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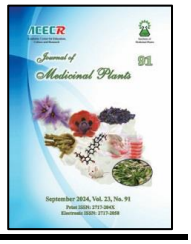

Review Article

Rose water, quality control, and its application

Mohaddese Mahboubi[1,*], Shao Hua Lu[2]

[1]*Research & Development, Tabib Daru Pharmaceutical Company, Kashan, Iran*
[2]*Commercial Department, Beijing Floralkin Aroma Science Co., Ltd, Beijing, China*

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ABSTRACT

Background: Rose water is mostly produced by the distillation of fresh rose flowers from *Rosa* × *damascena* Herrm. **Objective:** This review focused on Rose water, quality control, and its application. **Methods:** The information was gathered by searching different resources**. Results:** Iran, especially Kashan city (Qamsar Village) has a long history of this industry., indeed, Qamsar in Iran is the main origin of rose flowers in the world and rose water production is an old industry in Kashan city. Now, four provinces of Fars (Maymand), Kerman, Isfahan (Kashan), and East Azerbaijan have the most land under cultivation of *R* × *damascena* in Iran. Turkey and Bulgaria are the other producers of rose water in the world. Rose water is mostly used in cosmetic industries but has a long history of use as a drink and flavoring agent in Iran and Persian Gulf countries. **Conclusion:** This review evaluates rose water in different aspects of traditional uses, quality control, and therapeutic effects, and provides some information on adulteration and identification of original rose water.

1. Introduction

Rose water as by-product of the rose oil industry is produced by the distillation of fresh rose flowers. It is mostly produced from *Rosa* × *damascena* Herrm, but also from *Rosa gallica, Rosa centifolia, Rosa moschata, Rosa rugosa, Rosa bourbonica, and Rosa alba* in a distillation system [1, 2].

Iran is one of the leading producers of rose water in the world [3], with a long history in Kashan [4, 5]. Kashan is recognized as one of the most important regions for the cultivation of *R* × *damascena* and rose water in the world [6]. The industry of rose water in Iran and especially in Kashan City has a world reputation in terms of quantity, quality, and its connection with other sectors including tourism, perfumes, and essential oils industries has special economic importance for the people of this region [4, 5]. Qamsar is the oldest and most prominent place in Kashan City for the cultivation of *R* × *damascena* and the production of rose water, and this cultivation and the production has been slowly expanded from Qamsar to other villages in Kashan, such as Niasar, Barzok, Sadeh, and Kamu. Rose water is traditionally known as "Golab" in Iran [6].

Abbreviations: INSO, Iranian National Standards Organization; FDA, Food and Drug Administration; STZ, streptozotocin; AGE, advanced glycation end-product; HbA1c, glycated haemoglobin

*Corresponding author: m_Mahboubi@tabibdaru.com, Mahboubi1357@yahoo.com

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The first proof of rose production in Qamsar was the clay sprinklers inside the graves of "Imam Zadeh Dawood", and new Muslims perfumed the graves by putting the sprinklers of rose water close to dead bodies [7].

Furthermore, the documents reveal that the rose water industry originated from old Iran. The Iranians were possibly the first nations, who were familiar with the knowledge of rose water production by distillation. According to documents in the National Library of Paris, the production of rose water was a thriving industry in Shiraz in 810 AD, and Fars State was the world center of rose water production, which was required to pay the equivalent of thirty thousand bottles of rose water to Baghdad's treasury as ransom and exported the rose water to China and other Islamic countries around the world. The rose water industry was brought to Europe by Arabs in the 10 century and Spain was the first European country, who employ this industry [7].

Now, four provinces of Fars (Maymand), Kerman, Isfahan (Kashan), and East Azerbaijan have the most land under cultivation of *R* × *damascena* [8].

Due to the importance of rose water in Iran, this review evaluates the different aspects of rose water including traditional uses, quality, and therapeutic applications.

2. Rose water in Iranian Traditional Medicine

Rose water, also known as "Ma'al-Verd" in traditional Iranian medicine, is a powerful cold compound in nature [9]. Rose water is traditionally used in religious ceremonies as a therapeutic product in Iran [10] and Tunisia [11]. Rose water is utilized to induce tranquility and relieve discomfort in mosques and mourning ceremonies in Iran, and it is also used in the creation of various desserts and Iranian foods [10].

A small glass of rose water with a small spoon of honey is effective for the treatment of anorexia and is a tonic for the heart and stomach. It soothes the discomfort of the liver, spleen, stomach, and intestines and relieves blood pressure. Daily consumption of warm rose water can alleviate bleeding gums and groaning, as well as throat bleeding. Smelling and applying rose water on the head relieves hot headaches and eye pain, The combination of rose water with clove buds relieves cold headaches. The mixture of black seed and rose water treats the black bile. Pouring rose water into the nose can help strengthen the psyche and heart, increase vitality, and relieve hangovers, anesthesia, and suffocation. 60 g of concentrated rose water (or two heated rose water) is laxative. The daily dose of rose water is 50 to 90 grams. Rose water is not good for people with a cold nature and may decrease sexual power. It can turn the hair white color; so, it is better to eat with rocky candy [12, 13].

