Research Article
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Effect of modified atmosphere packaging (MAP) on the moisture and sensory property of saffron

Abstract

In this research, the effect of different Modified Atmosphere Packaging (MAP) and storage temperature was investigated on the moisture and sensorial properties of saffron under different conditions. Saffron samples were packed by using different combinations of CO2 and N2 including: MAP1 (100% N2), MAP2 (40% N2+60% CO2) and MAP3 (60% N2+40% CO2) and were stored at three different temperatures (4°C 25°C and 35°C) for 12weeks. Moisture and sensorial properties of samples were evaluated every three weeks. The results revealed that the moisture of saffron samples were preserved more favourably with MAP1 than with MAP2 and MAP3. Regarding temperature, 4°C was the most efficient. Results of sensory evaluation indicated that MAP1 had a significant positive effect on the external appearance of saffron samples.

Keywords: modified atmosphere packaging (MAP), moisture, saffron, sensory evaluation, temperature

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Abbreviations: MAP, modified atmosphere packaging

Introduction

Saffron is the most precious natural spice in the world derived from *Crocus sativus* L. flowers. It has unique sensory properties including colour, flavour, and odour. Modified Atmosphere Packaging (MAP) is one of advanced technologies for controlling product deterioration by providing an appropriate protective atmosphere around the product.[1] The aim of MAP is to exhaust the air inside the packaging and create vacuum, or replace the air with a mixture of gases which can control the chemical, enzymatic and microbial activities of the food. MAP is one of the most important food preservation methods that maintains the natural quality and extends the storage life of fruits and vegetables.[2,3] Packaging of fenugreek in two perforation packets with mustard seeds resulted in the best maintenance of chlorophyll, ascorbic acid, phenols and aroma.[4] It has also proved to be one of the most significant and innovative growth areas in retail and food packaging of the past two decades.[5] The accumulation of CO_2 and O_2 in a beneficial level by the application of MAP is known to extend the post-harvest life of many horticultural products.[6,7] MAP can be achieved by use of polymeric films where gas transmission across the film and the levels of CO_2, and O_2 within the package can be controlled.[8] Storage temperature influences the rate of many deteriorative processes and transcription because the temperature is one of the most important factors in the maintenance of product quality.[9] The aim of this research was to evaluate the effect of MAP, storage temperature and time on the moisture and sensory properties of first-season saffron.

Materials and methods

Materials

The Negin Pushal saffron (common name in Iran) or Mancha (common name in international markets) was obtained from a Local supplier in Torbat Heydarieh (a city in khorasan Razavi province) during saffron season. The film used as package was a flexible 3layers-layered plastic bag (PE/PA/PE), 70µm thick. The MAP machine (HENKELMAN 200A, made in Netherland) was connected to the mixing cylinder of the gas supply system, and the air was removed by a vacuum pump. Oven (SHELDON, made in U.S.A) controlled the temperature at 102±3°C for saffron drying.

Storage conditions and preparation of the samples

The samples were weighed, packed and divided according to statistical analysis. Due to the negative effect of O_2 on saffron (oxidation of colour pigment) our gas combination in this research included N_2 and CO_2 in following percentages for MAP treatments: MAP1 (100% N_2), MAP2 (60% N_2+40% CO_2), MAP3 (40% N_2+60%CO_2). Time treatments for sampling were 0, 3rd, 6th, 9th and 12th weeks. Samples were also kept at 4°C in refrigeration and 25°C and 35°C inside the incubators.

Sensory tests

The external visual characteristics of saffron were determined over the storage time by 20 trained panel members informed of the sensory attributes. The observed characteristics were colour changes (bright red up to dark red), the presence of off-odours (from no off-odours up to appreciable off-odours), flavour changes and total acceptance. A five-point Hedonic scale evaluation including: 1, very bad; 2, bad; 3, middle; 4; good 5, very good was used where, 5 corresponding to a most-liked sample and 0 corresponding to a least-liked sample.

Statistical analysis

Analysis of variance (ANOVA) and SPSS System (version 9.0 software) were conducted to investigate the effects of gas combinations and storage temperatures. To determine the statistical differences, mean comparisons between features were performed using Duncan tests at a significant level of $P<0.05$.

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Result and discussion

Chemical test

For determining mass moisture content of saffron, the following procedure described by equation (1) was used according to ISO 3632. This method was based on measuring the difference in the weight of samples before and after drying in the oven at 102±3°C for 16h. Moisture data were obtained from the formula.

$$w = \frac{(m_0 - m)100}{m_0\%}$$

Formula 1- moisture measurement in Saffron

m_0: Mass in grams of test portion

m: Mass in grams of dry residue

w: Moisture content (percent per gram)

Analysis and the results of study

The study was conducted using completely randomized factorial design. Samples were analysed in triplicate. Statistical data from SPSS and Excel 2011 software was used to draw graphs.

Effect of MAP, temperature and time on the moisture: Results of moisture measurement are shown in Figure 1. Analysis of data showed that MAP, storage temperature and time have a significant impact on the moisture of saffron ($p<0.05$). The amount of moisture in MAP1 had the highest value compared to MAP2 and MAP3 after 12 weeks of storage, and it was closest to the control samples (Figure 1A). MAP1 (100% N_2) had the best effect on the moisture and freshness of saffron. Increasing the temperature from 4°C to 35°C resulted in reduced moisture in the saffron samples, but the decline is much less at 4°C and samples were closest to our control samples (Figure 1B). The use of low storage temperature (refrigerator temperature) is best to preserve moisture in saffron. Amount of moisture declined over time, but the reduction was slighter and slower in MAP1 (100% N_2) (Figure 1C). Therefore, a combination of MAP, with N_2 and temperature (4□) is suggested for packaging and keeping saffron to maintain its moisture for long time. Debevere et al.[10] reported that the most important and efficient technology used to maintain the quality of food product is combination of MAP with refrigeration and it is considered as an alternative which could extend shelf-life and maintain the quality of fish products.[10]

