

The Effects of Ultrafiltration and Ultraviolet Radiation on Microbial Content and Chemical Composition of Rose Water

Abstract

Rose water is the known product of distillation process of *Rosa damascena* Mill. It is considered as relaxing and calming agent in religious ceremony as well as favorable food and beverage additive. Rose water contamination can limit its quality and applications. In this study, the combination of ultrafiltration and ultraviolet treatment (F-U treatment) was used to reduce rosewater contamination in traditional and industrial rosewater products. The compositions of essential oils of samples were also analyzed by gas chromatography–mass spectrometry (GC/MS) before and after treatment. The results demonstrate that F-U treatment was able to reduce microbial load in all samples without any significant effects on essential oil constituent. GC/MS analysis shows that phenethyl alcohol and citronellol are the main compounds identified in samples before and after treatment. Consequently, application of ultrafiltration and ultraviolet (UV) radiation not only can diminish microbial contamination but also do not decompose the chemical compounds of samples. On the basis of these results, the combination of ultrafiltration and UV radiation beside other physical methods may be valuable alternative technique to obtain high-quality rose water with preserving its constituents, which may be lost during traditional thermal methods.

Keywords: Gas chromatography–mass spectrometry, rose water, ultrafiltration, ultraviolet radiation

Introduction

Rosa damascena is known as “Gol-e-Mohammadi” in Persian.^[1] Iranian traditional medicine recommended decoction of the flowers for treatment of chest and abdominal pains, menstrual bleeding, and constipation.^[2,3] Rosewater is also known as analgesic, anti-inflammatory, hypnotic, and antitussive agent.^[4] Flowers serve to produce different commercial products including rose essential oil, rose water (hydrosol), dried rose hips, concrete and rose absolute.^[5] Rose hydrosol is made by hydrodistillation of flowers.^[6] Hydrosol is traditionally famous as “Golab” with typical flavor and scent that mostly related to the religious ceremonies.^[4] Microbial contamination is one of the serious problems of the product that may occur during storage in nonsterile containers, keeping in inappropriate temperature and sometimes use of nonsterile water for dilution before packing. Inadequate storage conditions lead to metabolize aromatic and other compounds by microorganisms. Spoiled hydrosol not only reduces its

chemical quality but also reduces major amount of rose water.^[7] Ultrafiltration is a selective separation process to remove high molecular weight molecules.^[8] Ultraviolet (UV) light is a germicidal agent that affects on surfaces or liquids such as water with variety of applications in the food industry.^[9]

The purpose of this study was elimination of microbial contamination of rose water by ultrafiltration and UV treatment. The effects of these agents on essential oil composition of rose water were also determined by gas chromatography–mass spectrometry (GC/MS).

Materials and Methods

Different brands of hydrosol were collected from local market in Fars province, Iran. Eight samples were produced by water distillation method in traditional pot (T) and two samples were produced by modern (industrial) industries (I).

Volatile constituents from hydrosol were subsequently extracted by liquid–liquid extraction using petroleum ether at ambient temperature, and the residuals were analyzed by GC/MS.

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Access this article online

Website:
www.jrpsjournal.com

DOI: 10.4103/jrtps.jrtps_31_18

Quick Response Code:



How to cite this article: Sabahi Z, Zebarjad Z, Moein M. The effects of ultrafiltration and ultraviolet radiation on microbial content and chemical composition of rose water. J Rep Pharma Sci 2019;8:102-5.

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Essential oil analysis by gas chromatography–mass spectrometry

The GC/MS was performed by a gas chromatograph equipped with mass detector. The analysis was carried out under the condition which was described in previous study.^[4] Determination of samples constituents was based on the comparison of its relative retention time and mass spectra with Wiley 275 and Adams data libraries as well as to those of the related literatures.^[4]

Ultrafiltration–ultraviolet treatment

Two liters of hydrosol were poured into feed tank then passed through the first filter using a peristaltic pump to remove large particles. Subsequently, the hydrosol was moved into the second filter (UF filter) to clarify spoilage microorganisms of rose water. Afterward, rose water was forced to pass through a UV source (254 nm) and 110 ml/min flow rate. This system was washed by deionized water completely after each sample.

Microbial analysis

To define the microbial changes in hydrosol treated with preservative procedures, pour plate method was applied to count the number of colony-forming bacteria present in the liquid sample. Each sample was enumerated by this method before and after ultrafiltration and ultraviolet (F-U) treatment.

Results

The components of the rose water before ultrafiltration and ultraviolet treatment

According to the results presented in Table 1, the most samples were rich in phenethyl alcohol, citronellol, and eugenol, respectively. Before treatment, phenethyl alcohol was more than 60% in eight samples and other important compounds were geraniol and methyl eugenol. There was no significant difference between constituents of traditional and industrial samples.