Zakariya Al-Razi, (865-925 AD) used rose water for the alleviation of hangovers after alcohol consumption. Ibn-I Sina (980-1037 AD) and Ibn-Al-Baitar (1197-1248 AD) prescribed rose water for heart and cognitive functions. Ibn-Al-Baitar used the steam of boiled rose water on the patient's head to heal the eye diseases [14, 15].

3. Rose water in Greek traditional medicine and other medicines

Rose water made from dried boiled petals in wine is good for headaches, itching ears, sore throats, aching gums, and pain, as well as it can be used as uterine suppositories, douches, or abdominal massages for uterine pain [12]. Rose water is used for cooking in Saudi Arabia and consumed orally due to its calming effect [16].

Gilbertus Anglicus in the Compendium of Medicine (c. 1250) prepared a lotion made of "Brazil-wood chips" soaked in rose water to

redden the pale cheeks. The red rose water is known as a general tonic, cooling, refreshing, and quickening the weak spirits, and is used as an eyewash against the redness and inflammation of the eyes. Rose water ointment is known as a cold cream with soothing and cooling effects for superficial skin lesions [1]. For the preparation of cold cream, the British Pharmacopoeia recommended mixing 14.1 g of liquid wax and 14.1 g melted wax with 255 g of almond oil, 198 ml of rose water, and one drop of rose oil.

In US Pharmacopeia, the cold ointment is prepared with 12.5 g cetyl esters wax, 12 g beeswax, 56 g almond oil, 500 mg borax, 2.5 ml concentrated rose water, 16.5 ml water, and 0.2 ml rose oil [1].

4. Production of rose water

Rose water is produced by two traditional and commercial procedures in Kashan's cities. The distillation process is crucial to the creation of both traditional and industrial rose water. The traditional rose water workshops in Kashan operate in an old-fashioned way. This method's working equipment is simple and basic, consisting of a copper pot, a Neyce (two aluminum tubes at a 45-degree angle), a copper pitcher, and a heating device known as a branch that runs on kerosene or diesel fuel (Fig. 1).

Fig. 1. The production of Rose water in the Traditional way (left hand), and industrial way (right hand)

The extraction of conventional rose water begins with the mixing of fresh rose flowers (12-30 kg) and water (30-60 liters) in the boiler. After filling the boiler with water and flowers, tightening the boiler cap, and installing Neyce (aluminum pipes), one side of the neyce is inside the fabric that was previously up to the neck in the cold-water pond, and the other side is joined to the boiler cap and tightened. The water and flowers in the boiler boil, and the generated vapors are carried through the neyce into the copper boiler, where they are distilled and turned into rose water by contact with the cool walls of the pitcher (due to being in the cold-water pond). After 4-5 hours, the copper pitcher is usually filled with rose water, and the procedure is completed by turning off the fire behind the boiler. Although traditional rose water

production takes only a few months (roughly), it is a repetitive and continuous working period.

The procedure and devices used in industrial rose water production are similar to those used in traditional rose water extraction, with some differences in volume capacity and automation of the devices and equipment [12].

Two-fired rose water (or heavy rose water) is another kind of rose water in Kashan, which is produced by the distillation of fresh rose flowers in rose water. Indeed, the fresh rose flowers mix with rose water and are distilled to produce this kind of rose water. The content of rose oil in this rose water is high and can reach 35 mg/100 ml rose water [12].

5. Quality Control of Rose water

The appearance of rose water is a clear colorless liquid or slightly clear with characteristics of rose aroma. The amount of extracted rose water relative to the fresh rose flowers is an effective factor in determining rose water quality. In general, for every kilogram of fresh rose flowers, three kilograms of rose water are produced, and the final rose water will have 12-13 mg of rose oil per 100 ml of product. If less rose water is extracted from the fresh rose flowers, the quality of rose water will be higher. The time between the rose harvesting and its distillation procedure can have an effect on the quality of rose water. Depending on the production procedure, 12–50 milligrams of rose essential oil can be found in every 100 ml of rose water [3].

Rose water is rich in flavonoids, anthocyanins, terpenes, and glycosides [17]. The amount of essential oil in rose water is very low amounts of (below 0.1 %) and phenyl ethyl alcohol is the main component of natural rose water [18]. Nerol, Geraniol, and citronellol are the other components in rose water. Solvent extraction, distillation, and simultaneous distillation–extraction are used for the extraction of rose oil and for studying the chemical composition of rose water [19]. Different solvents are used to extract the oil from rose water [20], but the essential oil is typically extracted using non-polar solvents. Hexane and benzene are unable to fully extract the essential oil from rose water, so pentane, diethyl ether, petroleum ether, and dichloromethane are typically used. Pentane, diethyl ether, and petroleum ether are used as solvents of extraction in Iran, Bulgaria, and Gulf Persian countries, respectively. Distillation method at atmospheric pressure (760 Torr) and vacuum is used for extraction of essential oil from rose water. The yield of extraction of rose oil in the vacuum distillation method is twice that of the distillation at atmospheric pressure [21].

