

# Review on Official Requirements/Standards of *Crocus Sativus* L. (Saffron)

R. B. SAXENA

Drug Standardization Research Project, Central Research Institute in Ayurveda, Amkhoo, Gwalior.

**ABSTRACT :** The question of standardization of quality control depends on the nature of saffron(king of spices; Family- Iridaceae) and compound drugs, on its source, which are the potent cause of variation in the properties and processes through which it is subjected to pass. With the globalization and urbanization, several lexicographers attempted for compendia of saffron in the medieval period, have given scope for substitution/ adulteration. Hence, the need of standardisation of traditional medicine (saffron) by applying scientific techniques is identified in the middle of the 20<sup>th</sup> century. For their requirement, quality grading was prepared by different countries and some of them applied. India and Spain have well prepared the standard values of saffron. Due to globalization, the quality grading is made according to specification in protocols proposed by International Standards Organisation (ISO). Different standards and objections in the official requirements/ standards of saffron have been reviewed.

**Key words :** Standardization, requirement, substitution, saffron.

## INTRODUCTION

Mankind has been using drugs for the thousands of years through intelligent observation of instincts of animals in choosing or rejecting plant eat, through trials and error and through institution, mankind accumulated knowledge about useful and harmful plant.<sup>1</sup> In ancient times, teacher-students method was present and have their own ingeniously evolved standards of manufacturing processes.<sup>2</sup> They used highest pure ingredients for preparations of compound drugs for their own practice and have not any motive of commercial profitability.<sup>3</sup> When the method of collective education was introduced then it was not possible to manage a full class to taken to the forest repeatedly for practical demonstrations.<sup>4</sup> Gradually due to the human habitation spread, the forests become desert especially. Near the human habitation, the number of patients has increased and the physician wanted the medicine to be supplied by those who know them or tribal people. The scarcity and non-availability of medicinal plants tempted some old students to find out the substituents for them. Knowledge of saffron and therapeutic utility has increased and as cost of saffron increase, different adulterants adulteration methods etc.also increase. This felt the necessity of standardization of the king of spices of plant saffron. In this paper, the official requirements/standards of saffron (Family-Iridaceae) has been reviewed.

## History :

Julius Jully stated that 'Medicine can now be regarded as the oldest of Indian sciences, and has

\* Ex-Research Officer - Chemistry, 9, Ganesh Colony, Naya Bazar, Gwalior.

proved to be the science in which Indians specialized first'. Its value is not just as an Intellectual exercise but for its practical utility was recognized in our country (India) at a very dawn of human civilisation.<sup>2</sup> In ancient times *Guru-Shishya Parmparas* was present in India. Due to this reason every physician was a composite unit of intimate knowledge of morphological features, pharmacognostical methods, pharmacological properties and therapeutic effects of herb (saffron also) used in day-to-day practice<sup>3,4</sup>. In *vedic-sahitya* (5000 BC), 150 drugs are found in different *Mantra*. In *Charaka samhita* approximately 1000 plants are used as drugs and food (Aahar) (Table No.1).<sup>5</sup> *Charaka* and *Sushruta* samhita describe 1200 harbal drugs under 37 classes or *Ganas*.<sup>5</sup> After the Eberus Papyrue era (1500BC) several new drugs of plants, animals and minerals origin were introduced in medico-botanical literature. China (5000BC) has developed pharmacopoeia of plant derived drugs, so did the *Babylonia*, *Assvriana*, *Hebrews* and *Greeks*<sup>3</sup>. Indian physicians were well known the uses of saffron<sup>6,7</sup>. Saffron enjoyed special attention from *Egyptians*, *Greeks*, *Roman*, *Hebrews*, *Hindus* and *Muslims*. In ancient times and middle ages, saffron enjoyed great popularity as a drug, possessing several therapeutic properties.<sup>8</sup>

## Drugs :

(1) Ayurveda describes the drug as :

बहुता तत्र योग्यत्वं अनेक विध कल्पना ।  
संपचेति चतुष्कोऽयं द्रव्याणां गुण उच्यते । (चरक संहिता)  
बहुकल्पं बहुगुणं सम्पन्नं योग्यमौषधम् । (अष्टांग हृदयम्)

(2) Charaka Samhita : Even acute poison is converted into an excellent medicine by the right method of preparation and administration, while, even a good medicine may act as acute poison if improperly administered.