After treatment, although phenethyl alcohol, citronellol, and geraniol remain the main components of all samples, phenethyl alcohol was reduced in seven samples after pass the F-U treatment. There was no general trend in reduction or rise in identified components percentages in traditional and industrial samples before and after F-U treatment. It seems that F-U treatment unable to change rose water constituent, significantly.

The effect ultrafiltration and ultraviolet treatment on the number of microbial counts

The results in Table 2 showed that T_4 and I_2 are the most contaminant samples before F-U treatment. There was a high rate of diminution in the microbial number in eight samples after F-U treatment. Proper results of F-U treatment show the possible efficiency of UF filtration and UV treatment to reduce number of microorganisms.

Discussion

The main components of samples in this research were similar to the results of previous studies which were done in Iran and Turkey.^[7] In addition, the citronellol, geraniol, and phenethyl alcohol were reported as the main components of rose water in a previous study.^[10] The content of phenethyl alcohol in rose water extracts can be different according to type of solvent.^[6]

In one study, the percentage of phenethyl alcohol was reported about 80% while using dichlorometan for extraction of volatile content of rose water.^[6] Although we used petroleum ether for extraction of phenethyl alcohol in a range of hydrosol which have studied, it seems that this content depends on chemotype and times of petal collection in spring.

Phenethyl alcohol was known as the main constituent of rose hydrosol and possesses pleasure flavors and fragrances.^[5,11] So it reveals the important role of rose water in perfumery industries.^[4] According to Table 1, the percentage range of methyl eugenol were 2.28-3.44% and 0.49- 6.17% in industrial and in traditional samples respectively.

R. damascena Mill.^[12] and Methyl eugenol was 0.11% in fresh rose concrete.^[13] and it was 1.7% in historical rose oil sample which samples were more than 50 years old.^[13] The deferred harvest and protracted distillation procedure is cause of increase eugenol in rose oils.^[14] Beside its broad applications in food and cosmetic industries, genotoxicity and carcinogenicity effects of this compound confirmed in different studies.^[15]

Generally, there is difference between regular hydrodistilled rose oil components and constituent of rosewater oil extracted by petroleum ether in this study. Long-chain hydrocarbons were the most determined compound in regular rose oil whereas rosewater oil contains slight quantities of these hydrocarbons. It seems that through water distillation these types of compounds relocated to the rose oil.^[7,16,17]

Generally, it seems that the main chemical composition of rose water oil protect through F-U treatment.

Membrane technology is standard approved technology in the beverage industry.^[18] Furthermore, ultrafiltration has wide applications in fruit and vegetable juices to remove fibrous pulp and spoilage microorganisms with several advantages comprise: preserve the nutrition value, safety, user and environmental friendly.^[8] UV light provides effective inactivation of different microorganisms by damaging DNA. This light is only effective on surfaces or clear liquids.^[9] Previous study showed that UV radiation reduces microbial load of fruit juice and nectar comprising bacteria, viruses, yeast, and molds.^[19]

Fortunately, UV application in this study does not change phytochemical content of hydrosol significantly. In other study, counter to the thermal treatment, UV processing does not have any effect on pectin methylesterase activity

Table 1: Essential oil composition of rose oil before and after ultrafiltration and ultraviolet treatment

