Methicillin-resistant *Staph. aureus* (MRSA) and four Methicillin-sensitive *Staph. aureus* (MSSA) was studied. The results showed that synergism effect between antimicrobial agents and plant extracts was occurred in both sensitive and resistant strains but the

magnitude of minimum fold inhibition in resistant strains especially MRSA strain was higher than the sensitive strains (78).

Essential oils of several plants including *R. damascena* were also tested for antimicrobial activity against gram-positive *Staph. aureus* (ATCC 25923), gram-negative *E. coli* (ATCC 25922), gram-negative *Ps. aeruginosa* (ATCC 27853), and yeast *Candida albicans* (ATCC 14053). The tested essential oils exhibited inhibitory and bactericidal activities against all tested microorganisms at low concentrations (79).

Antibacterial effect of major components of rose oil (citrenellol, geraniol and nerol) was reported (77, 80). Therefore, Antibacterial effect of rose oil maybe mediated by these components. Antibacterial properties of rose absolute could be attributed to its high phenylethyl alcohol content. The antimicrobial properties of alcohols have been known for a long time (81).

Antioxidant effects

The *R. damascena* similar to many aromatic and medicinal plants exhibits antioxidant properties. Sources of natural antioxidant are primarily phenolics compound that are found in all parts of plants such as the fruits, vegetables, seeds, leaves, roots and barks (82). The presence of phenolic compound in ethanolic extract of *R. damascena* has been shown by Kumar *et al* (2009). They determined antioxidant activity of this extract compare to standard antioxidant L-ascorbic acid by 1, 1-diphenyl-2-picryl hydrazyl (DPPH) free-radical method. This study showed that *R. damascena* has high antioxidant activities (83). The antioxidant activity of hydro-alcoholic extract of petals and essential oil of this plant was also evaluated by DPPH for measurement of free radical scavenging activity and by ferric ammonium thiocyanate method for evaluation of lipid peroxidation properties. Additionally, three flavonol glycosides of ethanolic extract including quercetin-3-O-glucoside, kaempferol-3-O-rhamnoside and kaempferol-3-O-arabinoside have antioxidant activity. However, the potential of this effect is maybe due to existence of quercetin 3-O-glucoside and other flavonoids in the extract (9). Both fresh flower (FF) and spent flower (SF) extracts of *R. damascena* flowers also showed antioxidant activity. However, the antioxidant activity of FF extract was higher than that of SF extract (76). The antioxidant effect of *R. damascene* and its inhibitory effect on lipid oxidation were evaluated in an *in vivo* study. The results showed a potent antioxidant and lipid peroxidation inhibitory effects comparable to α-tocopherol and suggest that the plant can be considered as a medical source for the treatment and prevention of many free radical diseases (84).

Other effects

The anti-inflammatory effect

This plant has also been shown to have anti-inflammatory effect (85). The effect of essential oil and hydroalcoholic extract of *R. damascena* on rat paw edema induced by carrageenan was demonstrated. Essential oil had no anti-inflammatory effect while the extract could significantly reduce edema which maybe acted by inhibiting the mediators of acuteinflammation (85, 86). In addition, *R. damascena* contains vitamin C (13) which has antioxidant and anti-inflammatory effects (50, 86).

The laxative and prokinetic Effects

Similar to traditional medicine gavage of boiled extract of *R. damascena* in rats showed significant laxative effects (increasing feces water content and the frequency of defecation). Because intraperitoneal (i.p.) injection of extract showed symptoms of constipation (no feces in 24 hr), it seems the laxative effects is partly due to osmotic infiltration of fluids into intestinal lumen (87).

Protective effect against surgically induced reflux esophagitis

The effect of poly herbal formulation (PHF) consisting of seven medicinal plants namely *Aegle marmelos*, *Elettaria cardamomum*, *Glycyrrhiza glabra*, *Citrus aurantifolia*, *R. damascena*, *Cissus quadrangularis,* and

Saccharum officinarum on experimentally induced reflux esophagitis and gastrointestinal motility in animals was also evaluated. The PHF exhibited significant decrease in lesion index and enhance the % protection of lesion in experimentally induced reflux esophagitis. The study indicated that the PHF has protective effect against surgically induced reflux esophagitis which may be due to its gastro protective, anti-oxidant, and prokinetic activity (88).