(3) Greek : Ancient Greeks word "Pharmacon" meant not only a curative drug but also a poison, a charm, a spell or an incantation. Today the word "drug" still has all these meanings.

#### Standardization :

(i) In ancient times, when substitution/adulteration has been started, at that time they had also prepared the points to maintain purity of drug (Table No. 2).<sup>9</sup>

(ii) Looking towards the above difficulties and demands like drug control act by different countries, it is extremely necessary that saffron to be properly identified and established. In the modern era, pharmacognosy developed certain methods and techniques to identify saffron, but these seem to be very complex. The official requirements/ standards of different countries are as follows :

#### (A) Food and Drug Administration (U.S.) :

The FDA stands require that saffron shall contain not more than 10% of yellow styles and other foreign organic matter, not more than 14% of volatile matter when dried at 100°C, not more than 7.5% of total ash and not more than 1% ash insoluble in HCl.<sup>10</sup>

According to FDA<sup>11</sup> saffron has GRAS status as a natural flavoring and flavour extractive. It is cleared for good use generally in amounts consistent with good manufacturing practices, except in standardized food, where food standards do not authorize its use.

As a colour additive for food use saffron is exempted from certification by the FDA.<sup>12</sup>

#### (B) The prevention of Food adulteration act (India) :

The PFA<sup>13</sup> requires that saffron shall not contain any foreign colouring matter or any other extraneous matter, and shall conform to be the following standards :

- |   |                   |
|---|-------------------|
| (i) Total ash                               | Not > 8% by wt.   |
| (ii) Ash insoluble in dil.Hcl               | Not > 1.5% by wt. |
| (iii) Volatile matter at 103±1°C            | Not > 14% by wt.  |
| (iv) Aqueous extract                        | Not < 55% by wt.  |
| (v) Total nitrogen<br>(on dry weight basis) | Not < 5% by wt.   |

(vi) Foreign matter i.e. sand, earth, dust, leaf, stem, chalk and vegetable matter. } Not < 1% by wt.

(vii) Floral waste defined as yellow filaments, pollen, stamens, part of ovary and other parts of flower of *C. sativus L.* Not > 15% by wt.

#### (C) British Pharmaceutical Codex<sup>14</sup> :

(a) Description (Macroscopical) : Red or reddish - brown tangled masses, composed of single stigmas or one to three stigmas attached to a portion of yellow style; stigmas hollow, narrowly obconical, and partially split longitudinally on the inner side, about 25mm long and 4 mm wide at the upper end, which is irregularly notched; free margin bearing cylindrical, stigmatic papillae upto 150 μ long. When quite dry, saffron is brittle to the touch; when damp it is more or less flexible; odour strong and aromatic, intensified when damped warmed; taste slightly bitter and characteristic devoid of any trace of sweetness.

(b) Identification test : A deep blue colour develops when placed in sulphuric acid.

(c) Alcohol (60%) soluble extractive Not less than 60% calculated with reference to the substance dried at 100° C.

(d) Ash Not more than 7.5 %.

(e) Colour intensity of aqueous extract 0.02g. yields to 100 ml of water a yellow colour similar in tint to, and not less in intensity than, that of 0.1% solution of potassium dichromate.

(f) Foreign organic matter Not more than 2%.

(g) Light petroleum extractive Not more than 1%.

(h) Loss on drying Not more than 14% of its weight when dried to constant weight at 100° C.

(i) Styles and anthers Not more than 8%.

#### (D) The Indian Pharmaceutical Codex<sup>15</sup> :

The IPC describes the macroscopic and microscopic characteristics of saffron and gives the following requirements :

- (a) Water soluble extractives Not less than 58%.  
 (b) Alcohol (90%) extractive Not less than 60%.  
 (c) Ash Not more than 7.5%.  
 (d) Petroleum ether (b.p. 40° to 60° extractive) Not more than 1 %.  
 (e) Loss on drying at 100°C Not more than 14 %.  
 (f) Styles Not more than 10 %.  
 (g) Foreign organic matter Not more than 2 %.  
 (h) Organic dyes 10mg does not give appreciable colour to any of the solvents, ether, chloroform, benzene, CCl<sub>4</sub> or Xylene  
 (i) Colour intensity 0.02 g. yields to 100ml of water a yellow colour similar in intensity and not less than that of a 0.1% solution of potassium dichromate.

