CHEMICAL COMPOSITION OF AGRIPRODUCT SAFFRON (*CROCUS SATIVUS* L.) PETALS AND ITS CONSIDERATIONS AS ANIMAL FEED

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Abstract

Proximate composition and mineral concentration of Saffron petals were investigated using standard analytical methods. Saffron petal samples were obtained from the flowers of Torbateheydariyeh farms and were evaluated for metals, protein, phosphorus, fiber, fat and ash content. The levels of protein (10.20 %), fat (5.3%), Ash (7.00 %), fiber (8.80%), sodium (25.75 mg/100g), potassium (542.13 mg/100g), calcium (486.25 mg/100g), copper (0.87 mg/100g), iron (17.99 mg/100g), magnesium (2.93 mg/100g), zinc (1.80 mg/100g) and phosphorus (209.90 mg/100g) detected in the saffron petals were compared with that of Iranian national standard for the animal food. As a conclusion, saffron petals can be used as an animal food.

Keywords: Saffron petal, animal feed, AAS

SAFRAN (*CROCUS SATIVUS*) YAPAKLARININ KİMYASAL BİLEŞİMİ VE HAYVAN YEMİ OLARAK DEĞERLENDİRİLMESİ

Özet

Bu çalışmada, safran yapraklarının bileşimi ve mineral içeriği standart analitik yöntemlerle belirlenmiştir. Safran yaprağı numuneleri Torbateheydariyeh bölgesindeki safran çiftliklerinden sağlanmış ve yaprakların; metaller, protein, selüloz, yağ ve kül içeriği belirlenmiştir. Safran yapraklarında bulunan protein miktarı (%10.20), yağ (%5.3), kül (%7.00), selüloz (%8.80), sodyum (25.75 mg/100g), potasyum (542.13 mg/100g), kalsiyum (486.25 mg/100g), bakır (0.87 mg/100g), demir (17.99 mg/100g), magnezyum (2.93 mg/100g), çinko (1.80 mg/100g) ve fosfor (209.90 mg/100g) İran ulusal hayvan yemi standardı ile karşılaştırılmıştır. Sonuç olarak safran yapraklarının hayvan yemi olarak kullanılabileceği görülmüştür.

Anahtar kelimeler: Safran yaprağı, hayvan yemi, AAS

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INTRODUCTION

Saffron is the dried and dark-red stigma of *Crocus sativus* L. flowers, a member of the large *Iridaceae* family. Crocus sativus plants are principally grown in Spain and Iran, but also cultivated on a lower scale in Greece, Azerbaijan, France, Italy, India, China, Morocco, Turkey, Israel, Egypt, United Arab Emirates, Mexico, Switzerland, Algeria, Australia, and New Zealand (1).

The value of saffron (dried stigmas of *Crocus sativus* L.) is determined by the existence of three main secondary metabolites: crocin and its derivatives which are responsible for color; picrocrocin, responsible for taste; and safranal responsible for odor. Indeed, saffron contains in excess of 150 volatile and aroma-yielding compounds. It also has many non-volatile active components, many of which are carotenoids, including zeaxanthin, lycopene, β-carotenes and polysaccharides. However, saffron's golden yellow orange color is primarily the result of α-crocin (2- 4).

The most important part of saffron, is its thread-like reddish colored stigma, which has average yield about 4.7 kg/ha (5). Saffron leaves (with producing about 1.5 tons dry matter each year) can provide forage for about 160 thousand heads of cattle. Saffron petal is one of by-products of fields that the appropriate way for reusing from them is unknown. The amount of this by-product is more than 10000 tons each year (6). Nowadays, the only usage of saffron petals is dye extraction, which is not flourished yet.

In the production of 1 kg of saffron, more than 160 thousand flowers of *Crocus sativus* are needed. In comparison with the stigma, the flower petal is almost completely neglected in commercial terms, although it is available in far greater tonnage and there is considerable potential for its exploitation. It has been reported that ethanol extract of saffron petals possesses antidepressant activity (7). Phenolic compounds are likely to be the biologically active components of the petals (8). Flavanoids and anthocyanins are among phenolic compounds of this species (9, 10). Phenolic compounds are likely to be the biologically active components of the petals (8).

