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Damask rose (*Rosa damascena* Mill.) essential oil is affected by short-and long-term handling

Maryam Mirzaei[a], Fatemeh Sefidkon[b], Noorollah Ahmadi[a,*], Abdolali Shojaeiyan[a], Hossein Hosseini[c]

[a] *Department of Horticultural Sciences, Tarbiat Modares University, Tehran, Iran*
[b] *Research Institute of Forests and Rangelands, Tehran, Iran*
[c] *R & D Department, Barij Essence pharmaceutical Co., Kashan, Iran*

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ABSTRACT

Damask rose cultivated for essential oil production mainly used in perfume industry. Due to the highly perishable flowers, post-harvest handling of the flowers prior to oil extraction would be considered as a key point in rose essential oil production. Evaluating the effects of various storage conditions on the yield and quality of the Damask rose essential oil (EO), the petals were stored under three conditions included packaging in LDPE and poly-film PET/EVOH/LDPE bags and immersing inside the water containers at room temperature (RT) or refrigerator (4 °C) for 1–3 days (short-term storage). Throughout the prolonged handling (for 7, 14 and 21 days), packed petals using the PET/EVOH/LDPE bags were evaluated under frozen, active and passive MAP as well as RT conditions. Essential oils produced by hydrodistillation were analyzed by GC and GC/MS. Petal storage using the poly-film bags at RT for 1 day and also water handling at 4 °C for 2–3 days exhibited the higher EO content and quality, with the yields of approximately the same, 19% and 23% (v/w) higher oil, respectively, relative to those from unstored petals. Moreover, frozen-stored petals qualified for the higher content and better characteristics of the oil for all the durations of the prolonged storage. The results provide a reference material for interested groups such as producers, consumers who are concerned about rose oil production.

1. Introduction

The Damask rose (*Rosa damascena* Mill.), commonly known as oil rose, is the most important *Rosa* species cultivated for production of rose oil and rose water (Widrlechner, 1981). As one of the most expensive base materials in flavor and fragrance industry, rose oil is characterized by high percentage of the monoterpene alcohols including citronellol, nerol, geraniol, linalool, and phenyl ethyl alcohol. These components contribute mainly to the perfumery values of rose oil (Baydar and Baydar, 2005). However, some minor components such as damascenon and rose oxides are considered for adding value of more than 90% to the total aroma impression in the essential oil of *R. damascena* (Baldermann et al., 2009). According to international standard of rose oil (ISO 9842, 2003); rose oil requires citronellol 20–34%, geraniol 15–22% and nonadecane 8–15% of the oil as the major compounds (Anonymous, 2003). Moreover, the ratio of citronellol/geraniol (C/G) is considered as a typical characteristic of rose oil, which in the range of 1.25–1.30 is preferred by perfumery industry (Baser, 1992). Harvested Damask rose flowers are highly perishable and should be processed within a short time from harvest. Huge amounts of the flowers pile up, usually inside plastic sacks, in factories during the short harvesting period and it takes almost a long time for them to be processed. Increasing temperature inside the sacks caused by high respiration rate of the petals resulted in decreasing the quantity and quality of the essential oil (Baydar and Baydar, 2005). While cold storage of the Damask rose flowers using different packaging materials could remarkably reduce the steep decline in the oil content (Kazaz et al., 2010). Modified atmosphere (MA) technology along with proper temperature and relative humidity management, has been widely used for extending the postharvest life and maintaining quality of fresh products, in which manipulation of CO_2 and O_2 inside the packages atmosphere leads to decrease in respiration rate in many fresh products (Burton, 1978; Artés et al., 2002; Farber et al., 2003; Singh et al., 2009). Post-harvest handling of the Damask rose as an important factor affecting on the yield and quality of the highly valuable rose oil has been regarded by many studies (Kazaz et al., 2010; Baydar and Baydar, 2005; Baydar et al., 2008 a, b; Mohamadi et al.,

* Corresponding author.
E-mail address: ahmadin@modares.ac.ir (N. Ahmadi).

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2011). However, to the best of our knowledge, there is no published report on storage of Damask rose using poly-film bags and active modified atmosphere packaging (MAP). Therefore, the objectives of this study were to determine the EO content and chemical components of Damask rose petals under these storage conditions along with other handling methods such as passive MAP, cold and frozen storage, water handling, and storage under ambient temperature throughout short - and long- term storage.

2. Experimental

2.1. Plant material

Fresh Damask rose petals were handpicked from a commercial Rosarium located in Mashhad-e-Ardehal, Kashan province, Iran, at the early hours of day during the main period of flowering in May 2013. The EOs obtained from unstored petals (0 day storage duration), which were hydro distilled instantly after harvest, were considered as the reference materials to elucidate the influence of subsequent handling conditions on the oil yield and components.

2.2. Storage conditions

Damask rose petals of 250 g (for each experimental replication) were evaluated for their EO content and components under different handling conditions as described below.