Anti-aging effects

The effects of a rose-flower extract on the mortality rate of *Drosophila melanogaster* was evaluated in a recent study. Supplementing *Drosophila* with the plant extract resulted in a statistically significant decrease in mortality rate in male and female flies. Moreover, the observed anti-aging effects were not associated with common confounds of anti-aging properties, such as a decrease in fecundity or metabolic rate. Therefore, *R. damascena* can extend *Drosophila* life span without affecting physiological mechanisms. This study postulated that the plant's antioxidant properties could have contributed to prolongation of life span in *Drosophila* (89).

The anti- lipase effect

In a recent study, the anti-lipase effect of the extract of several plant including *R. damascena* was studied. The ethanolic extract of *R. damascena* in this study showed anti lipase effect (90).

Ophthalmic effect

The effect of a herbal eye drop preparation (Ophthacare®) containing different herbs including *R. damascena* in patients suffering from various ophthalmic disorders namely, conjunctivitis, conjunctival xerosis (dry eye), acute dacryocystitis, degenerative conditions (pterygium or pinguecula), and postoperative cataract patients was studied. These herbs have been conventionally used in the Ayurvedic system of medicine since time immemorial and reportedly possess anti-infective and anti-inflammatory properties. An improvement was observed after receiving the herbal eye drop treatment in most of the cases. These results showed that herbal eye drop, Ophthacare®, has a useful role in a variety of infective, inflammatory and degenerative ophthalmic disorders (91).

Conclusion

The *R. damascena* is one of the most important species of Rosaceae family mainly known for its perfuming. Its major products are rose water and essential oil.

This plant contains several components such as terpenes, glycosides, flavonoids, and anthocyanins that have beneficial effects on human health. The pharmacological effects of *R. damascene* are widespread. Most of the CNS effects are hypnotic, analgesic, and anticonvulsant effects. The respiratory, cardiovascular, laxative, antidiabetic, antimicrobial, anti-HIV, anti-inflammatory, and antioxidant are other effects of this plant. It is suggested that lipid soluble (non-polar) constituents of this plant are mainly responsible for most of the above-mentioned effects.

References

1. Kaul VK, Singh V, Singh B. *Damask rose* and marigold:prospective industrial crops. J Med Aromat Plant Sci 2000; 22: 313-318.
2. Loghmani-Khouzani H, Sabzi-Fini O, Safari J. Essential oil composition of *Rosa damascena* Mill cultivated in central Iran. Scientia Iranica 2007; 14: 316-319.
3. Cai YZ, Xing J, Sun M, Zhan ZQ, Corke H. Phenolic antioxidants (hydrolyzable tannins, flavonols, and anthocyanins) identified by LC-ESI-MS and MALDI-QIT-TOF MS from *Rosa chinensis* flowers. J Agric Food Chem 2005; 53:9940-9948.
4. Nikbakht A, Kafi M, Mirmasoudi M, Babalar M. Micropropagation of *Damask rose* (*Rosa damascena* Mill.) cvs Azaran and Ghamsar. International J of Agriculture and Biology. 2004. 2005; 7(4):535-538.
5. Gudin S. Rose: genetics and breeding. Plant Breeding Reviews. 2000; 17:159-89.

