



Determination of saffron (*Crocus sativus* L.) quality characteristics in Herat – Afghanistan

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ABSTRACT

Purpose: Saffron (*Crocus sativus* L.) is a strategic medicinal and spice plant in the world. This study aimed to determine saffron stigma quality obtained from different regions of Herat province in Afghanistan. **Research method:** The experiment was conducted at the food technology lab, faculty of agriculture, Herat University, in 2018. The experiment was set up on a completely randomized design (CRD) with twenty replications. Saffron stigma samples were collected from different parts of Herat province (Ghoryan, Phashton Zarghon, Gozarah districts, and producer companies), and then transferred to the laboratory for determining the saffron quality parameters such as crocins, picrocrocin and safranal using spectrophotometer. **Findings:** Results showed that the amounts of picrocrocin and safranal were significantly different between stigmas produced in different regions, but there was no significant difference in terms of crocin. The highest amounts of picrocrocin (104.50 µg/g) and safranal (34.95 µg/g) were recorded in the stigma samples collected from production companies, while the highest amount of crocin (236.95 µg/g) obtained from Pashton Zarghon sample. Evaluation of mentioned qualitative attributes among saffron samples and their comparison with ISO 3632 standard showed that all samples were desirable in terms of crocin (>190 µg/g), picrocrocin (>70 µg/g) and safranal (>20 µg/g), which were laid in (I) category. **Research limitations:** There was no limitations to report. **Originality/Value:** This research is one of the first reports on saffron quality produced in Herat.

INTRODUCTION

Saffron (*Crocus sativus* L.) is an important medicinal plant in the world. Recently, Afghan farmers in Herat province improved their cultivation methods for saffron. Also, the government of Afghanistan motivates farmers to grow saffron instead of opium (*Papaver somniferum* L.) medicinal crop to improve their livelihood (Nazarian et al., 2018). Herat province geographically, is located in the neighborhood of Khorasan province in Iran, as the largest saffron production center in the world (Behdani & Fallahi, 2015). Saffron is an annual (with perennial cultivation) herbaceous plant, and its three branched stigma, which has red color contain three main compounds which are crocin, picrocrocin, and safranal (Tajik et al., 2012).

Crocin (color), picrocrocin (flavor), and safranal (aroma) are the main substances to measure the quality of saffron (Hadizadeh et al., 2007). ISO (the International Organization for Standardization) has established a set of classification based on the minimum requirements of each quality (Hadizadeh et al., 2007). Crocins improves the memory (Pitsikas et al., 2007), and can cure convulsion (Hosseinzadeh & Sadeghnia, 2007), depression (Akhondzadeh et al., 2004; Moshiri et al., 2006; Wang et al., 2009), cancer (Goyal et al., 2010; Mousavi et al., 2010), and tumor (Nair et al., 1991). Crocins are water-soluble compounds in saffron stigmas, which is belong to the family of mono-and di-glycosyl esters of polyene dicarboxylic acid named crocetin (Lozano et al., 1999). Picrocrocin is responsible for bitter taste and safranal is responsible for the odor of saffron stigma (Nazarian et al., 2018). Crocin and safranal, are used for curing many diseases, such as hypertension, convulsions, genotoxicity, and inflammatory disorders. They helps to increase blood flow in the retina and choroid and improves memory (Abdullaev, 2002).

Saffron stigma quality is affected by different factors; among them climatic factors are highly important (Behdani & Fallahi, 2015). Although, saffron cultivation has recently become popular in Herat, but there is little information on its qualitative parameters. The aim of this study was to determine saffron quality parameters obtained from different parts of Herat province.

MATERIALS AND METHODS

In order to determine saffron qualitative characteristics, an experiment was conducted at the Food Technology Lab, Agriculture Faculty of Herat University, Afghanistan in 2018. The experiment was set up on a completely randomized design (CRD) with twenty replications. Saffron samples were collected from different regions of Herat province (Ghoryan, Phashton Zarghon, Gozarah districts, and producer companies). Phashton Zarghon district is located in east, Ghoryan district in west, Gozarah district in south, and producer companies in center of Herat province. These different regions have different soil and climate conditions. In Herat, usually four-years old saffron field, produce the highest yield and it harvesting time is from October 20 to November 20.