**(E) International standard<sup>16</sup> :**

(a) The draft International standard<sup>16</sup> has classified saffron on the basis of filaments and its extraneous and floral waste contents into three categories as indicated below :

Sr. No.	Category	Floral waste % (m/m) max.	Extraneous matter % (m/m) max.
1.	Category I type (Mancha)	7	0.5
2.	Category II type (Rio)	13 - 15	1
3.	Category III type (Sierra)	17 - 20	1

(b) Saffron should have a specific flavour which is slightly bitter and little pungent; saffron should be free from foreign flavours.

(c) Saffron filaments are the dried full stigmas of *C. sativus* Linn., dark red in colour and rolled into cornets, scattered or indented at the distal end. The stigma may be either isolated or joined in two or three at the end of the portion of the style (which is also red in colour).

(d) Floral waste consists of yellow filaments, pollen, stamens, part of ovary, and other parts of the flowers of *C. sativus* Linn.

(e) Extraneous matter consists of leaves, stems, chaff and other vegetable matter. The only mineral matter permitted is sand, earth and dust.

(f) Yellow filaments have been defined as the dried yellow stigmas of *C. sativus* Linn.

(g) Saffron filaments are required to be free from living insects and molds, and practically free from dead insects fragments and rodents contamination visible to the naked eye (corrected, if necessary, for abnormal eye sight) using the required magnifying instruments in each particular case. If magnification is greater than 10x, it shall be mentioned in the test report.

(h) Chemical requirements for saffron in filaments or in powder form, as given by ISO (3632 - 1980), are presented in Table No. 3.<sup>16</sup>

**OBJECTIONS**

- (i) No maximum limits have been set for crude fibre.  
 (ii) No maximum limits difference between the percentages of reducing sugars before and after inversion have been set.  
 (iii) The value of colouring powder given above are on an experimental basis. (i) TLC pattern of pigments peculiar to saffron has been employed for checking its authenticity. According to the TLC method described Annex (E) of ISO standard, 1-μl portion of saffron extract (0.05 gm extracted with 2 ml of 80% v/v ethanol) is deposited on a silica coated plate. The plate is developed using as elution solvent consisting of 4:1:1 (by volume) mixture of butanol, acetic acid and water. For the resultant spots, R<sub>f</sub> values and other details are to be varified (Table No. 4.)

The three spots of R<sub>f</sub> 0.29, 0.43 and 0.56 are the principal spots and characterize the stigma of pure saffron. They are yellow orange coloured in day-light (orange if significant quantities are present). All the three give a brown fluorescence in the UV-light. However, the corresponding colour of the spots of R<sub>f</sub> 0.63, 0.80 and 0.96 has not been mentioned.

Saffron in powder form, when examined as above, shall not reveal the presence of pigments other than those peculiar to saffron.

**Microscopy of Saffron :**

Like other food materials, saffron has been distinguishing microscopic characteristics :

**(a) Transverse section of saffron stigma (Fig. 1) :**

- (i) A parenchyma, formed from cells which are polygonal or rounded of their angles, with walls of low thickness.

(ii) Vascular bundles, with a rounded section.

(iii) An epidermis, composed of a series of cells arranged in row, slightly elongated perpendicularly to the surface of the stigma and covered with cutical of low thickness; some of the cells of the epidermis have a small papilla in the centre of their external wall.

**(b) Microscopic characteristic of saffron powder :**

The main microscopic features of saffron powder (prepared by approximate methods) are :

(i) Fragments of the distal part of the stigma with large papillae which are elongated like hair (Fig.2).

(ii) Debris of the epidermis of the stigmata with small papillae (Fig.3).

(iii) Smooth grains of pollen (Fig. 4).

Other features that can be observed include parenchymatous debris, debris of the epidermis of the style, and debris of the thin vascular bundles (Fig.5).

**(F) Indian Standard Specification<sup>18</sup> :**

The ISI - 5463 - 1969 describes two grades of saffron, viz. 'Special' and Standard; which represent the trade grades of Mongra and Lachcha, respectively. The requirements are :

S. No.	Grade	Colour	Floral waste content % max.	Foreign matter % max.
1.	Special	Deep red	5	0.5
2.	Standard	Light reddish to bright	15	1.0

Saffron should meet the requirements of physical description, identification test (Pure saffron when placed in 0.1 g. of diphenylamine in 20 ml H<sub>2</sub>SO<sub>4</sub> and 4 ml H<sub>2</sub>O of immediately produces blue colour which rapidly turns to brown red; the blue colour persists in the presence of nitrates), tests and flavour, freedom from molds, insects etc. It should not contain any added foreign flavouring matter. The following chemical requirements should be satisfied.