Rose water supplied in Iran should contain at least 12 mg per 100 ml of rose oil, according to rose water ISIRI 5759 standards [22]. According to the national food standard, rose water is classified into three categories based on its essential oil content: light (0.1–11.99), medium (12–35), and heavy (more than 35).

The chemical composition of rose water can be determined by different methods. The High-Performance Liquid Chromatography method is used as an acceptable technique because of easy sample preparation and speed analysis tests. It works better to inject rose water samples directly than to use dimethyl ether or dichloromethane solvent extraction methods, which need to dilute the samples first. Because of its great sensitivity and low interference, the wavelength of 210 nm is appropriate for determining phenyl ethyl alcohol. Because of the short detection wavelength of 210 nm, the mobile phase-water system is preferable to methanol acetonitrile. The 35:65 acetonitrile-water ratios are ideal for speedy and effective separation. The GC-MASS

analysis is usually used for studying the chemical composition of rose oil extracted from rose water. Phenyl ethyl alcohol, citronellol, geraniol, and nerol are the main components of rose water [20]. Monoterpene alcohols (alpha-terpineol, 4-terpineol, linalool, and nerol), chain-substituted guaiacol derivatives (eugenol and methyl eugenol) are the other components of rose water (Table 1) [19].

Table 1- Chemical composition (%) of volatiles from rose water [19]

Compounds	Min	Max
cis-rose oxide	< 0.1	0.2
trans-rose oxide	< 0.1	0.1
linalool	1.5	7.5
citronellol	1.8	22.7
α-damascenone	< 0.1	0.1
nerol	0.2	11.6
2-damascenone	< 0.1	0.2
geraniol	0.9	16.8
2-phenyl ethyl alcohol	21.5	81.6
nonadecane	0.1	0.8
nonadecene	0.1	0.8
methyl eugenol	0.1	0.9
eicosane	< 0.1	0.6
henicosane	< 0.1	2.9
eugenol	< 0.1	0.8

The method of extraction can influence the chemical composition of rose water. The percentage of alcohol, phenyl ethyl alcohol, linalool, and geraniol has increased, and the percentage of eugenol, methyl eugenol, and nonadecane has decreased by vacuum distillation method [21].

Although phenyl ethyl alcohol (69.7-81.6 %) is the primary component of rose water and is responsible for the scent and aroma of fresh rose flowers, its quantity in essential rose oil is quite low due to its polar and water-soluble nature. The amount of phenyl ethyl alcohol in essential oil from rose water by distillation method is lower than solvent extraction [10]. The rose oil obtained from Indian rose water by solvent extraction (dichloromethane) consisted of phenyl ethyl alcohol (69.7-81.6 %), citronellol (1.8-7.2 %), geraniol (0.9-7.0 %), linalool (1.5-3.3 %), and nerol (0.2-4.2 %) as main components of rose water [19].

There are different standards to determine the quality of rose waters. Table 2 compares the specifications of rose waters in different countries.

Table 2. Characteristics of Rose water in different standards from Iran, Persian Gulf countries, Bulgaria

Characteristics	ISIRI 5759	GSO 05/FDS/ :20221017	Bulgaria BS 11-02
Relative density	Max 0.999	-	0.992-0.999
Content of natural alcohol	Max 0.25 %	-	Max 4 %
Content of natural Methanol (mg/Kg)	Max 100	-	-
Essential oil content (mg/100 ml)	Min 12	0.012	0.025
Acid Value	Max 6.0 (mg Acetic acid/100 ml)	Max 0.4 (mg Pottasium hydroxide/ml)	-
pH	3.8-5.5	5.5-7.0	4.0-7.5