Compounds	Samples																						
	T _{1b}	T _{1a}	T _{2b}	T _{2a}	T _{3b}	T _{3a}	T _{4b}	T _{4a}	T _{5b}	T _{5a}	T _{6b}	T _{6a}	T _{7b}	T _{7a}	T _{8b}	T _{8a}	I _{1b}	I _{1a}	I _{2b}	I _{2a}	KI ^C	KI ^R	
n-Octane	-	-	-	-	-	-	-	-	-	-	-	-	-	1.55	-	-	-	-	-	-	-	800	800
6-Methyl-5-hepten-2-one	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.53	-	-	-	-	-	-	985	985
1,8-Cineole	-	-	-	-	-	-	-	-	-	-	-	-	-	0.73	-	-	-	-	-	-	-	1033	1031
Linalool	1.14	1.69	-	-	-	0.99	1.90	1.36	-	-	2.73	2.31	2.87	2.53	7.95	1.53	-	-	1.49	2.05	-	1100	1096
Phenethyl alcohol	75.20	69.88	76.95	33.96	69.05	45.51	49.06	61.60	75.64	81.55	76.08	71.10	64.31	59.46	19.80	24.49	66.22	63.32	75.05	72.76	1115	1107	
1-Terpineol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.49	-	-	-	-	-	-	1135	1133
Isomenthone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.56	-	-	-	-	-	-	1166	1162
Borneol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.39	-	-	-	-	-	-	1168	1169
α-Terpineol	0.92	0.87	-	-	-	2.94	0.84	0.66	-	-	1.94	-	4.03	4.38	8.27	4.23	-	-	1.44	1.43	-	1192	1188
γ-Terpineol	-	-	-	-	-	-	-	-	-	-	-	1.76	-	-	1.41	0.72	-	-	-	-	-	1199	1199
Citronellol	12.86	16.42	12.69	37.23	13.96	20.27	17.75	15.29	13.03	10.49	14.37	17.11	12.70	15.18	28.42	23.57	18.71	21.33	13.20	14.08	1228	1225	
Pulegone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.43	-	-	-	-	-	1242	1237
Neral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.98	-	-	-	-	-	-	1242	1238
Carvone	-	-	-	-	-	-	0.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1246	1243
Piperitone	-	-	-	-	1.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1257	1252
Geraniol	-	2.66	2.50	5.72	4.19	25.87	18.25	14.41	1.62	0.89	3.44	4.27	2.16	2.51	21.73	42.91	6.48	7.57	-	2.67	-	1258	1252
Geranial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.38	-	-	-	-	-	-	1271	1267
E-Anethole	-	-	-	-	-	-	-	-	0.81	-	-	-	-	-	-	-	-	-	-	-	-	1287	1284
Thymol	-	-	-	4.46	0.74	0.52	1.93	1.35	0.80	1.65	1.44	-	-	-	0.36	0.46	-	-	-	-	-	1291	1290
Carvacrol	-	-	-	-	-	-	-	-	-	1.28	-	0.90	-	-	-	-	-	-	-	-	-	1291	1299
Piperitenone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.34	0.48	-	-	-	-	-	1344	1343
Eugenol	5.64	4.48	5.10	8.48	5.05	1.77	4.65	3.45	4.35	2.51	-	2.55	8.37	7.16	7.39	1.18	6.18	5.44	4.55	4.73	1359	1359	
Methyl eugenol	2.58	1.81	2.76	6.17	2.21	0.49	0.69	0.65	3.75	1.63	-	-	4.65	4.27	-	-	2.41	2.34	3.44	2.28	1405	1403	
Dillapiole	-	-	-	-	-	-	2.37	1.23	-	-	-	-	-	-	-	-	-	-	-	-	-	1628	1620
Unknown	1.66	2.19	-	3.98	3.37	1.64	2.04	-	-	-	-	-	0.91	2.23	-	-	-	-	0.83	-	-	-	-
Total identified	98.34	97.81	100	96.02	96.63	98.36	97.96	100	100	100	100	100	99.09	97.77	100	100	100	100	100	99.17	100	-	-
Monoterpenes	90.12	91.52	92.14	81.37	89.37	96.10	92.62	95.90	91.09	95.86	100	97.45	86.07	84.79	92.08	98.82	91.41	92.22	91.18	92.99	-	-	-
Phenylpropanoids	8.22	6.29	7.86	14.65	7.26	2.26	5.34	4.10	8.91	4.14	-	2.55	13.02	11.43	7.39	1.18	8.59	7.78	7.99	7.01	-	-	-
Other compounds	-	-	-	-	-	-	-	-	-	-	-	-	-	1.55	0.53	-	-	-	-	-	-	-	-

T: Traditional sample, I: Industrial sample, b: Before treatment, a: After treatment

Table 2: The results of with pour plate counts microbial test before and after ultrafiltration and ultraviolet treatment

Sample	Average of CFU/100 ml	
	Before F-U treatment	After F-U treatment
T ₁	4.5×10	1.4×10
T ₂	6.7×10 ²	3.6×10
T ₃	2.6×10 ²	3.2×10
T ₄	9.5×10	1.6×10
T ₅	9.1×10 ²	2.7×10
T ₆	2.2×10 ²	2.1×10
T ₇	5.6×10 ²	1.6×10
T ₈	1.7×10 ²	2.1×10
I ₁	9.5×10	6.4×10
I ₂	6.4×10 ²	6.1×10

T: Traditional sample, I: Industrial sample, F-U treatment: Ultrafiltration and ultraviolet treatment, CFU: Colony-forming units

as well as the color and pH of the orange juice.^[20] Also, the UV radiation is defined as alternative process to reduce contamination of wine-related microorganisms such as *Brettanomyces*, *Saccharomyces*, *Acetobacter*, *Lactobacillus*, *Pediococcus*, and *Oenococcus* in grape juice and wine.^[21]

Conclusion

Our result indicates that F-U treatment not only reduces microbial load significantly but also has no noteworthy effect on chemical constituents. In the next step, it is necessary to realize the type of microbes was affected by these methods. Furthermore, adding accepted chemical preservative compounds after hydrosol production and during storage may be another possible way to preserve the quality of hydrosol as healthy beverage and food additive.

Acknowledgments

This study was financially supported by Shiraz University of Medical Sciences, Shiraz, Iran (Grant number: 94-01-70-11179).

Financial support and sponsorship

The study was supported by a grant from the Research Deputy of Shiraz University of Medical Sciences.

Conflicts of interest

There are no conflicts of interest.

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