Sensory evaluation

The sensory evaluation of saffron samples during the storage time are shown on Figure 2. In terms of colour, samples showed clear differences with different MAPs. A brilliant red colour similar to the control samples was observed with MAP1 (100% N_2). Saffron with MAP2 (40% N_2+60% CO_2) also had dark brown colour and there was a combination of dark red to brown colour with MAP3 (60% N_2+40% CO_2) (Figure 2A). Thus, it is confirmed that the quality of external saffron colour steadily increased over time with MAP1 (100% N_2). Regarding flavour, MAP1 (100% N_2) showed the best flavour and came closest to the control samples. The lowest intensity of flavour was obtained with MAP2 (Figure 2B). The highest intensity of aroma was also obtained with MAP2 (Figure 2C). The total acceptance of saffron samples with MAP1 and MAP2 corresponded to the highest and lowest ranks, respectively (Figure 2D). Saffron color was the most important factor regarding the interest of consumers.

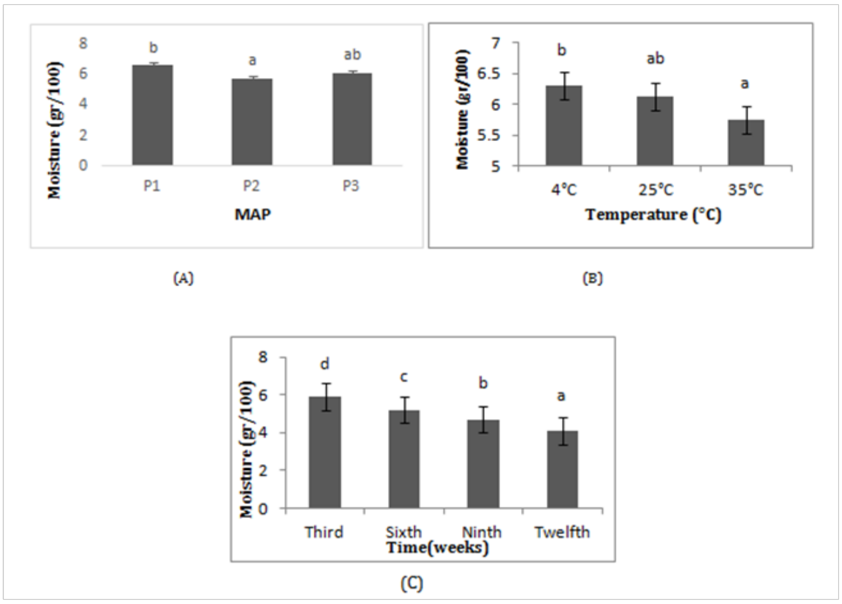

Figure 1 Effect of MAP (A) storage temperature (B) and storage time (C) on the moisture amount of saffron. Different superscripts indicate significant differences at (p□0.05) and error bar represent standard deviation.

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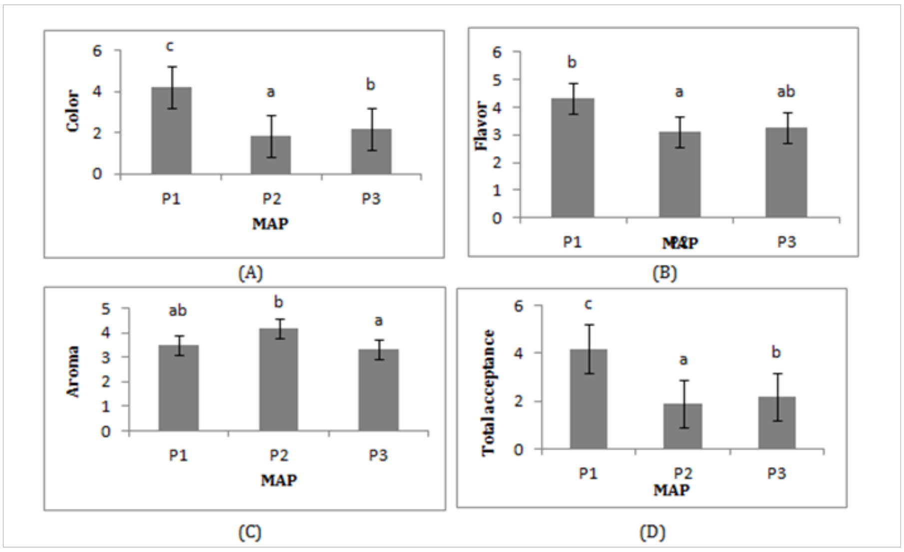

Figure 2 Effect of MAP on the sensory properties of saffron colour (A) flavour (B) aroma (C) and (D) total acceptance.

Conclusion

The results of analyses show that as temperature and time increased, the amount of moisture and consequently, the appearance and freshness of saffron decreased. Declines of moisture and external sensory evaluation of saffron samples packaged under MAP1 (100% N_2) was much slower and slighter than with the two other packaging procedures, and the results obtained came closer to the control sample. It is concluded that the best kind of MAP packaging and temperature for keeping the first season saffron quality were MAP1 (100% N_2) and 4°C. Based on the results of sensory acceptability, the highest and lowest ranks were assigned to MAP1 and MAP2 respectively. In summary, the results indicate that N_2 in three-layer films maintained a higher level of saffron quality. The temperature of 4°C also created a favourable condition for moisture and sensory quality of saffron.

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Conflicts of interest

The author declares no conflict of interest.

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