2.2.1. Short-term storage

The petals stored under three handling conditions, including packaging in two different types of plastic bags and immersing in water (W) inside an plastic containers of size $35 \times 25 \times 20$ cm, at two temperature conditions of room temperature (RT, 25 °C ± 2, 45 ± 5% RH) and refrigerator (Ref, 4 ± 1 °C, 90 ± 5% RH) for 1–3 days. The plastic bags, of size 35×25 cm, (characterized in Table 1) were applied for short-term storage of petals: the low-density polyethylene (LDPE) of 60 μm thickness, and PET/EVOH-LDPE poly-film bags, named as PET in the following, comprised of polyethylene-terephthalate (PET) 24 μm –LDPE 70 μm with Ethylene vinyl alcohol (EVOH) as a sealant layer, (Chap Iran Zamin Co. Ltd., Iran). Bags containing petals were sealed and stored at RT or Ref.

2.2.2. Prolonged storage

The petals were placed in PET/EVOH/LDPE bags (Table 1) and stored under 3 conditions including modified atmosphere packaging (MAP), room temperature (RT, 25 °C ± 2, 45 ± 5% RH) and freezer (Frz; −20 °C) for 7, 14 and 21 days. Modified atmosphere was provided by packaging machine (Henkelman 200A, Netherlands) using 3 gas compositions, which were designed according to the optimal storage conditions for some perishable products that previously described by Mattos et al. (2012), viz., MAP_0 (passive MAP) using the normal air (O_2 21%, Co_2 0.03%, N_2 78%) and active MAP which consisted of MAP_1 (O_2 5%, Co_2 3%, N_2 92%) and MAP_2 (O_2 3%, Co_2 5%, N_2 92%). Sealing the packages, MAP samples were stored at refrigerator (4 ± 1 °C, 90 ± 5% RH). After the considered durations of time, frozen stored packages kept in 4 °C for 2 h prior to the oil extraction.

2.3. Essential oil extraction

The extraction of essential oil was performed by hydrodistillation of 250 g fresh rose petals with 750 ml of distilled water using a 4 L Clevenger type apparatus. The distillation time was 1.5 h and quantity of the obtained oils was calculated as percentage (v/w). In case of water handling method, the water applied for storage was also used for distillation. The extracted oils were dried over anhydrous sodium sulphate and stored in sealed vials at 4 °C until analysis.

2.4. Essential oil analysis

2.4.1. Gas chromatography (GC)

The EOs were analyzed on a Thermo-UFM (Ultra-fast model, Italy) gas chromatograph equipped with a Ph-5 (non polar) capillary column (10 m × 0.1 mm). The inner surface was covered with stationary phase Dimethyl Seloxane Phenyl 5% with 0.4 μm film thickness. The oven temperature was held at 60 °C for 3 min, programmed to 285 °C at the rate of 80 °C/min, detector (FID) and injection chamber temperatures were 280 °C. Helium was used as the carrier gas with a flow rate of 0.5 ml/min. Split injection was conducted with a ratio split of 1:100. The samples of 0.2 μl were injected directly. The percentages of compounds were computed by the area normalization method, without considering FID response factors.

2.4.2. Gas chromatography-mass spectrometry (GC/MS)

The GC/MS analysis was performed using a Varian 3400 gas chromatograph connected to a mass spectrometer model Saturn II, the ion trap system, ionization energy of 70 eV with a semi-polar DB-5 fused silica capillary column (30 m ×0.25 mm and film thickness 0.25 mm; gas pressure 35 pounds per square inch, column temperature 60–250 °C at a rate of 3 °C/min, the injection chamber temperature and the transfer line were set at 260 °C and 270 °C, respectively. The carrier gas was helium with a linear velocity of 31.5 cm/s, split ratio 1:60, scan time 1 s, mass range 40–300 a.m.u. Spectra identification was performed using their retention indices and by injection of n-alkanes (C7–C25) under the same conditions and confirmed with the Wiley 275-L library and literature (Adams, 1989; Shibamoto, 1987; McLafferty and Stauffer, 1989).

2.5. Data analysis

The short-term handling experiment was carried out as a factorial design based on randomized complete block design (RCBD) and the prolonged handling followed a combined analysis based on RCBD. Analysis of data from the EO contents was done using the general linier model (GLM) of SAS 9.2. Mean values were compared at the 5% ($p \leq 0.05$) and 1% ($p \leq 0.01$) levels of significance using LSD test. There were three replications for every combination of the variances in the both experiments.

3. Results and discussion

As the results revealed, generally the investigated post-harvest handling conditions had a significant effect on the essential oils contents and characteristics as discussed further below.

3.1. Short-term storage

3.1.1. Essential oil content

Essential oil contents obtained from rose petals stored in different handling conditions for 1–3 days are represented in Fig 1. Statistical analysis demonstrated that EO yields were significantly affected by storage conditions (water handling (W), LDPE and PET) and storage duration at 1% and 5% levels of significance, respectively. The only cases of increase in the oil yield throughout the storage periods occurred in petals immersed in water either at Ref or RT for all the storage durations. In this respect, storage of petals in Ref-W recorded a significant increase of 16%, 19% and 23% in EO content after 1–3 days handling, respectively, over the unstored petals as the control group which represented the average value of 0.069% (v/w). However, the storage temperature effect was not