Saffron flowers were harvested during flowering season of 2018. Then, stigmas were separated and dried in different regions. After that, samples were transferred to the laboratory for determining saffron quality characteristics including crocins, picrocrocin, and safranal with spectrophotometer method. For determination of crocin, picrocrocin, and safranal, ISO/TS 3622 standard was considered. Stigma samples (500 mg) were powdered and transferred into the balloon that had the capacity of 1000 ml and added 900 ml distilled water. Then mixed with magnate mixer for one hour with speed of 1000 circle per minute. After that 100 ml distilled water was added to reach the 1000 ml and again mixed. After that, 20 ml of

solution was transferred to a 200 ml volumetric flask and was filled to the mark, using distilled water. The solution was filtered far from light and finally a spectrophotometer was used to measure saffron quality parameters in the range of 200-700 nm wavelength. The amount of light absorption was used 257 nanometers for picrocrocin, the range of 330 nanometers for safranal, and the range of 440 nanometers for crocin. To calculate the amount of each component the below equation (1) was used (Kaveh & Salari, 2018):

$$E = \frac{D \cdot 1000}{m(100-H)} \quad (1)$$

Where, E is the amount of each compound, D is specific absorbance at 257, 330, and 440 nm (number recorded in spectrophotometer), m is the weight of stigma sample in gram and H is the weight percentage of moisture and volatile matter in the samples.

The analysis of variance (ANOVA) was performed by using GLM Proc. In SAS program version 9.1 (SAS Institute Inc., Cary, NC, USA) and the least significant different test (LSD) was used for mean comparison.

RESULTS AND DISCUSSION

Analysis of variances for saffron quality in different regions of Herat province showed that the amount of picrocrocin and safranal were significantly different among regions, but there was no significant difference for crocin between samples collected from different districts (Table 1).

The highest amount of picrocrocin (104.50 μ g 257nm) and safranal (34.95 μ g 330nm) were obtained from the stigma samples that were collected from producer companies in Herat city. The differences between the amount of picrocrocin and safranal in Ghoryan, Pashton Zarghon and Gozarah districts were not significant and all of them were in the same group (Fig. 1). Although, there was no significant difference for the amount of crocin in different districts, but, its highest amount (236.95 μ g 440nm) among all collected samples was obtained for Pashton Zarghon region (Table 2).

The correlation between saffron qualitative parameters showed that there was a positive correlation within the amount of crocin, picrocrocin and safranal (Table 3). Evaluation of mentioned qualitative attributes among saffron samples at different regions, and their comparison with ISO 3632 standard showed that all stigma samples were in the I category. So that, the amount of crocin was >190, picrocrocin was >70 and safranal (μ g 330nm) was >20 (Table 4).

Table 1. Analysis of variances (MS) for saffron quality in different parts of Herat Province – Afghanistan

S.O.V	df	Safranal (μ g) 330nm	Picrocrocin (μ g) 257nm	Crocin (μ g) 440nm
Region	3	192.45**	1186.25**	3711.98ns
Error	76	34.81	157.21	1904.70
Total	79			

**, * and ns are significant at the 0.01 and 0.05 levels of probability and no significant, respective.

Table 2. Mean comparison for saffron quality in stigma samples obtained from different regions in Herat Province - Afghanistan

No.	District	Safranal (θ) 330nm	Picrocrocin (ϕ) 257nm	Crocin (ω) 440nm
1	Ghoryan	30.95 ^b	86.90 ^b	210.95 ^a
2	Pashton Zarghon	27.45 ^b	90.25 ^b	236.95 ^a
3	Companies	34.95 ^a	104.50 ^a	211.70 ^a
4	Gozarah	30.15 ^b	91.80 ^b	232.45 ^a
	LSD 0.05%	3.72	7.90	27.49

Means in each column, followed by a similar letter (s) are not significantly different at 5% probability level, using least significant different Tests (LSD).

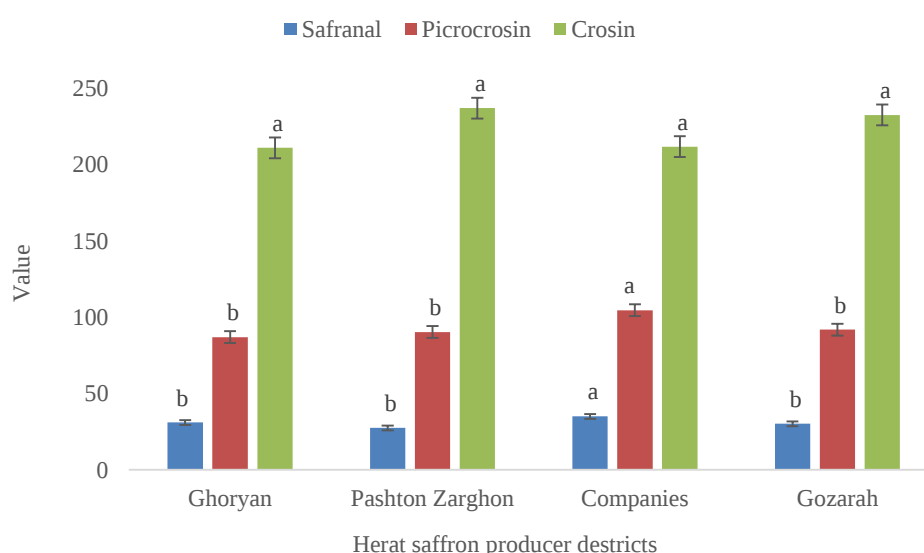
Table 3. Correlation between saffron qualitative parameters in samples obtained from Herat Province-Afghanistan

	Safranal (θ)	Picrocrocin (ϕ)	Crocin (ω)
Safranal	1.00		
Picrocrocin	0.54	1.00	
Crocin	0.24	0.56	1.00

Table 4. Sample classification based on ISO 3632/1-2 normative (ISO, 2003).