S.No.	Characteristics	Requirments
1.	Matter volatile at 105°C, by weight max.	14 %
2.	Total ash, by weight,max.	08 %
3.	Ash insoluble in HCl, percent by weight, max.	1.5 %
4.	Aqueous extract, by weight min.	55 %
5.	Total nitrogen, by weight, min.	02 %

**(G) French Standard :**

The French standard is on the lines of the proposed ISO standard described earlier. Colouring powder of saffron extract is measured by the specific absorbancy of an aqueous extract at 440, 325 and 255 nm.<sup>19</sup>

**(H) Indian Standard Specification<sup>20</sup> :**

The IS - 5453 - 1996 described the classification of saffron filaments in four grades as follow :

S. No.	Grades	Floral waste, % by mass, max.	Extraneous matter % by mass, max.
1	Grade 1 (Shahhi)	00.5	0.1
2	Grade 2 (Mongra)	04.0	0.5
3	Grade 3 (Laccha)	07.0	1.0
4	Grade 4 (Gucchi)	10.0	1.0

Chemical requirements for saffron, in filaments or powder form are given in Table No. 3.

**Anatomical Structure of Saffron :**

**(a) Transverse section of stigma (Fig.1) :**

(i) A parenchyma, formed of polygonal cells or cells with rounded corners, with this walls.

(ii) Vascular bundles, of round cross-section.

(iii) An epidermis composed of a row of slightly elongated plate cell perpendicular to the surface of the stigmas and covered by a thin cuticle. Some epidermis cells have a small papilla in the middle of their outside walls.

**(b) The essential microscopic features of saffron powder :**

(i) Fragments of the top extremity of the stigmas with large, hair-like elongated papillae capable of reaching a length of 150µ m (Fig.2).

(ii) Epidermis debris of stigmas with small round papillae (Fig.3).

(iii) Round pollen grains of large diameter (85µ m to 100µ m) with a thick, smooth cell wall and with a finely granular exine (Fig.4).

(iv) Parenchymatous debris (Fig.5).

(v) Debris of the epidermis of the style, consisting of long, thin-walled and slightly sinuous cells (Fig.5).

(vi) Debris of thin vascular bundles (Fig.5).

**Important :** Saffron powder does not have sclerous cells, fibres, covert hair or starch grains. The contents of the cells dissolve in water to give an orange-yellow colour.

TABLE NO. 1 : DRUGS KNOWN IN EACH COUNTRY IN ANCIENT TIMES :

S. No.	Name of Country	Number of drugs
1.	Avicenna	760
2.	Asayrian	300
3.	Babylon	300
4.	Chinese	265
5.	Egyptian	700
6.	Hindu	760 (1000)
7.	Hypocrate	400
8.	Persian	584
9.	Theophrastres	500

TABLE NO. 2 : PURITY AND PROPERTY TESTS OF DRUGS IN ANCIENT PERIOD :