Petals of Crocus sativus are rich in flavonoids and anthocyanins. The protective activity of carotenoid against cancer has obtained support from a large number of epidemiological and experimental studies (11-14).

In this paper the usefulness of saffron petals as a source of protein, fats, and essential macro minerals necessary for the growth of animals is being investigated.

MATERIALS AND METHODS

Reagents

All chemicals and solvents were of analytical-reagent grade and were used without further purification that supplied by Merck (Darmstadt, Germany). The water used was double distilled and purified using a millipore system. Saffron petal samples were collected from the flowers of Torbateheydariyeh farms (Khorasan, Iran). The samples were powdered with a mechanical grinder, packaged and stored in a refrigerator at 4 °C until required for use.

Apparatus

For metal determination, an Analytik Jena AG AAS ZEEnit 700P AAS (Jena, Germany) equipped with a flame and graphite furnace (GF) with the Zeeman background corrector was used in the experiments. WinAAS Version 4.5.0 software was used. A Shimadzu UV-1700 Pharma spec. (Tokyo, Japan) was used for the determination of phosphorus.

Metal determination

The Na, K, Ca, Cu, Fe, Zn and Mg were determined by atomic absorption spectrophotometry. For digestion with wet ashing, 5 g from saffron petal samples were used. Wet digestion of samples was performed by using mixtures of two acids, namely, HNO_3–HCl. Thirty mL of concentrated HNO_3 was used for a 5.0 g sample. Each mixture was heated on the hot plate. Gently boil unit 3-6 mL digest remains. Then, 25 mL concentrated HCl was added. Increase heat, and boil until 10-15 mL volume remains. After cooling, the residue was filtered through blue band filter paper. Then

Table 1. Mineral composition (all the concentrations are shown in mg/100g)

Element	Saffron petals (mean±SD)	LOD	LOQ
Sodium (Na)	25.75±0.01	0.22	0.83
Potassium (K)	542.13±0.01	0.07	0.24
Calcium (Ca)	486.25±0.12	0.08	0.32
Copper (Cu)	0.87±0.008	0.06	0.22
Iron (Fe)	17.99±0.09	0.14	0.54
Magnesium (Mg)	2.93±0.02	0.13	0.59
Zinc (Zn)	1.80±0.13	0.04	0.15
Phosphorus (P)	209.90±0.17	0.08	0.11

LOD: Limit Of Detection LOQ: Limit Of Quantification

the sample was diluted to 50 mL with distilled water. The blank digestions were also carried out in the same way (15).

Physicochemical characteristics

The recommended methods of the Association of Official Analytical Chemists were employed in determining the levels of ash, crude protein, crude fat and fiber.

Ash was determined by the incineration of 2 g samples placed in a muffle furnace (LMF4 from Carbolite, Bamford, Sheffield UK) maintained at 550 °C for 5 hours. Crude protein (% total nitrogen x 6.25) was determined by Khedjal method (16), using 2 g samples; crude fat was obtained by exhaustively extracting 2 g of each sample in a Soxhlet apparatus using petroleum ether (boiling range 40-60 °C) as the extractant (17). Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (W/V) H_2SO_4 and 1.25% (W/V) NaOH solutions under specific conditions (18). Phosphorus was determined by spectrophotometer method based on Iranian national standard No. 513 (19). Phosphorous was determined as PO_4^{3-} by the sodium phosphomolybdate in which the phosphorous present as the orthophosphate reacts with a sodium molybdate reagent to produce a yellow - orange complex, the absorbance of which was measured at 420nm. Determinations were done in triplicates and results were expressed as averages on dry weight basis.

