Effect of drying temperature, air velocity and flower types on dried saffron flower quality

M. H. Saeidirad*, P. Sharayei, S. Zarifneshat

(*Assistant professor, Khorasan Agricultural and Natural Resources Research Center, Mashhad, Iran*)

Abstract: The separation of saffron stigma from fresh flowers is the most important and the most difficult step of saffron harvesting. The separation of saffron stigma is done by hand which is time-consuming and costly. The saffron flowers will decay if separating of saffron stigma is not done quickly. Drying is one method of keeping saffron flowers. The dried saffron flowers have the higher shelf life, and deadline of stigma separating is extended. The main object of this study was to determine the best saffron flower drying method. Therefore, the effect of variables including drying temperature in three levels (40 ℃, 50 ℃ and 60 ℃), air velocity in two levels (0.5 and 1 m/s) and three levels of flowers (buds, semi opened and fully opened) were investigated on the amount of crocin (stigma color), saffronal (fragrance) and picrocrocin (bitter taste). The results showed that the amount of crocin decreased and the amount of saffronal increased with increasing of drying temperature. The best conditions for flowers drying were obtained at 50 ℃ drying temperature and 0.5 m/s air velocity. The dried saffron flower buds had the higher amount of saffronal than dried flowers of semi opened and fully opened.

Keywords: Saffron flower, drying, Saffronal

Citation: Saeidirad, M. H., P. Sharayei and S. Zarifneshat. 2014. Effect of drying temperature, air velocity and flower types on dried saffron flower quality. Agric Eng Int: CIGR Journal, 16(4): 251−254.

1 Introduction

The dried stigmas of saffron flower (*Crocus Sativus* L.), is one of the most expensive spices of the world. Iran, with an annual production of about 220 tones of saffron, approximately 94% of the world production, was the main producer of this crop in 2010. Spain, India, and Greece, held the lower ranks as minor producers, respectively (Anon, 2009). Saffron is usually used for cooking as a seasoning and coloring agent. It also has some other applications for medicinal and dye purposes. There are 2170 flowers per one kilogram of harvested fresh saffron flower. The 1 kg of dried stigmas obtains from 78 kg saffron flowers processing. The harvesting of saffron flowers, including cutting and picking up flowers should be carried out in early morning before the stigmas are damaged by the sunshine. It is done manually and during harvesting season daily. The processing of harvest and post-harvest of saffron flowers should be conducted warily to avoid any harmful effects on taste, color, and aroma of the stigmas. The first stage of the post-harvest processing is separation of stigmas from the other parts of saffron flowers that it is done with the hand labor and it is time-consuming and costly. The next stage is drying up of the stigmas. The mechanization of postharvest processing of saffron flowers is important due to the time limitation, daily harvesting, and possible contamination (Behnia, 1991).

The saffron flowers will decay if separation of saffron stigma is not done quickly. Drying of saffron flowers is one way to enhance longevity of saffron flowers. The dried saffron flowers have the higher shelf life and deadline of stigma separating is extended. The open sun drying method negatively affects the quality in color and saffronal stigma. Air-drying is the easiest and most common way to preserve most flowers (Smith, 2011).

Received date: 2013-12-07 **Accepted date:** 2014-11-17

*** Corresponding author: Mohammad Hossein Saeidirad,** Assistant professor, Khorasan Agricultural and Natural Resources Research Center, Mashhad, Iran. Email: Saiedirad@yahoo.com.

The drying conditions as temperature and air rate have effect on the quality of saffron stigma. The aim of this research was distinguish of the best saffron flower drying conditions.

Sharayee (2004) investigated the effects of harvesting and processing methods on microbial contamination and qualitative characteristics of saffron. The result showed that the highest quality of saffron and the lowest the microbial contamination were related to harvesting of saffron flowers buds form, the handling by clean containers, storge in the cold place away from sunlight and drying by the ordinary oven and the Spanish heater.