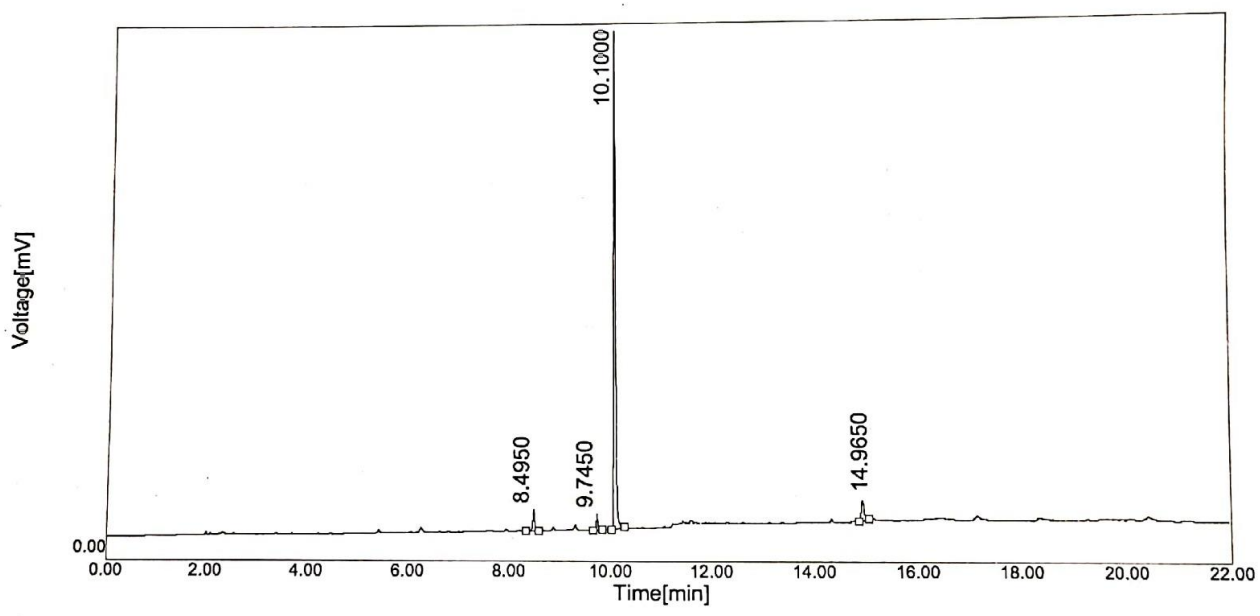
During the one-year storage of rose water, the desired changes in the smell of rose water happen as the result of a slight decrease in phenyl ethyl acetate, methyl eugenol, and eugenol content of rose water and an increase in phenyl ethyl alcohol, linalool contents [23].

The smell of rose water, distilled under pressure, relates to a burning odor, so, the extraction of rose water at high temperatures and pressures does not result in the manufacture of high-quality rose water.

6. Adulteration in Rose water

Some artificial rose waters contain synthetic essential oils or other natural essential oils, which have been diluted with water. Also, rose oil (0.02-0.05 %) is simply diluted with distilled water and some preservative is added to make rose water [10]. The phenyl ethyl alcohol should be high in the essential oil from natural rose water by solvent extraction [20], while the amount of phenyl ethyl alcohol in artificial rose water with other diluted essential oils is low (12.02-47.78 %). Natural Rose water has colorless liquid with Relative density (g/cm3) from 0,990 to 0,999, Refractive index (20 °C) from 1,3330 to 1,3370 [10].

In one study, which compared the chemical composition of artificial and original rose water, the amount of phenyl ethyl alcohol was much lower in the artificial samples than the original samples ($P \leq 0.05$). There was no significant difference between the amount of citronellol in both samples ($P > 0.05$), while the geraniol content was much higher in the artificial samples and the citronellol/geraniol ratio had a very low value in the artificial samples in comparison to the original rose water. Ethanol and methanol were found in the original rose water, and propylene glycol was found in the artificial rose water. Ethanol and methanol were not found in the artificial samples. Therefore, the ethanol, methanol, phenyl ethyl alcohol, geraniol, and citronellol/geraniol ratio can be used as a good marker for identifying the original rose water [24]. Ethanol and methanol are produced during the process of producing rose water as the result of petioles and sepals with rose flowers, and dehydration of rose flowers, which leads to the production of ethanol and methanol in the original rose water [25]. Propylene glycol is used for the solution of rose oil in water and it can be found in artificial rose water. Figure 2 compares the chromatograms related to natural and synthetic rose water.



