Journal of Traditional and Complementary Medicine 6 (2016) 10–16

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Contents lists available at ScienceDirect

Journal of Traditional and Complementary Medicine

journal homepage: http://www.elsevier.com/locate/jtcme

Review article

Rosa damascena as holy ancient herb with novel applications

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ARTICLE INFO

Article history:
Received 13 June 2015
Received in revised form
31 August 2015
Accepted 15 September 2015
Available online 30 October 2015

Keywords:
Rosa damascena
Traditional
Chemical composition
Pharmaceutical application
Gol-E-Mohammadi

ABSTRACT

Rosa damascena as an ornamental plant is commonly known as "Gole Mohammadi" in Iran. Iranian people have been called this plant, the flower of Prophet "Mohammad". *R. damascena* is traditionally used for treatment of abdominal and chest pains, strengthening the heart, menstrual bleeding, digestive problems and constipation.

This paper reviews the ethnopharmacology, phytochemistry and pharmaceutical investigations on *R. damascena*.

All relevant databases and local books on ethnopharmacology of *R. damascena* were probed without limitation up to 31st March 2015 and the results of these studies were collected and reviewed.

R. damascena has an important position in Iranian traditional medicine. It is economically a valuable plant with therapeutic applications in modern medicine. The antimicrobial, antioxidant, analgesic, anti-inflammatory, anti-diabetic and anti-depressant properties of *R. damascena* have been confirmed. Citronellol and geraniol as the main components of *R. damascena* essential oil are responsible for pharmacological activities.

Overall, *R. damascena* as holy ancient plant with modern pharmacological investigations should be more investigated as traditional uses in large preclinical and clinical studies.

1. Introduction

Rosa damascena Mill is the hybrid between *R. gallica* and *R. Phoenicia* and is the member of Rosaceae family with more than 200 species and 18,000 cultivars around the world. *R. damascena* as the king of flowers has been the symbol of love, purity, faith and beauty since the ancient times. It was originated from Iran and essential oil extracting from its flowers has been started since 7th century A.D. It was brought to Europe and has been cultivated in European countries. Nowadays, Bulgaria and Turkey are the main producers of *R. damascena* essential oil in the world and the Bulgarian *R. damascena* oil is the known best ones. The Iranian people called it, Gol-E-Mohammadi (the flower of Prophet "Mohammad") (Fig. 1). *R. damascena* flowers should handpick daily at early morning and are used immediately after harvesting for industrial purposes.

2. Different commercial derivations from *R. damascena*

Nowadays, different commercial products are produced from rose flowers. They are including:

2.1. Rose essential oil

Rose essential oil or liquid gold is expensive yellow pale essential oil that is extracted by different commercial methods. Bulgaria, Turkey and Morocco are the main producers of rose essential oil in the world.[1] The essential oil yield from Bulgarian rose varied from 0.032–0.049% (w/w).[2]

2.2. Rose water

Rose water or colorless liquid water with common name Golab (in Iran) due to its calming and relaxing properties is used in religious ceremonies like washing the God House in Mecca (Saudi Arabia) and also for flavoring the foods in Iran.

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Peer review under responsibility of The Center for Food and Biomolecules, National Taiwan University.

http://dx.doi.org/10.1016/j.jtcme.2015.09.005

Fig. 1. *Rosa damascena* flowers, buds and leaves.

2.3. Dried flowers

The dried buds and petals of rose are sold in groceries as flavor and laxative agents. In Iran, dried flowers are used as laxative agent and flavoring in foods.

2.4. Rose hips

Rose hips are the berry like fruits under the petals of flower. They are rich of vitamins, minerals and fatty acids, polyphenols, carotenoids and tannins[3,4] The vitamin C content of rose hips is higher than citrus fruits.

2.5. Rose concrete

Rose concrete, a red orange Vaseline mass is extracted by non polar solvent extraction and is the main material for production of rose absolute.