Diamante et al. (2010) investigated the drying characteristics of green and gold kiwifruit using an air velocity of 0.20 m/s at ambient humidity and different temperatures (60℃, 80℃ and 100℃). They reported that the values for chroma of the dried green kiwifruit increased while the dried gold kiwifruit decreased with higher temperature as compared with the fresh samples. The values for browning index of dried green and gold kiwifruits increased at higher temperature. There was not much change on the ascorbic acid contents of fresh and dried green and gold kiwifruits when drying at 60℃ and 80℃. However, there was about 19% decrease in the ascorbic acid content of dried green and gold kiwifruits after drying at 100℃.

Nasiroglu and Kocabiyik (2009) studied the effects of infrared power (300, 400 and 500 W) and at three air velocities (1.0, 1.5 and 2.0 m/s) on drying characteristics and changing of quality parameters of red pepper. They reported that the drying rate increased with increasing IP and decreasing air velocity. The shortest drying time was obtained at 1.0 m/s air velocity at *IP* of 500 W. There was no constant drying rate period for all the drying conditions. The highest drying rate was obtained at 1.0 m/s air velocity at *IP* of 500 W. The drying rate increased with the decrease in moisture content and with the increase in *IP*. Specific energy consumption values were varied between 4.62 and 7.59 kW h/kg for all the drying conditions. The specific energy consumption was varied between 4.62 and 7.59 kW h/kg for all the drying conditions. Thickness change/ shrinkage were found to be in the range of 0.162 and 0.263 mm. The color parameters and the rehydration ratio were significantly influenced by IP and air velocity.

Raina et al. (1996) were observed a significant variations in the concentration of pigments (10 0%–17 0%) and flavor components during different post-harvest processing conditions of saffron. They reported the crocin of pigments concentration was highest (15%–17%) in the saffron samples that dried between 35℃ and 50℃ either in a solar dryer or in an oven dryer and this also resulted in considerable reduction of normal drying time. They observed that prolonged storage affected the pigments and flavor concentration largely, but proper packaging and storage in 5% moisture were reduced the saffron deterioration, thereby increasing the shelf life of the product.

Nauriyal et al. (1997) reported that the sun drying method was caused the low quality of Indian saffron. Hemmati (1992) investigated the effect of four drying methods (Iranian conventional method, by Spanish heater, by general oven and by vacuum oven) on saffron quality. They reported there is a significant difference between drying methods. The best quality of saffron dried was obtained by general oven drier.

In order to determine the best saffron flower drying method, in this research, the effects of drying temperature, air velocity and flowers kinds were investigated on the dried saffron flowers quality.

2 Materials and methods

Fresh saffron flowers were obtained in late harvesting season of 2011 from a farm in Khorasan agricultural research center, Iran. The saffron flower buds, semi opened flowers and fully opened flowers were harvested in early morning before sunrise, after sunrise and 10 am, respectively. The flowers were taken directly to the lab in the shortest period. They were kept in a dark store at ambient temperature (4 ± 1℃) and were taken out daily from the store for sample preparation.

In this study, the effect of variables including drying temperatures in three levels (40℃, 50℃ and 60℃), air velocity in two levels (0.5 and 1 m/s) and flowers types (buds, semi opened and fully opened) on the amount of crocin (color of saffron stigma), saffronal (fragrance of saffron stigma) and picrocrocin (bitter taste of saffron stigma) were investigated. The testifier treatment sample was dried in sunlight.

Each of the dried saffron stigma samples was prepared in water solution. The absorbance amounts of each solution were measured using spectrophotometer (Genesys IM8, American) at a wavelength of 200 to 700 nm.

The crocin, picrocrocin and saffronal amount were determined using the ISO 3632-2 method (ISO, 1993) and were computed by the following Equation (1).

$$\text{Amount} = \frac{A \times 10000}{0.5(100 - H)} \quad (1)$$

where, A is the amount of absorbance at 440, 257 and 330 nm for crocin, picrocrocin and saffronal, respectively, on dry basis and H (%) is the moisture content of saffron stigma.