6. Jabbarzadeh Z, Khosh-Khui M. Factors affecting tissue culture of *Damask rose (Rosa damascena* Mill.). Sci Hortic 2005; 105:475-482.
7. Widrlechner MP. History and Utilization of *Rosa damascene.* Econ Bot 1981; 35:42-58.
8. Nikbakht A, Kafi M .A Study on the Relationships between Iranian People and Damask Rose (Rosa damascena) and its Therapeutic and Healing Properties. Acta Hort (ISHS) ? 2008; 790:251-254
9. Yassa N, Masoomi F, Rohani Rankouhi SE, Hadjiakhoondi A. Correspondence chemical composition and antioxidant activity of the extract and essential oil of *Rosa damascena* from Iran, Population of Guilan. Daru 2009; 17:175-180.
10. Kurkcuoglu M, Baser KHC**.** Studies on Turkish Rose Concrete, Absolute and Hydrosol. Chemistry of Natural Compounds 2003; 39:375-379.
11. Baydar H, Baydar NG. The effects of harvest date, fermentation duration and Tween 20 treatment on essential oil content and composition of industrial oil rose (*Rosa damascena* Mill.). Ind Crop Prod 2005; 21: 251-255.
12. Hongratanaworakit T. Relaxing effect of rose oil on humans. Nat Prod Commun 2009; 4: 291-296.
13. Libster M. Delmar's Integrative Herb Guide for Nurses. Delmar Thamson Learning, Albany: 2002. p. 360-370.
14. Rechinger K. Flora Iranica. Graz, Austria, 1982.
15. Vetricka, V. Roses. London, England: R&B Press; 1997.
16. Zargari A. Medicinal plants. 5th ed. Tehran: Tehran University Press; 1992.
17. krussman G. The Complete Book of Roses. Portland, Oregon: Timber Press; 1981.
18. Chevallier A. The Encyclopedia of Medicinal Plants. London UK: Dorling Kindersely; 1996.
19. Guenther E. The Essential Oils. Florida: Krieger Publishing Company Malabar; 1952.Vol.5, pp 506.
20. Rusanov K, Kovacheva N, Vosman B, Zhang L, Rajapakse S, Atanassov A, *et al*. Microsatellite analysis of *Rosa damascena* Mill. accessions reveals genetic similarity between genotypes used for rose oil production and old Damask rose varieties. Theor Appl Genet 2005; 111:804-809.
21. Tabaei-Aghdaei SR, Babaei A, Khosh-Khui M, Jaimand K, Rezaee MB ,Assareh MH, *et al.* Morphological MR oil content variations amongst *Damask rose* (*Rosa damascena* Mill.) landraces from different regions of Iran. Sci Hortic 2007; 113:44-48.
22. Wood G, Bache F. The Dispensatory of the United States of America, 4th ed. Philadelphia: Griggand Elliot; 1839.
23. Ave-Sina. Law in Medicine. Interpreter; Sharafkhandy A, Teheran: Ministry of Guidance publication; 1990.p. 129-131.