2.6. Rose absolute

Rose absolute or the ethanol extract of rose concrete has an orange red liquid with rose aroma.[5]

3. Chemical composition of *R. damascena*

Citronellol, geraniol, nerol, phenyl ethyl alcohol, nonadecane, nonadecene, eicosane, heneicosane, tricosane, α-guaiene, geranyl acetate and eugenol have been reported from different parts of world (Table 1). Phenyl ethyl alcohol (71%) as the main component of rose essential oil was reported from Pakistan.[6] Citronellol, nonadecane and geraniol were the main components of rose essential oil from central of Iran[7,8] while the chemical composition of rose essential oil has been changed to triacosane (24.6%), 1-nonadecene (18.6%), n-tricosane (16.7%) and geraniol (15.5%) from north of Iran.[9] Citronellol, geraniol, nonadecane and nerol were reported by Bulgarian authors as the main components.[10] There was low variability in chemical composition of Bulgarian rose oil.[11]

The chemical composition of Turkian rose essential oil[12,13] was similar to chemical compositions of rose essential oil from central of Iran.[7,8]

Different chemotypes of rose essential oil were reported from India,[14,15] furthermore one study has been reported citronellol, geraniol, nonadecane[15] as the main components of Indian rose essential oil.

The chemical compositions of rose essential oil change under different conditions; one of the most factors is the used plant's organ. For example, citronellol is obtained with a better yield in petals. Other factor is the freshness or dryness of petals that can affect on chemical compositions of rose essential oil.[12,15] The use of acidic solutions like sulfuric acid solutions in extraction method removes some compounds such as geraniol, linalool, geraniol acetate, cis farnesol, nerol and 2-actamine and decreases the percentage of citronellol.[7] Therefore, writing a documented procedure for harvesting of rose fresh petals, time of harvesting, condition of preservation and extracting the essential oil can help to produce the rose essential oil with high quality.

In total, the percentage of citronellol (20–34%), nerol (5–12%), geroniol (5–22%), parrafins c17 (1–2.5%), parrafins C19 (8–15%) and parrafins C21 (3.0–5.5%) are the best criteria for producing a high quality rose essential oil. In other word, the citronellol/geranial ratio should be between 1.25–1.3. 2-octamine in essential oil decreases the quality of rose essential oil while citronellol is responsible for quality.[7]

There are some studies on chemical compositions of rose water and rose absolute.[13,15,16] Phenyl ethyl alcohol (78.4%), citronellol (9.9%), nonadecane (4.4%) and geraniol (3.7%) have been reported as the main compounds of rose absolute.[13] Geraniol (30.7%), citronellol (29.4%), phenyl ethyl alcohol (23.7%) and nerol (16.1%) have been reported as the main components of rose water[13] while heneicosane (19.7%), nonadecane (13%), tricosane (11.3%), citronellol (7.1%), geraniol (2%) and citronellal (2.2%) also have been reported as the main component of rose water.[15] In study that is published in 2015,[16] the analysis of 10 rose water samples from Shiraz (Iran) revealed the presence of phenylethyl alcohol, geraniol and β-citronellol as the main components of rose water samples.

Table 1
Chemical composition of rose essential oil from different part of the world.