Experiments were performed as completely randomized block design in three replications. Statistical analysis was done on randomized complete block design applying the analysis of variance (ANOVA) using SPSS 13 software. Duncan's multiple ranges test was utilized to separate means at a 5% level of significance.

3 Results and discussion

Variance analysis of data in Table 1 indicates that the drying temperature created a significant effect on the amount of crocin (stigma color), saffronal (fragrance) and picrocrocin (bitter taste) (P<0.05). The air velocity and the flower type had a significant effect on the amount of saffronal (P<0.01) and they had not significant effect on crocin and picrocrocin. According Table 1, the combination effects of (drying temperature × air velocity) were significant on the amount of crocin and picrocrocin.

In the following paragraphs, the effects of each factor on the characteristics have been discussed comprehensively.

According to Table 2, there was a significant difference on all characteristics between 40℃ and 60℃. The amount of crocin decreased as the drying temperature increased from 40℃ to 60℃. This conclusion was consistent with the findings of Raina et al. (1996), who reported that the stigma color of saffron was reduced, as drying temperature was higher than 50℃.

Table 1 Analysis of the variance of parameters considered on amount of crocin, saffronal and picrocrocin (Mean of squares)

Variation source	DF	Crocin	Saffronal	Picrocrocin
Drying temperature, ℃	2	9680.23*	137.32**	1812.703*
Air velocity, m/s	1	5484.89 ns	340.56**	766.18 ns
Flower type	2	1946.56 ns	2187.81**	848.27 ns
Drying temperature × air velocity	2	8456.60*	56.17 ns	1049.03*
Drying temperature× flower type	4	3386.91 ns	61.89 ns	160.21 ns
Air velocity × flower type	2	4535.62 ns	10.35 ns	237.93 ns
Drying temperature× air velocity × flower type	4	262.57 ns	29.05 ns	95.98 ns
Error		2931.48	30.32	384.20

Note: ns: Corresponding to no significant difference; * corresponding to significant difference at P=0.05 ;**corresponding to significant difference at P=0.01.

Table 2 Means comparison of characteristics in different variations

Factors	Factors levels	Crocin	Saffronal	Picrocrocin
Drying temperature, ℃	40	367.79a	33.11a	131.88a
	50	343.00ab	35.71ab	135.67a
	60	313.88b	37.61b	119.97b
Air velocity, m/s	0.5	332.37a	38.19a	133.09a
	1	350.92a	31.45b	131.32a
Flower type	Fully opened	342.19a	28.35a	122.71b
	Semi opened	343.83a	32.48b	132.21a
	Bud	357.65a	45.59c	132.61ab

Note: Means for the same factor and in the same column flowed followed by the same letter are not significantly different (P<0.05) according to Duncan's Multiple ranges Test.

As given in Table 2, the amount of saffronal increased with the increasing of drying temperature. The increasing of drying temperature reduced the drying duration, as a result, the fragrance of saffron stigma was preserved mostly. This might be attributed to the fact that because of the airflow decrease the saffronal amount gradually.

The amount of picrocrocin decreased from 131.88 to 119.97 as the drying temperature increased from 40℃ to 60℃. There was a significant difference on amount of picrocrocin between them (40℃ and 50℃) and 60℃.

All characteristics (crocin, saffronal and picrocrocin) were reduced for stigma of saffron that drying by sunlight in testifier samples. It proves that the high duration of drying and sunshine directly had a negative effect on stigma color, fragrance and bitter taste of saffron. Nauriyal et al. (1997), who reported that the sun drying method was caused the low quality of Indian saffron, have documented the latter result.

Considering the values presented in Table 1, the air velocity had a significant effect on the amount of saffronal. The amount of saffronal decreased from 38.19 to 31.45 with increasing of air velocity from 0.5 to 1 m/s (Table 2). This may be attributed to the fact that the 17.5% decreasing of saffronal amount has occurred due to the moving too much air velocity in the dryer. The airflow can remove the fragrance of saffron stigma. Therefore, drying in the lower air velocity maintained the stigma quality.