24. Buckle DR, Arch JRS, Boering NE, Foster KA, Taylor JF, Taylor SG, *et al*. Relaxation effect of potassium channel activators BRL 38227 and Pinacidil on guinea-pig and human airway smooth muscle, and blockade of their effects by Glibenclamide and BRL 31660. Pulm Pharmacol 1993; 6:77-86.
25. Momeni T, Shahrokhi N. Essential oils and their therapeutic actions. Tehran, Iran: Tehran University. Press; 1991. (in Persian)
26. Moein M, Karami F, Tavallali H, GhasemiY. Composition of the essential oil of rosa damascena Mill. From south of Iran. Iran J Pharmaceut Sci 2010; 6:59-62.
27. Oka N, Ikegami A, Ohki M, Sakata K, Yagi A, Watanabe N. Citronellyl disaccharide glycoside as an aroma precursor from rose flowers. Phytochemistry 1998; 47:1527-1529.
28. Knapp H, Straubinger M, Fornari S, Oka N, Watanabe N. (S)-3,7-Dimethyl-5-octene-1,7-diol and related oxygenated monoterpenoids from petals of *Rosa damascena* Mill. J Agri Food Chem 1998; 46:1966-1970.
29. Shieber A, Mihalev K, Berardini N, Mollov P, Carle R. Flavonol glycosides from distilled petals of *Rosa damascena* Mill. Z Naturforsch C 2005; 60:379-384.
30. Kumar N, Singh B, Kaul VK. Flavonoids from *Rosa damascena* Mill. Nat Prod Commun 2006; 1:623-626.
31. Green M. The Rose. Aromatic thymes; 1999. p. 11-15.
32. Buckle J. Clinical aromatherapy in nursing. Arnold, London; 1997.
33. Mahmood N, Piacente S, Pizza C, Burke A, Khan AL, Hay AJ. The anti-HIV activity and mechanisms of action of pure com-pounds isolated from *Rosa damascena*. Biochem Biophys Res Commun 1996; 229:73-79.
34. Nyeem MAB, Alam MA, Awal MA, Mostofa M, Uddin M, Islam SJN, *et al*. CNS Depressant Effect of the Crude Ethanolic Extract of the Flowering Tops of *Rosa Damascena.* Iran J Pharm Res 2006; 5:171-174.
35. Ulusoy S, Boşgelmez-Tinaz G, Seçilmiş-Canbay H.Tocopherol, carotene, phenolic contents and antibacterial properties of rose essential oil, hydrosol and absolute. Curr Microbiol 2009; 59:554-558
36. Aydinli M, Tutas M. Production of rose absolute from rose concrete. Flavour Fragr J 2003; 18:32-35.
37. Leenen R, Roodenburg AJC, Tijburg LBM, Wiseman SA. A single dose of tea with or without milk increases plasma antioxidant activity in humans. Eur J Clin Nutr 2000; 54:87-92.
38. Ng TB, Liu F, Wang ZT. Antioxidative activity of natural products from plants. Life Sci 2000; 66:709-723.
39. Ren W, Qiao Z, Wang H, Zhu L, Zhang L. Flavonoids: promising anticancer agents. Med Res Rev 2003; 23:519-534.
40. Crespo ME, Galvez J, Cruz T, Ocete MA, Zarzuelo A. Anti-inflammatory activity of diosmin and hesperidin rat colitis induced by TNBS. Planta Med 1999; 65:651-653.