Main components	Origin	References
Phenyl ethyl alcohol (70.9%), citronellol (3.7%), rhodinol (2.7%), citranellyl acetate (2.5%), eugenol (1.6%), geraniol (1.5%)	Pakistan	[6]
Citronellol (23%), nonadecane (16%), geraniol (16%), heneicosane (5%)	Iran-Kashan	[8]
Citronellol (14.5–47.5%), nonadecane (10.5–40.5%), geraniol (5.5–18%), henicosane (7–14%)	Iran-Kashan	[7]
Citronellol (48.2%), geraniol (17%), β-phenyl ethyl benzoate (5.4%) and phenyl ethyl alcohol (5.1%)	Iran-Kashan	[25]
Citrenellol (35.2%), geraniol (22.2%), nonadecane (13.8%), nerol (10.3%)	Turkey	[13]
Citronellol (15.9%–35.3%), geraniol (8.3–32.3%), nerol (4–9.6%), nanadecane (4.5–16%), heneicosane (2.6–7.9%)	India	[15]
Linalool (3.4%), nerol (3.1%), geraniol (15.5%), 1-nonadecene (18.6%), n-tricosane (16.7%), n-pentacozane (5.1%), n-hexa triacosane (24.6%)	Iran-Guilan	[9]
Citronellol (38.7%), geraniol (17.2%), nerol (8.3%), nonadecane (7.2%)	Turkey	[24]
Citronellol (24.5–42.9%), nonadecane (6.4–18.9%), geraniol (2.1–18.1%), ethanol (0–13.4%), heneicosane (2.3–8.9%), nerol (0.75–7.6%) and 1-nonadecene (1.8–5.4%)	Turkey	[12]
Phenyl ethyl alcohol (27.2%), octadecane (10.5%), hexadecane (7.8%)	India	[14]
Citronellol (23.4%), geraniol (19.0%), nonadecane (11.9%), nerol (7.5%)	Bulgaristan	[10]
Citronellol (23–28%), geraniol (14–20%), nonadecane (11–16%), nerol (6–11%), linalool (8%) and heneicosane (7%)	Saudi Arabia	[93]

4. Traditional uses of rose products

In Iranian traditional Medicines, the decoction of flowers was used for treatment of chest and abdominal pains, menstrual bleeding and digestive ailments (gentle laxative for constipation). It has been famous as cardiotonic agent for strengthening the heart.[17] Rose essential oil was extracted by AveSina (Famous Iranian Scientist) in 10th century and was used for treatment of different ailments. Rose water traditionally was used as antiseptic agent for eye washing[18] and mouth disinfecting[19] and as antispasmodic agent for alleviating the abdominal pains, and bronchial and chest congestions.

The decoctions of dried rose water was used as diuretic and was recommended for reliving the fever, breast pain and menstrual problems.[20] In Iranian traditional medicine, rose petals were cooked with sugar or honey and used for cooling the mind and body. Rose hips were prescribed as blood purifier and also are used by Iranian people with bread.

5. Modern research on *R. damascena*

5.1. Antimicrobial activity

5.1.1. In vitro

Methanol and aqueous extracts of rose petals showed antiviral activity against HIV infection by targeting different stages of HIV replicative cycle. Kaempferol and its derivatives affect on viral protease and gp120/CD4.[21] The antiviral activity of main components of rose essential oil, citronellol, geraniol were confirmed against HSV-1, *Haemophilus parainflunzae* type 3.[22]

Furthermore, the acceptable antibacterial activity of rose essential oil were confirmed against *Xanthomonas axonopodis* spp. *Vesicatoria*[23], *Chromobacterium violaceum* and *Erwinia carotovora* strains,[13] *Staphylococcus aureus*,[24] *Bacillus cereus*, *Staphylococcus epidermidis*, *Pseudomonas fluorescens*.[18] *Pseudomonas aeruginosa*[10,24,25], *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Candida albicans*, *Enterococcus faecalis*,[24] *Enterococcus faecium* and *Salmonella typhimurium*[24,25] were less sensitive to rose essential oil. Bulgarian rose oil has been shown no antimicrobial activity.[2]

Alcoholic and aqueous extracts of rose petals showed higher antibacterial activity than that of petroleum ether extract. *E. coli* was resistant to rose petal ethanol extract while its aqueous extract showed more sensitivity.[26] Ethanol extract also showed antimicrobial activity against methicillin resistant *S. aureus*, *S. typhimurium*, *B. cereus*, *C. albicans*.[27] The antibacterial activity of rose petal acetone extract was confirmed against *E. coli* and *B. subtilis*. This activity was higher than its aqueous extract.[23] *A. niger* exhibited less sensitivity to rose petal ethanol extract.[27]

The antibacterial activity of rose water and rose absolute was confirmed against *E. coli*, *P. aeruginosa*, *B. subtilis*, *S. aureus*, *Chromobacterium violaceum* and *Erwinia carotovora* strains.[13,23,28] The antibacterial activity of rose absolute, rose essential oil has been higher than rose water and rose extracts.[13]

Therefore, *R. damascena* like other holy medicinal plants[29] had antimicrobial activity.