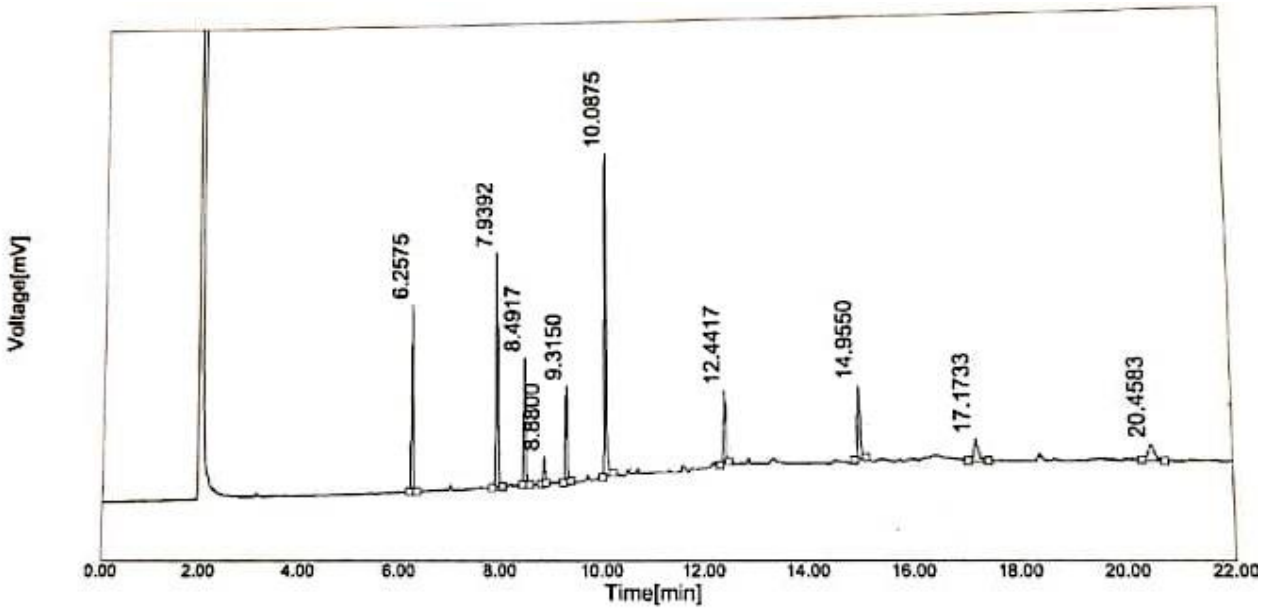


Fig. 2. Two different chromatograms from artificial rose water (up), and natural rose water (down)

7. Microbial Contamination of rose water

Due to high water content, rose water provides an ideal growth environment for contamination with bacteria, yeasts and fungi. Contamination of rose water with bacteria or mold has an effect on quality of rose water. Some microbial contaminations can metabolize the aromatic compounds in rose water or produce some metabolites which can cause undesired odors.

There is a specific quality assurance standard for rose water in Iran by the Iranian National Standards Organization (INSO). According to this standard (INSO No. 5759), [45] the microbial test is done for total bacterial count (100 CFU/mL) and applying the membrane filter technique for 100 mL rose water to test the presence of molds, yeast, coliforms, *Escherichia coli*., *Enterococcus* spp. and *Pseudomonas aeruginosa* (Negative).

According to Bulgarian Standard, the permissible level of microbial counts for children cosmetic purposes (3 years and above), eye products and food is 100 CFU/ml total bacterial count, and absence of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Candida albicans* in every 0.5 ml products. For all other cosmetic purposes, the total microbial count should be lower than 10^3 CFU/ml, and absence of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Candida albicans* in every 0.1 ml product.

According to GSO standard [26], Edible rose water for human consumption should have the total Microbial count, coliform count, and yeast not more than 100, 10, and 20 CFU/ ml. Also, it should be free from *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida* sp., *Bacillus cereus*, and all other pathogenic micro-organisms [27] (Table 3).

Rose water should be safe for use on the skin and as a drink. Different methods of pasteurization [23], ultraviolet Radiation [23, 28], ultrafiltration [28] and different chemical preservatives [23] are used to keep the quality of rose water. The use of ultrafiltration and ultraviolet radiation is recommended to preserve the rose water after production [28].

Pasteurization and UV treatment, and chemical preservatives have no effects on quality and chemical components of rose water, but if the contamination with bacterial spores or molds occurs in rose water, pasteurization and UV treatment are not effective treatment for control of microbial contaminations. So, the use of chemical preservatives can be effective. Food and Drug Administration (FDA) allowed to use of sodium benzoate in cosmetics as antimicrobial agent against bacteria and fungi at a maximum dose of 0.1 % [29]. The usage of phenoxy ethanol as natural preservative is allowed even for children at a maximum concentration of 1 % in cosmetic products [30]. 1,2-hexandiol is another safe ingredient that can increase the shelf life of cosmetics [31].

The Indian rose water samples mostly had been methylparaben at concentration of 0.15-0.30 % [19].

In Iran, distillation, pasteurization and ultrafiltration play the key role on the quality of rose water. In conventional distillation process, rose water is obtained in high-capacity copper or stainless-steel distillation apparatus in an air-tight apparatus at high temperatures (100 °C), which is safe to be used for at least one year without any microbial contamination in shelf.

Table 3. Microbial contamination of rose water in different standards

Microbial contamination	INSO 5759	Bulgarian standard		GSO05/FDS/1017, 2022
		Children cosmetic purposes (3 years and above), eye products and food	For all other cosmetic purposes	
Total bacterial count	100 CFU/ml	100 CFU/ml	10^3 CFU/ml	100 CFU/ml
Molds & yeast	Negative/100 mL			20 CFU/ ml
coliforms	Negative/100 mL			not more than, 10
Enterococcus spp	Negative/100 mL			
Pseudomonas aeruginosa	Negative/100 mL	Absence/0.5 ml	Absence/0.1 ml	Negative
Staphylococcus aureus		Absence/0.5 ml	Absence/0.1 ml	
Candida albicans		Absence/0.5 ml	Absence/0.1 ml	Negative
Escherichia coli	Negative/100 mL	Absence/0.5 ml	Absence/0.1 ml	Negative
Bacillus cereus				Negative

It seems that the use of physical methods such as pasteurization, and UV treatment along with the use of approved chemical preservatives in rose water can help the preserve the quality of rose water during long storage [23]. According to GSO standard [26], the use of food additives as preservatives is allowed in Edible rose water for human consumption [32].