41. Miyazawa M, Okuno Y, Nakamura SI, Kosaka H. Antimutagenic activity of flavonoids from Pogostemon cablin. J Agri Food Chem 2000; 48:642-647.
42. Butterweck V, Jurgenliemk G, Nahrstedt A, Winterhoff H. Flavonoids from Hypericum perforatum show antidepressant activity in the forced swimming test. Planta Med 2000; 66:3-6.
43. Rakhshandah H, Hosseini M, Dolati K. Hypnotic effect of *Rosa damascena* in Mice. Iran J Pharmac Res 2004; 3:181-185.
44. Rakhshandah H, Hosseini M. Potentiation of pentobarbital hypnosis by *Rosa damascena* in mice. Indian J Exp Biol 2006; 44:910-912.
45. Rakhshandah H, Shakeri MT and Ghasemzadeh MR. Comparative hypnotic effect of *Rosa damascena f*ractions and Diazepam in Mice**.** Iran J Pharm Res 2007; 6:193-197.
46. Shafei MN, Rakhshandahb H, Boskabady MH. Antitussive effect of *Rosa damascena* in Guinea pigs. IJPR 2003; 2:231-234.
47. Rakotonirina VS, Bum EN, Rakotonirina A, Bopelet M. Sedative praperties of the decoction of the rhizome of *Cyperus articulatus*. Fitoterapia 2001; 72: 22-29.
48. Nogueira E, Vassilieff VS. Hypnotic, anticonvulsant and muscle relaxant effect of *Rubus brasiliensis.* Involvment of GABA (A)-system. J Ethnopharmacol 2000; 70:275-280
49. Rakhshandah H, Vahdati mashhadian N, Dolati K, Hosseini M. Antinoceptive effect of *Rosa Damascena* in mice. J Biol Sci 2008; 8:176-180.
50. Hajhashemi V, Ghannadi A, Hajiloo M. Analgesic and anti-inflammatory effects of Rosa damascena hydroalcoholic extract and its essential oil in animal models. Iran J Pharm Res 2010; 9:163.
51. O'Neil M J, Smith A, Heckelman PE. The Merck index. Merck and Co. Inc, 13th ed. 2001, pp:1438.
52. Hacimuftuoglu A, Handy CR, Goettl VM, Lin CG, DaneS, Stephens RLJ. Antioxidants attenuate multiple phases of formalin-induced nociceptive response in mice. Behav Brain Res 2006; 173:211-216
53. Schiber A, Mihalev K, Berardini N, Mollov P, Carle R. Flavonol glycosides from distilled petals of Rosa amascene Mill. Z Naturforsch C 2005; 60:379-84
54. Heim KE, Tagliaferro AR, Bibilya DJ. Flavonoid antioxidants: chemistry, metabolism and structure–activity relationships. J Nutr Biochem 2002; 13:572-84
55. Awale1 S, Tohda C, Tezuka Y, Miyazaki M, Kadota S. Protective effects of *Rosa damascena* and its active constituent on Ab(25–35)-induced Neuritic Atrophy. eCAM 2009; 149:1-8.
56. Pike CJ, Walencewicz-Wasserman AJ, Kosmoski J, Cribbs DH, Glabe CG, Cotman CW. Structure-activity analyses of beta-amyloid peptides: contributions of the beta 25–35 region to aggregation and neurotoxicity. J Neurochem 1995; 64:253–265.
57. Yankner BA, Duffy LK, Kirschner DA. Neurotrophic and neurotoxic effects of amyloid beta protein: reversal by tachykinin neuropeptides. Science 1990; 250:279–282.
58. Tohda C, Matsumoto N, Zou K, Meselhy MR, Komatsu K. Ab (25–35)-induced memory impairment, axonal atrophy, and synaptic loss are ameliorated by M1, a metabolite of protopanaxadiol-type saponins. Neuropsychopharmacology 2004; 29:860–868.
59. Grace EA, Rabiner CA, Busciglio J. Characterization of neuronaldystrophy induced by fibrillar amyloid b: Implications for alzheimer's disease. Neuroscience 2002; 114:265–73.
60. Tohda C, Tamura T, Komatsu K. Repair of amyloid beta (25–35)-induced memory impairment and synaptic loss by a kampo formula, zokumei-to. Brain Res 2003; 990:141–7.
61. Maurice T, Lockhart BP, Privat A. Amnesia induced in mice by centrally administered beta-amyloid peptides involves cholinergic dysfunction. Brain Res 1996; 706:181–93
62. Kheirabadi M, Moghimi A, Rakhshande H, Rassouli MB. Evaluation of the anticonvulsant activities of *Rosa damascena* on the PTZ induced seizures in wistar rats. J Biol Sci 2008; 8: 426-430.
63. Ramezani R, Moghimi A, Rakhshandeh H, Ejtehadi H, Kheirabadi M. The effect of *Rosa damascena* essential oil on the amygdala electrical kindling seizures in rat. Pak J Biol Sci 2008; 11:746-751.
64. Ashrafzadeh F, Rakhshandah H, Mahmoudi E. *Rosa damascena* oil: an adjunctive therapy for pediatric refractory seizer. Iranian journal of child neurology 2007; 1:13-17.
65. Wie MB,Won MH, Lee KH, shin JH ,Lee JC. Eugenol protects neuronal cells from excitotoxic and oxidative injury in primary cortical cultures. Neurosci Lett 1997; 225:93-98.
66. Boskabady MH, Kiani S, Rakhshandah H. Relaxant effects of *Rosa damascena* on guinea pig tracheal chains and its possible mechanism(s). J Ethnopharmacol 2006; 106:377-382.
67. Advenier C, Lagente V, Boichot E. The role of tachykinin receptor antagonists in the prevention of bronchial hyperresponsiveness, airway inflammation and cough. Eur Respir J 1997; 10:1892-1906.
68. Martin CAE, Naline E, Bakdach H, Advenier C. Beta3 adrenoceptor agonists, BRL 37344 and SR 58611 A do not induce relaxation of human, sheep and guinea-pig airway smooth muscle in vitro. Eur Respir J 1994; 7:1610–1615.