5.1.2. In clinics

The effectiveness of herbal mouthwash containing rose extract in treatment of recurrent aphtous stomatitis were confirmed in two weeks randomized double blind, placebo-controlled clinical trial on fifty patients. The clinical results of mouthwash on pain, size and the number of ulcers was significantly different with placebo group. In other word, rose mouthwash was more effective than that of placebo group.[30]

The anti-infective and anti-inflammatory effects of ophthacare®, a product containing different herbs in combination with *R. damascena* were confirmed in patients with conjunctivitis, dry eye, acute dacryocystitis, pterygium or pinguecula disorders.[31,32]

In poultry industry, dried rose dreg (by-product) decreased the occurrence of pathogen microorganisms including mesophilic aerobic bacteria, *Enterococci*, *Entrobacteriaceae* and *S. aureus* without any effect on broiler performance and feed conversion ratio during the production period.[33]

Indeed, the antimicrobial activity of rose extracts especially rose essential oil and absolute is related to chemical components especially geraniol, citronellol and nerol or synergistic effects between these components. The antibacterial[34–38] and antifungal[39–43] activities of geraniol were confirmed against a large number of microorganisms. Also, the synergistic effect between citronellol, geraniol and nerol were demonstrated against Gram positive, Gram negative bacteria.[28] In other hand, the antimicrobial activity of rose extracts is related to chemical components of extracts and their synergistic or antagonistic effects.

5.2. Anticancer activity of R. damascena

The anti-tumor, anti-carcinogenic[44] and cytotoxic effects of *R. damascena*[45,46] against cancer cells were confirmed. The geraniol as the main compounds of *R. damascena* acts via different mechanisms. It induces the apoptosis in cancer cells and increases the expression of apoptotic protein Bak,[47] arrests the G_0/G_1 phase of cell cycle and reduces cdk2 activity,[48] inhibits the 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA) reductase[49] and ornithine decarboxylase activity[50] that finally causes the death in cancer cells.

5.3. Relaxant and anti-depressant activity of R. damascena

R. damascena via stimulating the β-adrenergic receptors,[51] inhibiting the histamine H1 receptors and blocking the calcium channels of tracheal chain,[52] inhibiting the KCl-related contraction and electrical field stimulation[8] shows the relaxant activity.

R. damascena aqueous and ethanol extracts affect on respiratory system of guinea pigs by inhibition of tachykinin and decrease the number of citric acid induced coughs,[52] therefore, it shows bronchodilatory and antitussive effects.

Other sub-fractions of *R. damascena* such as its ethyl acetate fraction shows inhibitory effects on muscarinic receptors and induces relaxant effects on tracheal smooth muscles.[53] Therefore, *R. damascena* can be used as antitussive agent in clinics. Verifying this effect needs more clinical studies.

The anti-depressant effects of *R. damascena* aqueous extract were confirmed in animal models.[54] Rose absolute exhibits the anti-depressant activity by decreasing the lipid peroxidation and increasing the antioxidants in cerebral cortex.[55] Furthermore, depression is one reason for libido. As mentioned before, it is believed that rose essential oil and rose water bring happiness, self-confidence and are known as sensual and aphrodisiac agents. It has been confirmed that rose essential oil helps to infertility and libido via increasing the diameters of seminipherous tubules, sperm count and motility and enhancing the testosterone production.[56] Furthermore, administration of rose essential oil improves sexual dysfunction and symptoms of depression in male patients suffering from major depressive disorders (consuming the selective serotonin-reuptake inhibitors) higher than placebo group after week 2 to week 8.[57] In other world, patients with depression may benefits from rose extracts by their antidepressant activity and anti-libido effects.