Drug Test (औषधस्य परीक्षा)		Standardization (प्राचीन मानकीकरण मापदण्ड)		Standardization confirmation (मानकीकरण की कसौटियाँ)	
क्र.सं.	परीक्षा	क्र.सं.	परीक्षा	क्र.सं.	परीक्षा
१.	इदमेवं प्रकृत्या	१.	शब्द	१.	अग्नि
	स्वभाव		खरखर, कचकच, फुसफुस		निर्धूमत्व, स्थैर्य गंध
२.	गुणम्	२.	स्पर्श	२.	अंगुली
	गुणवत्ता		खर, श्लक्ष्ण, मृदु, कठिन, शीत, उष्ण		रेखापूर्णत्व, श्लक्ष्णता
३.	प्रभावम्	३.	रूप	३.	अम्ल
	विशिष्ट कार्यक्षमता		प्रभा, वर्ण, स्निग्ध, रूक्ष		फुसफुस शब्द स्थिरता, रंग
४.	अस्मिन् देशे जातम्	४.	रस	४.	आमलकी
	उत्पत्ति स्थान, औषधि निर्माता		कटु, तिक्त इत्यादि		रंग स्थैर्य
५.	अस्मिन् ऋतौ एवं गृहीतम्	५.	गंध	५.	कदली
	संग्रहकाल		सधूम, निर्धूम		पाक
६.	निहितं एवं उपस्कृतं	६.	धूम	६.	खल्व
	संग्रहस्थान तथा संस्कार		सचंद्रिका, निश्चन्द्रिका		खरखर (शब्द)
७.	अनया मात्रया युक्तं	७.	चंद्रिका	७.	चालनी
	मात्रा		---		सूक्ष्मत्व
८.	अस्मिन् व्याधौ	८.	अपुर्णभव	८.	जल
	रोगघ्नता		---		लघुत्व
९.	एवं विधस्य पुरुषस्य	९.	लघुत्व	९.	जिह्वा
	रोगी		---		दाहकत्व
१०.	अपक्ववति/उपशमयति	१०.	वारितरत्व	१०.	घ्राण
	रोग निवारकता		---		गंध, अग्नि
११.	एतावहं दोष	११.	स्थिरत्व	११.	त्वक्
	उपभोक्ता (वैद्य-रुग्ण)		---		स्पर्श
		१२.	सूक्ष्मत्व	१२.	दंत
			चूर्ण, रेखापूर्णत्व		कचकच
		१३.	स्नेहाकर्षण	१३.	दही
			---		रंग स्थैर्य
				१४.	नेत्र
					प्रभा, वर्ण सूक्ष्मत्व
				१५.	पंचमित्र
					अपुर्णभव
				१६.	भृंगराज
					निरुत्थत्व
				१७.	लोह चुंबक
					स्नेहाकर्षण
				१८.	सूर्य
					चंद्रिका
				१९.	सूक्ष्मदर्शिका
					चंद्रिका सूक्ष्मत्व
				२०.	क्षार
					अपुर्णभव

TABLE NO. 3 : CHEMICAL REQUIREMENTS FOR SAFFRON, IN FILAMENTS OR IN POWDER FORM :

S. No.	Characteristic	Requirements	
		Saffron in filaments	Saffron in Powder form
1.	Moisture and volatile matter, % by mass, max.	12	10
2.	Total ash, % by mass, on dry basis, max.	08	08
3.	Acid insoluble ash, % by mass of dry basis, max.		
	(a) Grade 1 & 2	01	01
	(b) Grade 3 & 4	1.5	1.5
4.	Solubility in cold water, % by mass on dry basis max.	65	65

Contd...

5.	Bitterness, expressed as direct reading of the absorbance of picrocrocin at 257 nm, on dry basis, max.		
(a)	Grade 1	70	70
(b)	Grade 2	55	55
(c)	Grade 3	40	40
(d)	Grade 4	30	30
6.	Safranal, expressed as direct reading of the absorbance at 330 nm, on dry basis.		
	Min.	20	20
	Max.	50	50
7.	Colouring strength, expressed as direct reading of the absorbance of crocin at 440 nm, on dry basis, max.		
(a)	Grade 1	190	190
(b)	Grade 2	150	150
(c)	Grade 3	110	110
(d)	Grade 4	080	080
8.	Total nitrogen, % by mass.	003	003
9.	Crude fibre, % by mass on dry basis, max.	006	006

TABLE NO. 4 : EVIDENCE OF PIGMENTS PECULIAR TO SAFFRON :

S. No.	R <sub>f</sub> (relative to the front-approximate value)	Intensity of spots	Colour of spots	
			Day light	UV-light
1.	0.96	Very faint	Yellow orange	---
2.	0.80	Very faint	Yellow orange	---
3.	0.63	---	Yellow orange	---
4.	0.56	Clear	Yellow orange	Brown
5.	0.43	Clear	Yellow orange	Brown
6.	0.29	Significant	Yellow orange	Brown

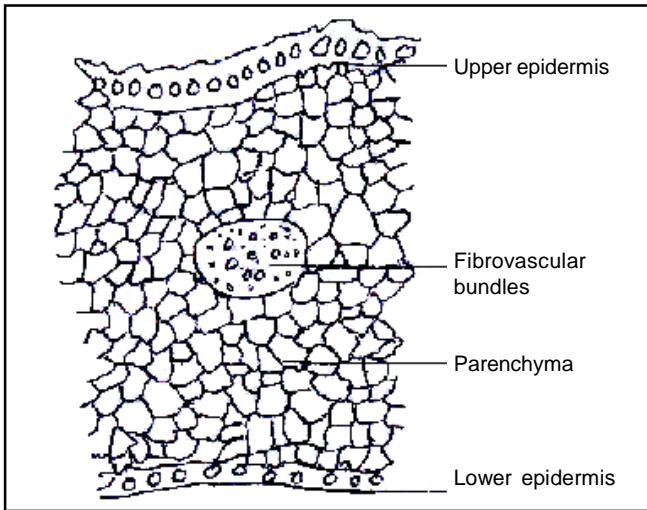
TABLE NO. 5 : PROXIMATE COMPOSITION OF SAFFRON :