8. Contamination of rose water

Dibutyl phthalate as polyethylene terephthalate is also detected in some rose waters in the market, which is released into the samples from their containers [10]. So, the temperature of filling the rose water and the container is the important subject of consideration.

9. The therapeutic effects of Rose water

9.1. Antinociceptive properties of rose water

Labor pain is one of the most intense pains experienced by women. Aromatherapy is one of the methods to reduce this pain. In one clinical trial study, the effects of aromatherapy with rose water on primiparous women was performed, in comparison with placebo (distilled water) and control (routine care) groups (n = 111). Pain intensity was measured with a visual pain scale (VAS) 30 minutes after each intervention. There was no significant difference in the intensity of labor pain between the three groups before the interventions. The intensity of pain was significantly less in rose water group than that of two groups ($P < 0.001$) [33].

The other clinical trial on 80 primiparous women with labor pain was performed. The women were randomly divided into two groups of intervention (n = 40) and control groups (n = 40). The patients in the intervention group received the smell of rose water during the active phase of labor, while the patients in control group received routine care. The pain severity (VAS score) in two groups was measured before the treatment and after intervention in dilation of 4-6 cm, 6-8 cm and 8-10 cm. There was no significant difference between the two groups in pain severity before the treatments ($P = 0.223$). After intervention, there was a significant difference between two groups with dilation of 8-10 cm ($P = 0.023$) [34].

9.2. Rose water and treatment of eye diseases

Eye diseases always afflict the human population. Antibiotics and steroids are commonly used to treat these issues, but long-term usage of these medications might have negative side effects. *R* × *damascena* is one of the plants that have been used in traditional prescriptions and formulations for the treatment of eye problems in conjunction with other plants. In Ayurveda and Greek medicine, two preparations containing rose water are used to cure eye disorders.

Berberis aristata (14 %), *Cassia absus* (2 %), *Coptis teeta* (2.4 %), *Symplocos racemosa* (2.4 %), *Azadirachta indica* (2.8 %), alum (0.4 %), rose water (0.4 %), and phenyl ethyl alcohol (0.5 %) make up the Greek medicine ophthalmic solution. This formulation has antibacterial properties against *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus mutans*, and *Klebsiella* sp., as well as antihistamine properties in guinea pig ileum. Its anti-inflammatory impact on the inflammation generated by turpentine ointment in rabbit eyes reveals that this formulation has a good anti-inflammatory effect in Greek medicine. In patients with conjunctivitis with allergic conjunctivitis, conjunctivitis with purulent conjunctivitis, and viral conjunctivitis, this formulation was quite effective. This formulation is anti-inflammatory, antibacterial, and anti-allergy, making it a safe and effective treatment for conjunctivitis [35].

45 days oral administration of rose water (151.5 mg/100 ml and 50.0 mg/100 ml total volatiles expressed as citronellol) was evaluated on clinical biochemistry, lens enzymatic activity, hematology, and lens pathology in streptozotocin (STZ)-induced diabetic rats. Oral administration of rose water (151.5 mg/100 ml) significantly improved hematologic, hepatic, and renal functions. Rose water significantly reduced the serum glucose, and glycated haemoglobin (HbA1c) levels and showed anti-hyperglycemia and reduced the advanced glycation end-product (AGE) formation in a dose-dependent manner. Rose water significantly increased the glutathione peroxidase and decreased the aldose reductase activity in lens and prevented

cataractogenesis without any toxic effect on hematology, renal, and hepatic functions [36].

9.3. Treatment of oral disorders with rose water

Candida albicans-induced denture stomatitis is a common issue in the mouths of people who have dentures and those who do not practice good oral hygiene. There are three levels of these lesions: simple localized inflammation or point hyperemia (grade 1), more diffuse erythema involving most of the mucus (grade 2), and inflammatory hyperplasia and granularity (grade 3). This lesion shows up as a diffuse inflammation in the maxillary areas of the sub denture. Soft liners in dentures produce a permeable environment that allows *Candida* and yeasts to develop and connect mechanically.