Investigation of the interaction effects of drying temperature and air velocity on crocin amount showed that there was a significant difference between 0.5 and 1 m/s air velocity under drying temperature level 50℃ (Figure 1). This is possibly due to the fact, the air velocity increasing reduced the drying duration and it is caused to increase the amount of crocin, despite the fact that it decreased with increasing of temperature drying.

According to Table 1, the flower type had a significant effect on only the saffronal amount. Investigation of mains comparison showed that there was a significant difference between saffron flower types on saffronal amount. As given in Table 2, the saffronal amount found to be the highest value (45.59) for buds flowers and the lowest saffronal amount (28.35) for fully opened flowers. The stigma of saffron have been surrounded by petals in buds, thus, their fragrance preserved better than semi and fully opened flowers.

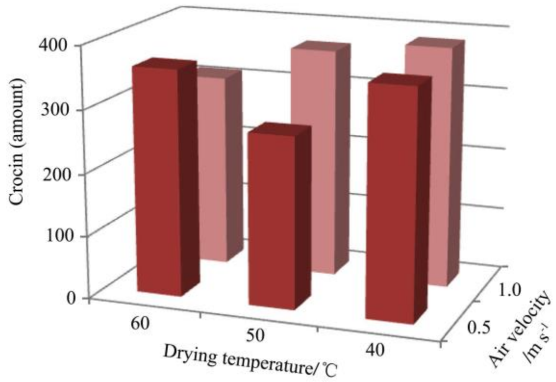

Figure 1 The effect of drying temperature and air velocity on the amount of crocin

Based on this research, generally it can be concluded that the best condition for saffron flower drying is 60℃ and 0.5 m/s air velocity. The saffron flowers are buds shape in farm at early morning before sunrise. The saffron flower buds harvesting in early morning and theirs drying immediately caused to preserved the stigma fragrance.

Acknowledgements

The authors appreciate Khorasan Razavi Agricultural and Natural Resources Researches Center for full support of conducting this research.

References

Anon. 2009. Agricultural Statistical Bulletin. Ministry of Jihad-Agriculture, Khorasan Organization. (in Farsi).

Behnia, M. 1991. Cultivation of saffron. Publication of Tehran university. (in Farsi).

Diamante, L., M. Durand, G. Savage, and L. Vanhanen. 2010. Effect of temperature on the drying characteristics, colour and ascorbic acid content of green and gold kiwifruits. *International Food Research Journal,* 17(3): 441-451.

Hemmati, A. 1992. Effect of stigma drying methods on saffron quality, Research reports. Iranian industrial and scientifically research organization, Khorasan rsearch institute. (in Farsi).

ISO 3632-2. 1993. Saffron (*Crocus sativusL.*). The International Organisation for Standardisation (First Edition). *Switzerland. ww.iso.ch/iso/en/*.

Nauriyal, J. , R. Cupta, and C.K. George. 1997. Saffron in India. *Arecanut Spices Bull,* 8(3): 12-59.

Nasiroglu, S., and H. Kocabiyik. 2009. Thin layer infrared radiation drying of red pepper slices. *Journal of Food Process Engineering,* 32 (2009): 1–16.

Raina, B. L., S. G. Agarval, A. K. Bhatia, and G. S. Gaur. 1996. Changes in pigments and volatiles of saffron (Grocus Sativus L.) during processing and storage, *Journal of Science Food and Agriculture*, 71(1): 27- 32.

Sharayee, P. 2004. Determination the best saffron harvesting and processing method in order to reduction of microbial contamination. Final report of research project, Agricultural Engineering Research Institute, No: 693/83. (In Farsi).

Smith, K. 2011. Drying and Preserving Flowers and Plant Materials for Decorative Use. Alabama Cooperative Extension System, *ANR-1115*.