S. No.	Country	Water %	Protein %	Fixed oil %	Volatile oil %	N-free extract %	Starch equiv. %	Fibre %	Ash %
1.	Spanish	15.59	12.57	04.69	00.81	57.30	11.99	04.88	04.05
2.	Italian	14.45	13.58	08.57	00.37	54.39	12.51	04.38	04.26
3.	Persia (India)	09.20	10.15	05.63	00.60	43.64	13.15	04.43	04.40
4.	Greek	8.5-9.6	---	---	1.01-1.12	---	---	---	05.10

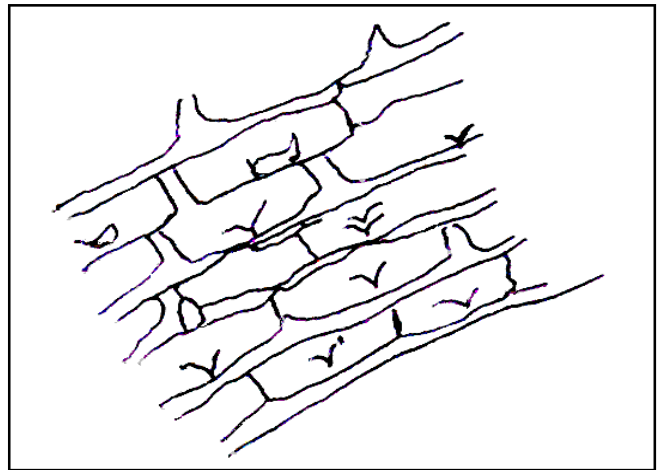
TABLE NO. 6 : PROXIMATE ANALYSIS OF COMMERCIAL SAFFRON (% w/w) :

S.No.	Test	Response %
1.	Moisture	10.0
2.	Water soluble matter including	53.0
	(a) Sugar (invert)	14.0
	(b) Gums	10.0
	(c) Pentosans	08.0
	(d) Pectin	06.0
	(e) Starch	06.0
	(f) $\alpha$ -crocin	02.0
	(g) Other carotenoides	01.0
3.	Protein (N x 6.25)	12.0
4.	Ash (inorganic matter)	06.0
5.	Ash insoluble in HCl	00.5
6.	Non - volatile oils	06.0
7.	Volatile oils	01.0
8.	Crude fibre	05.0