Two tablespoons of grape vinegar and five tablespoons of rose water are used as mouthwash in traditional Iranian medicine for the treatment of oral ulcers (three times a day), and this process causes the elimination of corrupt and infectious components as well as the drying of the infection. The traditional mouthwash of rose water and vinegar in the treatment of *Candida* denture stomatitis improved the condition when compared to nystatin three times a day as gargle. *Candida albicans* and other *Candida* sp. accounted for 83.33 % of the colonies produced. Nystatin treatment caused taste, foul odor, nausea, and vomiting, but patients treated with traditional vinegar and rose water mouthwash all said that after using this product, they had a pleasant mouth and were eager and satisfied to continue the treatment. The clinical profile of the lesion was totally improved in the traditional medicine group; however, despite the cessation of bleeding, the clinical profile of the lesion was not modified in the nystatin group. Although both mouthwashes are effective in the treatment of denture stomatitis candidiasis, nystatin had a larger reduction in the average count of *Candida* sp. colonies while having several adverse effects and leaving patients less satisfied [37].

Rose water is one ingredient of Griffith's mixture (Mistura Ferri Composita) and is used as a flavoring agent in the preparation of the BP Rose basis for lozenges [38].

9.4. Rose water and skin

A concentrated rose extract including the rose water and rose essential oil (free of methyl eugenol) with main ingredients of phenyl ethyl alcohol (56.7 %), citronellol (16.7 %), geraniol (8.90 %), nerol (4.6 %), and nonadecane (3.8 %) at concentration of 5×10^{-3} % activates the skin human olfactory receptors (OR10A6, OR2AG2, and OR11H4), which phenyl ethyl alcohol and phenyl propyl alcohol play a critical role in activation of these receptors. Phenyl ethyl alcohol is an agonist of all three skin ORs, with a micromolar range of activity. So, the effects of rose extract could mediate by OR10A6, OR11H4, and OR2AG2 expressed in skin cells from the environment, beyond the nose, which may help to transduce the physiological effect of rose extract and its components. Rose extract increases the expression of cAMP levels in keratinocytes in a dose-dependent manner. Stress significantly reduced the expression of skin OR10A6 and OR2AG2, at the mRNA and protein levels. Rose extract had preventive effects on downregulation of skin OR at the mRNA levels during epinephrine-induced stress. The odor is detected by skin or brain ORs, which play for their physiological functions in response to stress. The use of cream containing this rose extract for 28 days significantly reduced the dark circles under eye area of women under stressful lifestyle. Rose extract protects the skin against stress mediators by skin olfactory receptors [39].

A cream containing rose water exhibited the antioxidant and anti-inflammatory activity in ferric reducing power assay, age inhibition (%) of protein denaturation assay in a dose dependent manner. Polyphenolic, flavonoids, tannins, triterpenoids, saponins are found the main responsible ingredients for the antioxidant and anti-inflammatory properties of rose water [40].

The use of rose water hand rub on skin flora of 23 volunteers was compared with alcohol-based hand-rub (n=22), the result of this clinical study showed rose water has no effect on microbial count of hand in comparison with alcohol-based hand-rub [41].

Rose water has a moisturizing and glowing effect on the skin of healthy volunteers [42]. The *in vitro* SPF of rose water was 0.8 and Reducing Power Ability of rose water showed antioxidant effects [43].

The antioxidant activity of rose water helps to reduce the skin redness and improve the skin. Rose water is useful for all skin types and hair. Rose water NF is prepared by 2 ml rose oil- 2 ml ethanol (90 %) and purified water q.s.- 100 ml and is used as flavoring agent, mild carminative, diaphoretic, and is used in lotions for skin ailments [38]. Formulated rose water in cosmetics is non-sensitizing and safe according to authorization of Cosmetic Ingredient Safety assessment. Maximum concentration of use (%) for rose water in cosmetics is 0.009-32.7 [44]. Rose water did have high cytotoxic and genotoxic effects in three types of experimental test systems including the higher plant in vivo, human lymphocytes in vitro and ICR mice in vivo [17]. Rose Water is used in bath soaps and detergents up to 0.09 %. The acute LD_{50} of rose water in Swiss albino mice was higher than 6000 mg/kg [45].

10. Rose Water for human consumption

Rose water is mainly used for flavoring food, tonic beverage, ice creams, yogurt, cake, rice pudding, jam, marmalade, cake, and syrups [46]. Iranian people use the rose water as drink and have many recipes with rose water.

According to GSO standard [26], there is an standard for edible rose water for human consumption [32]. Following the regulation for organic products within the European Union, it is only allowed as an organic certified product (food/beverage), if it does not contain any preservatives or additives. Only in case these additives are mentioned within the regulation and its amendments.

Regarding conventional rose water (food), there must be a regulation on preservatives and additives that are permitted in Germany and the EU. Furthermore, the content of the methyl eugenol should not exceed a certain level. This is not only valid for cosmetic products but also for food. According to annex III EU regulation n°1334/2008 (Regulation (EC) No. 1334/2008 of the European Parliament and of the Council on flavorings and certain food ingredients with flavoring properties for use in and on foods) the limited content of this substance is 1 mg/kg for "beverages without alcohol".