RESULTS AND DISCUSSION

Mineral composition of saffron petals

The mineral content of saffron petals is shown in Table 1, levels of Na, K, Ca, Cu, Fe, Mg, Zn and P detected with value of 25.75, 542.13, 486.25, 0.87, 17.99, 2.93, 1.80 and 209.90 mg/100g. The concentrations are average values of three replicate measurements. K had the highest concentration (542.13±0.01 mg/100g). K has been recognized as an essential nutrient in animal nutrition since its importance was pointed out by Sidney Ringer in 1883. K is essential for life. Young animals will fail to grow and will die within a few days when the diet is extremely deficient in K (20). The concentration of Ca in saffron petals is 486.25±0.12 mg/100g. Ca is responsible for bone formation. Ca regulates many cellular processes and has important structural roles in living organisms (21).

Na and K are found in extracellular and intracellular fluid. A low K-Na ratio in diet is associated with elevated blood pressure (22).

Phosphorus is an essential nutrient for all animals too. Deficiency of Phosphorus is the most widespread of all the mineral deficiencies affecting livestock. Phosphorus must be balanced in the animal diet with adequate Ca and vitamin D for growth, reproduction, gestation, and lactation (23).

Mg has been reported to be involved in maintaining the electrical potential in nerves and activation of some enzyme systems (24).

Table 2. Physicochemical parameters of Saffron petals

Parameter	Saffron petals (% w/w)
Protein	10.20
Fiber	8.80
Ash	7.0
Fat	5.3

Physicochemical properties of saffron petals

Table 2 presents the physicochemical properties of saffron petals. From the data it was observed that the saffron petals contained crude fat (5.3%) and protein (10.2 %). It also contained ash (7.00%) and crude fiber (8.8 %). Ash content of saffron petals in this study was 7 %. Based on Iranian national standard ash content of maize, soybean oilcake and sunflower meal to be 1.5, 6 and 7%, respectively (25, 26, and 27). Therefore with the value of ash reported in this study, saffron petals may be suitable for animal feeds.

The value of crude fat (5.3%), protein (10.2 %) and fiber (8.8 %) are comparable to the values for varieties of animal feed reported by Iranian national standard. The fat content was higher than those reported for maize, soybean oilcake and sunflower meal with value of crude fat 3.5, 0.5-2 and 2.5%, respectively (25-27). Fat promotes the absorption of fat soluble vitamins hence it is very important in diets (28). Fats contain the highest amounts of energy. In fact, fats contain 2.25 times more energy than carbohydrates. Fats play an important role in supplying the energy needed by an animal for normal body maintenance. Protein also plays a part in the organoleptic properties of foods in addition to being a source of amino acid. The Protein content was higher than those reported for maize with value of 8% and lower than those reported for soybean oilcake and sunflower meal with value of 42-48 and 40%, respectively (25-27). Crude fiber helps in the maintenance of normal peristaltic movement of the intestinal tract hence diets containing low fiber could cause constipation and eventually lead to colon diseases (piles, cancer and appendicitis) (29). Fiber also plays an important role in ruminant digestion by increasing bacterial populations in the rumen. The crude fiber content was higher than those reported for maize and soybean oilcake with value of 2.7% and 3.3-7%, respectively and lower than those reported for sunflower meal with value of 14% (25-27).

CONCLUSION

As a table 1 shows levels of Na, K, Ca, Cu, Fe, Mg, Zn and P detected with value of 25.75, 542.13, 486.25, 0.87, 17.99, 2.93, 1.80 and 209.90 mg/100g. Minerals are important in the diet because they serve as cofactors for many physiologic and metabolic functions and in their absence, clinical deficiencies may occur. Both Ca and K were detected at significant levels. The levels of Na and K detected suggested that the saffron petals might prove useful in lowering elevated blood pressure. A significant level of Fe was also present in the saffron petals Fe, Cu, Zn and Mg play an important role in biological systems; they are essential for nutrition and are widely used in the fields of clinical medicine, environmental science, medical jurisprudence and health (30, 31, 32, and 33). As a table 2 also shows levels of protein, fat, Ash and fiber were 10.2, 5.3, 7.00 and 8.8%, respectively. Therefore the obtained results show that the saffron petals can be used as an animal food.

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