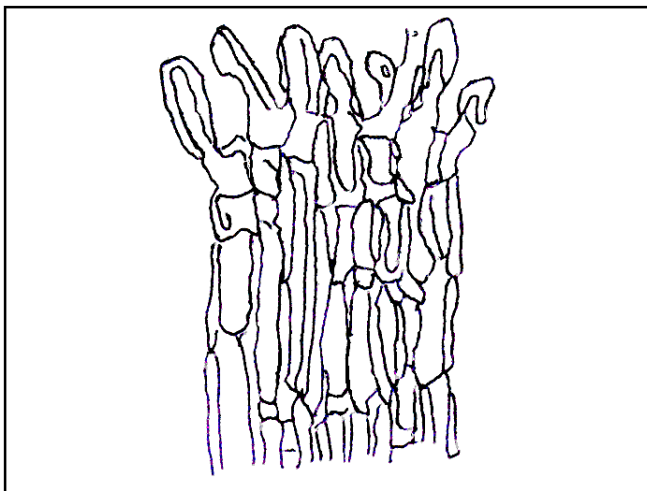
**FIG. NO. 1 : TRANSVERSE SECTION OF STIGMA OF SAFFRON (CROCUS) :**



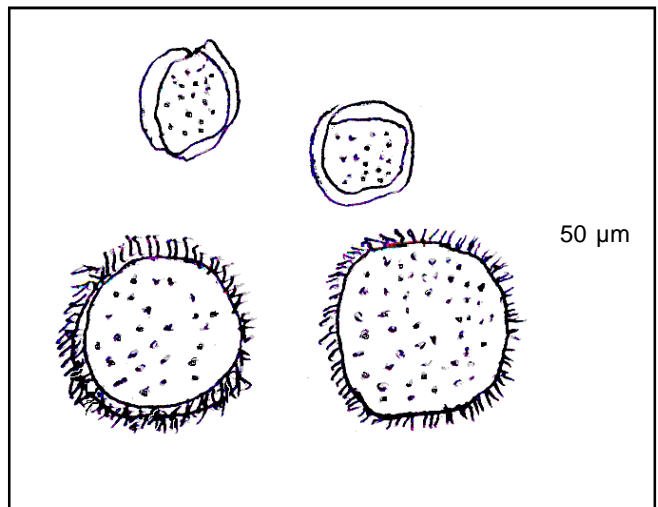
**FIG. NO. 3 : UPPER EPIDERMIS OF THE STIGMA OF SAFFRON CROCUS (FRONT VIEW) :**



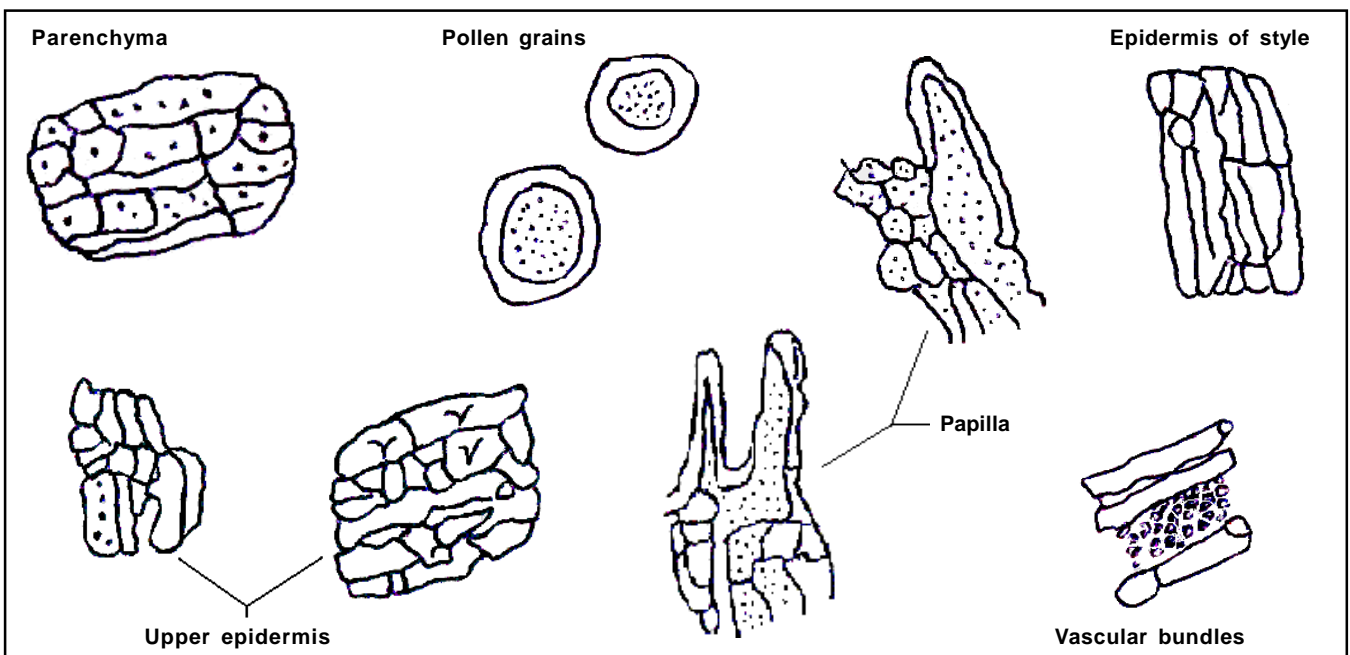
**FIG. NO. 2 : UPPER EXTREMITY OF STIGMA OF SAFFRON (CROCUS) :**



**FIG. NO. 4 : POLLEN GRAINS OF SAFFRON (CROCUS) (MAGNIFICATION x 300) :**



**FIG. NO. 5 : SAFFRON IN POWDER FORM :**



**Evidence of pigments peculiar to saffron :**

Using the microsyringe or the micropipette (5 $\mu$ l and 10  $\mu$ l) deposit separately in bands of length 2 cm to 4 cm on silica gel plate 5  $\mu$ l of the solution to be examined and 5  $\mu$ l of the reference standard solution. Develop in the cell with the elution solvent (ethyl acetate : propa-2-ol : water, 65 : 25: 10 Volume) until the solvent front has progressed 10 cm.