69. Popa VT, Somani P, Simon P, Simon V. The effect of inhaled verapamil on resting bronchial tone and airway constriction by histamine and acetylcholine in normal and asthmatic subjects. Am Rev Respir Dis 1984; 130:106–113.
70. Rakhshandah H, Boskabady MH, Mossavi Z, Gholami M, Saberi Z. The Differences in the relaxant effects of different fractions of *Rosa damascena* on guinea pig tracheal smooth muscle. Iran J Basic Med Sci 2010; 13:126-132.
71. Boskabady MH, Vatanprast A, Parsee H, Ghasemzadeh M. Effect of aqueous-ethanolic extract from *Rosa damascena* on guinea pig isolated heart. Iran J Basic Med Sci 2011; 14:116-121.
72. Kwon EK, Lee DY, Lee H, Kim DO, Baek NI, Kim YE, *et al*. Flavonoids from the Buds of *Rosa damascena* inhibit the Activity of 3-Hydroxy-3-methylglutaryl-coenzyme A Reductase and Angiotensin I-Converting Enzyme. J Agric Food Chem 2010; 58:882–886.
73. Gholamhoseinian A, Fallah H, sharifi-far F, Mirtajaddini M. The inhibitory effect of some Iranian plantstracts on the alpha glucosidase. Iran J Basic Med Sci 2008; 11:1–9.
74. Gholamhoseinian A, Fallah H, Sharififar F. Inhibitory effect of methanol extract of *Rosa damascena* Mill. Flowers on a-glucosidase activity and postprandial hyperglycemia in normal and diabetic rats. Phytomedicine 2009; 16:935-941.
75. Basim E, Basim H. Antibacterial activity of Rosa damascenea essential oil. Fitoterapia 2003; 74: 394-396.
76. özkan G, Sagdiç O, Baydar N G, Baydar H. Antioxidant and antibacterial activities of *Rosa Damascena* flower extracts. Int J Food Sci Technol 2004; 10:277-281.
77. Andoğan BC, Baydar H, Kaya S, Demirci M, Özbaşar D, Mumcu E. Antimicrobial activity and chemical composition of some essential oils. Arch Pharm Res 2008; 25:860-864.
78. Adwan G, Mhanna M. Synergistic effects of plant extracts and antibiotics on *Staphylococcus aureus* strains isolated from clinical specimens. Middle East j sci res 2008; 3:134-139.
79. Lisin G, Safiyev S, Craker LE. Antimicrobial activity of some essential oils. Acta Horticulturae(ISHS) 1999; 501:283-288.
80. Gochev V, Wlcek K, Buchbauer G, Stoyanova A, Dobreva A, Schmidt E, *et al*. Comparative evaluation of antimicrobial activity and composition of rose oils from various geographic origins, in particular Bulgarian rose oil. Nat Prod Commun 2008; 3:1063–1068.
81. Etschmann MMW, Bluemke W, Sell D, Schrader J. Biotechnological production of 2-phenylethanol. Appl Microbiol Biotechnol 2002; 59:1–8.
82. Pratt DE, Hudson JE. Natural antioxidants not exploited commercially. In: Hudson BJF. Editor. Food Antioxidants. Amsterdam UK: Elsevier; 1990.p.171-192.
83. Kumar N, Bhandari P, Bikram Singh A, Shamsher S, Bari B. Antioxidant activity and ultra-performance LC-electrospray ionization-quadrupole time-of-flight mass spectrometry for phenolics-based fingerprinting of Rose species: *Rosa damascena*, Rosa bourboniana and Rosa brunonii. Food Chem Toxicol 2009; 47:361-367.
84. Shahriari S, Yasa N, Mohammadirad A, Khorasani R, Abdollahi M. *In vitro* antioxidant potential of *Rosa damascene* extract from guilan, Iran comparable to α-tocopherol. Int J Pharmacol 2007; 3:187-190.
85. Maleev A, Neshtev G, Stoianov S, Sheikov N. The ulcer protective and antiinflamatory effect of Bulgarian rose oil. Eksp Med Morfol 1972; 11:55–60.
86. Tannenbaum SR, Wishnok JS, Leaf CD. Inhibition of nitrosamine formation by ascorbic acid. Am J Clini Nutr 1991; 53:247S–250S.
87. Arezoomandan R, Kazerani HR, Behnam-Rasooli M. The Laxative and prokinetic effects of Rosa damascena mill in rats. Iran J Basic Med Sci 2011; 14:9-16.
88. Sengottuvelu S, Srinivasan D, Ramasamy S. The Effect of polyherbal formulation-PHF on experimentally induced reflux esophagitis in rats. J Pharm Res 2008; 1:11-15.
89. Jafari M, Zarban A, Pham S, Wang T. *Rosa damascena d*ecreased mortality in adult *Drosophila.* J Med Food 2008; 11:9–13.
90. Gholamhoseinian A, Shahouzehi B, Sharififar F. Inhibitory effect of some plant extract on pancreatic lipase. Int J Pharmacol 2010; 6:18-24.
91. Biswas NR, Gupta SK, Das GK, Kumar N, Mongre PK, Haldar D, *et al*. Evaluation of ophthacare® eye drops - a herbal formulation in the management of various ophthalmic disorders. Phytother Res 2001; 15:618-620.