5.4. Antioxidant activity of R. damascena

Decoctions,[58] aqueous extract,[59] essential oil,[60–62] absolute,[13] methanol,[63] ethanol extracts[17,62] of rose petals have been shown antioxidant activity in different systems. The antioxidant activity of rose absolute with higher amount of carotene, α,β,γ-tocopheroles was higher than that of rose essential oil and rose water.[13]

The antioxidant activity of *R. damascena* is not related to anthocyanin level,[64] but is correlated to total phenolic, flavonol contents of *R. damascena*.[63] Leaf methanol extract of rose with high amount of (+)-catechin and (−)- epicatechin as phenolic compounds has been shown antioxidant activity higher than that of BHT, trolox and BHT.[63]

The benefit effects of rose essential oil against formaldehyde inhalation on reproductive system are related to the antioxidant activity of rose essential oil. Pretreatment with rose essential oil has been decreased the abnormal sperm and increased the sperm counts in rats.[60] Rose hips as herbal teas are consumed as strong antioxidant beverages.[65]

Therefore, the benefit effects of *R. damascena* in scavenging of free radicals introduce it as good beverage for helping the health condition. In Iranian cultures, rose water was added to cold beverages as refreshing agent.

5.5. Analgesic, anti-inflammatory activities of R. damascena

The analgesic, anti-inflammatory effects of *R. damascena* ethanol,[66] chloroform extracts[67] have been shown in animal models, while rose essential oil has been exhibited no analgesic and anti-inflammatory effects.[67] Indeed, the component(s) that have analgesic effects in ethanol extract were not found in rose essential oil.

There are confusing results about the beneficial effects of rose hips in treatment of patients suffering from knee or hip osteoarthritis.[22,68–70] It has been shown rose hip powder (10 g) for 1 month showed no anti-inflammatory or antioxidant effects in rheumatoid arthritis patients,[68] while others have been indentified rose hips as anti-inflammatory agent.[22,69,70] Unsaturated fatty acids, triterpenoic acids or unidentified compounds and their synergistic effects exhibit anti-inflammatory effect[71] via inhibiting cyclooxygenase 1 and 2.[3,4]

5.6. Other pharmacological activities of R. damascena

The hypnotic effects of *R. damascena* different extracts (ethanol, aqueous extracts, and ethyl acetate, aqueous and n-butanol fractions) were comparable to diazepam.[72–74] The best hypnotic effects of extracts were reported for ethyl acetate fraction. The hypnotic effects of ethyl acetate fraction may be related to the affinity of flovonoids in extracts to benzodiazepine receptors.[74]

R. damascena is benefit to Alzheimer and dementia patients due to inhibitory effects on amyloid β formation, induction of neurite outgrowth[75,76] and anti-cholinesterase activity.[77]

The protective effects of *R. damascena* ethanol extract on memory performance of scopolamine-induced memory deficits rats were confirmed. The antioxidant effects of rose extract was the cause of memory enhancing.[78]

Rose essential oil,[79] ethanol and aqueous extracts have been shown anti-seizure effects because of their anticonvulsant effects[80] and reducing of epileptic seizures. The affinity of flavonoids on GABAergic system in brain has been proposed as one of probable mechanisms because flavonoids enhance the effect of benzodiazepines on GABA receptors.[81]

As its traditional uses, the usefulness of *R. damascena* ethanol extract for treatment of digestive disorders has been shown. *R. damascena* decreases ileum movements dose-dependently, probably through stimulating the β-adrenergic and opioid receptors and voltage-dependent calcium channels.[82]