Conclusion

Rose water is the byproduct of the rose oil industry, and the content of rose oil in each 100 g of rose water depends on the ratio of fresh rose flower to extracted rose water. If you extracted 3 kg of rose water from 1 Kg fresh rose flower, you will have weaker rose water than 1 kg rose water from 1 kg fresh rose water. For quality control of rose water, the physical properties of rose water should be evaluated, the pH of rose water can be between 3.8-7.5 in different international standards., but it is better to be lower than 5.5

according to Iranian Standard. The presence of natural methanol and ethanol in rose water can confirm its naturality. Solvent extraction is usually used for extraction of rose oil from the rose water. Different countries have different minimum standards for rose oil content of rose water and can be changed from 0.012 % to 0.025 %.

The main ingredient of rose water is water soluble phenyl ethyl alcohol, which can be a criterion for identifying the original rose water. The solvent extraction by non-polar solvent is not suitable for whole extraction of phenyl ethyl alcohol and depends on the solvent. Pentane helps to extract around 25-30 % of phenyl ethyl alcohol (author experience). The presence of phenyl ethyl alcohol, citronellol, geraniol, nerol, methyl eugenol confirms the naturality of rose water.

Storage of rose water improves its smell because of changes in some ingredients. The rose water is susceptible to microbial contamination; if the production is performed under good manufacturing process, it can be stocked for one year. Different physical methods of pasteurization, ultrafiltration and UV treatment can be used for control of microbial contamination. Physical treatments have no effects on the chemical profile of rose water. The use of preservatives is allowed in some countries for edible or cosmetic rose water. The preservatives can be used if contamination with bacterial spores or fungi occurs. The ultrafiltration and pasteurization are used in Iranian rose water industrial factories.

Rose water has some biological activities and can be used for decreasing the pain, reduction of inflammation and treatment of eye diseases. There is mouth wash from rose water and vinegar to use as mouthwash. Rose water can be used as the main ingredient of skin care products.

Rose water is used as flavoring agent in food industries of Iran and many Arabian countries and is used as drink or use in mourning ceremonies, but the use of rose water in Europe has different story, but it is allowed to use under some strict regulations.

Author contributions

MM is the author of this manuscript, who prepared, read and submitted the manuscript. LSH helps to finalize the manuscript. The author read and approved the final manuscript.

Conflicts of interest

The authors declare that they have no competing interests.

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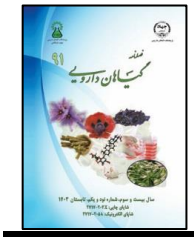

مقاله مروری

گلاب، کنترل کیفیت و کاربردهای آن

محدثه محبوبی[1،*]، شائو هو لو[2]

[1] تحقیق و توسعه، شرکت داروسازی طبیب دارو، کاشان، ایران

[2] دپارتمان تجاری، شرکت علوم رایحه فلوزالکین پکن، پکن، چین

اطلاعات مقاله

گل واژگان:

گلاب

فنیل اتیل الکل

کنترل کیفیت

طب سنتی

تقطیر

چکیده

مقدمه: گلاب از تقطیر گل‌های تازه گل محمدی با نام علمی رزا داماسنا تولید می‌شود. **هدف:** این مطالعه مروری بر روی گلاب، کنترل کیفیت و کاربردهای آن تمرکز دارد. **روش بررسی:** اطلاعات با جستجوی در منابع مختلف جمع‌آوری شد. **نتایج:** ایران خصوصاً شهر کاشان (روستای قمصر) سابقه طولانی در صنعت گلابگیری دارد، در واقع قمصر در ایران خاستگاه اصلی گل محمدی در جهان است و گلاب‌گیری از صنایع قدیمی شهرستان کاشان است. اکنون چهار استان فارس (میمند)، کرمان، اصفهان (کاشان) و آذربایجان شرقی بیشترین زمین های زیر کشت گل محمدی در ایران را دارند. ترکیه و بلغارستان دیگر تولیدکنندگان گلاب در جهان هستند. گلاب عمدتاً در صنایع آرایشی و بهداشتی استفاده می‌شود اما به عنوان یک نوشیدنی و طعم‌دهنده در ایران و کشورهای حوزه خلیج فارس دارای سابقه طولانی است. **نتیجه‌گیری:** این مقاله مروری گلاب را از دیدگاه‌های مختلف سنتی، کنترل کیفی و اثرات درمانی بررسی می‌کند و اطلاعاتی در مورد تقلب و شناسایی گلاب اصلی ارائه می‌دهد.

مخففها: INSO، سازمان ملی استاندارد ایران؛ FDA، سازمان غذا و دارو؛ STZ، استرپتوزوسین؛ AGE، محصولات گلیکاسیون پیشرفته؛ HbA1C، هموگلوبین گلیکوزیله‌شده

* نویسنده مسؤول: m_Mahboubi@tabibdaru.com ،Mahboubi1357@yahoo.com

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