ISO category	E1% 257nm	E1% 440nm
I	70	190
II	55	150
III	40	100

Accordingly, to the absorbance readings at different wavelengths of solutions of the same concentration (E1% (w.v⁻¹) at 257 and 440 nm. Source : (Gresta et al., 2009).

**Fig. 1.** Saffron quality parameters in Herat Province – Afghanistan. Means followed by the same letter shows no significant differences among treatments at 0.05 level by LSD.

Saffron quality characteristics are related to the concentration of its three major metabolites, which provide the unique colour and flavor to the stigma. Picrocrocin ($C_{16}H_{26}O_7$) is responsible for the bitter taste of saffron. It is a monoterpene glycoside precursor of safranal ($C_{10}H_{14}O$), the major volatile oil considered for the aroma of saffron. b-glucosidase process on picrocrocin liberates the aglycone, 4-hydroxy-2,6,6-trimethyl-1-cyclohexene-1-carboxaldehyde (HTCC, $C_{10}H_{16}O_2$) which is altered to safranal via dehydration during the drying process of the stigma (Lozano et al., 2000; Winterhalter & Straubinger, 2007). In many countries, the chemical composition of saffron samples indicates that the values reported are strongly depend on the climatic condition, agronomic practices, harvesting manner and methods used for drying (Kanakakis et al., 2004; Lozano et al., 2000; Zareena et al., 2001; Behdani & Fallahi, 2015).

Reports show that saffron components have a wide range of values and the amount varies greatly from country to country. It has been reported that values for crocins vary from 0.85% to 32.4% dry weight (Alonso et al., 2001). In different countries, other values reported differ between 2.9 mg% (29 mg g⁻¹) (Li et al., 1999) and 4.6 mg% (45.99 mg g⁻¹) (Caballero-Ortega et al., 2004) for Iranian saffron and 6.7 mg% (67.3 mg g⁻¹) (Sujata et al., 1992) for Indian saffron. Levels of safranal reported by some scientist are around 0.80 mg% (8 mg g⁻¹) (Sujata et al., 1992). Other values reported for safranal vary between 0.06 mg g⁻¹ and 0.29 mg g⁻¹ (Hadizadeh et al., 2007). Picrocrocin values, was between 0.79% and 12.94% in Spanish saffron, 1.07–2.16% in Indian, and 2.18–6.15% in Iranian saffron (Rios et al., 1996; Straubinger et al., 1998). In another study, comparison of saffron quality produced in khorasan province showed that the amount of picrocrocin was higher in highland regions (Kaveh & Salari, 2018).

In various regions of the world, saffron is dried differently (shade, heating system, electric ovens, sunlight, etc.), and drying methods affect the final composition of saffron. Crocins and picrocrocin values decreased naturally in the stigmas cell during drying, storage and extraction process (Straubinger et al., 1998). Soil chemical composition and temperature could also affected saffron quality (Lage & Charles, 2009). Soil pH (Gresta et al., 2008) and climatic parameters especially temperature (Mollafilabi, 2004; Gresta et al., 2008; Behdani & Fallahi, 2015) can also affect the saffron yield and quality. Saffron quantity and quality studies under different altitudes, showed significant correlation between altitude and crocins content. In addition, in some areas found a positive relationship of yield with safranal compound (Lage & Charles, 2009). In previous studies the effect of biological fertilizers (Omidi et al., 2009; Naghdibadi et al., 2011; Heydari et al., 2014), irrigation (Feizi et al., 2015), soil fertilization (Ismaeili et al., 2015; Rezaie et al., 2019), and foliar application of nutrients (Akbarian et al., 2012) were significant on saffron quality. Therefore, besides the climatic and soil differences between different areas of Herat, the type of crop management can also affect the quality of the stigma. Overall, in the present study, the differences between saffron qualitative parameters may be due to different cropping management, micro climatic conditions, altitude and different drying methods in different parts of Herat province.

CONCLUSION

Results showed that the amount of picrocrocin and safranal in stigma were different between different regions of Herat. The highest amount of picrocrocin and safranal were obtained in the saffron samples that collected from production companies. The highest amount of crocin obtained in Pashton Zarghon region. Comparison of stigma samples produced in Herat with ISO standard showed that the quality of all samples was desirable. This study suggests that

differences in soil and climatic factors among regions and drying methods can significantly affect saffron quality.

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Conflict of interest

The authors declare that there is no conflict of interest.

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