Rose essential oil has been used traditionally for treatment of cardiac diseases via massage on the skin. Nowadays, it has been shown *R. damascena* aqueous extract increases the heart rate and contractility in guinea pig via stimulatory effect on β-adrenoceptor[83] and suppressing the activity of ACE (angiotensin- I- converting) enzyme.[84]

The efficacy of *R. damascena* extract on primary dysmenorrheal syndrome (PMS) was confirmed in double blind cross over clinical trial on 92 single girls. *R. damascena* extract with no side effects decreased the average of pain density in PMS such as mefnamic acid.[85]

R. damascena methanol extract like other ethnobotanical holy plants such as *Trichilia emetica*, *Opilia amentacea* showed anti-diabetic activity.[86] *R. damascena* methanol extract inhibited α-glucosidase enzyme and suppressed carbohydrate absorption from small intestine. So, it reduces the postprandial glucose level, therefore it had anti-diabetic effects.[87]

R. damascena methanol extract had moderate effects on reduction of total cholesterol, triglyceride and low density lipoprotein and plaques formation.[87] It has no effect on high density lipoproteins levels. Therefore, the anti hyperlipidemic effects of *R. damascena* methanol extract is caused through inhibiting the activities of pancreatic lipase and HMG COA reductase.[88,89]

Waste rose petals as by product of rose essential oil's industries have been explored as a source of immune-modulating peptic polysaccharids.[90] Further studies are required to confirm the applications of waste rose petal as immunomodulator agent.

6. Toxicity

Oral LD_{50} of *R. damascena* and rose absolute was >5 g/Kg in rats and dermal LD_{50} of *R. damascena* was >2.5 g/kg in rabbits.[91] Rose essential oil may cause sensitization in sensitive persons.

The potential toxic effects of *R. damascena* infusion in dogs at doses 90–1440 mg/kg/day (0.5–8 times of human uses) for 10 successive days revealed a minimal nephrotoxic or hepatotoxic effects. Therefore, it may have hepatotoxic effects at extraordinary high doses.[92]

7. Conclusion

R. damascena Mill is one of the most important plants from *Rosaceae* family is a holy ancient plant with long historical uses in Iranian traditional medicine. Although, people in folklore, use rose as rose water or dried rose petals, but the majority application of *R. damascena* is producing of rose water and rose essential oil for application in religious ceremonies, cooking of some foods and in high grade perfumes. Rose essential oil is the important industrial product for different applications. The rose essential oil yield is very low (0.3–0.4 ml/kg). Ecological, geographical and environmental conditions, soil composition, harvesting and storage condition, distillation methods may affect on chemical composition of rose essential oil. The best rose essential oil is the oil with high amounts of monoterpenes. Therefore, finding the methods for increasing the oil yield and decreasing the expense of oil production are important issues for future.

The modern investigations on *R. damascena* have been confirmed the antiviral, antibacterial, anticancer, antidepressant, antioxidant, analgesic, anti-inflammatory, anticonvulsant activities and its relaxant and hypnotic effects.

Although, many studies demonstrate the medicinal applications of rose *in vitro* and in animal models, but other large preclinical and

Fig. 2. Some Iranian products from *Rosa damascena*.

clinical studies are needed for evaluating its potencies on different patients. In other word, there is low attention to therapeutic applications of rose products. In Iran, there are three famous products from BarijEssence Pharmaceutical Company (Fig. 2). GOL-E-Ghand Majoon has been produced according to traditional perscription and is prescribed for constipation as laxative agent. GOL-E-SORKH oral drop is used as anti-depressant and aphrodisiac agents. Gol-E-Mohammadi oil (the petal of rose in vegetable oil) is prescribed for ear pain and hemmorroid ailments.

There is a good situation for evaluating the potencies of *R. damascena* as traditional applications and planning the new products as the results of these researches.

Conflict of interest statement

We declare that we have no conflict of interest.

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