(i) *Observation in day-light* : The lower third of the chromatogram shows three yellow spots. The spot on the bottom strip is of more intense colour, and corresponds in colour and size to the Naphthol yellow spot. It characterizes crocin.

(ii) *Observation in UV - light* : The chromatogram observed in UV - light at a wavelength of 254 nm shows four main fluorescent spots, three corresponding to the spots observed in day light and another with a higher  $R_f$  value (around 0.55), which characterizes picrocrocin.

**Spraying with the revealing solution :**

(a) *Revealing solution sudan red G* : One or two rather faint spots of fluorescence are visible characterizing  $\beta$  - hydroxycyclocitral and safranal.

(b) *Revealing solution* (4 - methoxybenzaldehyde: ethanol : sulphuric acid, 10:90:10).

(i) Crocin becomes greyish green in colour.

(ii) Picrocrocin becomes violet in colour.

**Important** : The chromatogram shall not show any other colour spots (Particularly yellow-orange or red spots) before spraying, particularly at the starting point. These would correspond to a deterioration of the crocin and / or the presence of foreign colouring matter.

**Comparative studies of commercial saffron :**

The chemical composition of commercial saffron of four countries i.e. Spain, Italian, Persia (India) and Greece are given in Table No. 5. The analysis reflects the excellent quality of Greek saffron<sup>21, 22</sup>.

**OBJECTION OF STANDARDIZATION****(A) Ayurveda<sup>23</sup> :**

These are the following objections of standardization of quality control of saffron and prepared compounds.

(1) The question of standardisation of quality control depends on the nature of saffron and its drugs, on its source i.e. *Bhumi* (soil), *Desha* (climate) and *Ritu*

(the period of the year - season) which are the potent causes of variations in the properties, and also the *Samskara* (Processes) through which it is subjected to pass i.e. cultivation, manure, irrigation facility, manufacture, storage etc.

Due to these natural conditions the percentage of the chemical constituents of the saffron plant, their morphological growth does not remain uniform. The same will also for compound products and processes of compound formation to vary from region to region / country to country / person to person.

(2) Dosha comes next on which actions and usefulness in a living body is to be judged. Pharmacodynamics and therapeutics effects can not be expected unless there is uniformity in the contents of natural drug and its properties are also of the same grade. Action of *Aushadha* (Therapeutic agent) in the body are also varied - some act on particular organ / a system, body fluid / microbes, *Dosha Prashamana* (medicinal effect), *Dhatupradushana* (Literious and toxic effects). Saffron / its drugs are examined 'in-vitro' and 'in- vivo' to fix their minimum dose before using in human as a therapeutic agent. Ayurveda has given emphasis as :

भेषजं हि अनभिज्ञातं नामरूपगुणैस्त्रिभिः ।  
विज्ञातं चापि दुर्यकं अनर्थायोपपद्यते ॥ (चरक सूत्र १)

मात्राकालाश्रया युक्ति सिद्धियुक्तयोव्यपाश्रिताः ।  
तिष्ठत्युपरि युक्तज्ञैः द्रव्यज्ञानवतां सदा ॥ (चरक सूत्र २)

(3) Ayurveda has given the physical properties, active principal and pharmaceutical processes through which it is subjected to pass, should also of some fixed standard to ensure desired quality of action which represent respectively to *Prakriti*, *Nama*, *Rupa*, *Rasa*, *Gunavijnana*, *Vipaka* and *Viryavijnana*, *Vidhivisheshha* or *Karana*, *Samskara* or *Kalpana* and finally *Prabhava vijanana* (specific action) of saffron and prepared drugs.

(4) Ayurveda describes the average fixed standard and is expressed in definite *Samkhya* (Figure). It is not possible to arrive at the idea of plus, minus points (*Sama*, *Vishama* or *Pravara*, *Hina*, *Madhya* or *Kshaya*, *Sthana* and *Vridhhi* ) of doses and potency of the saffron actions.

(5) Importance of standard value of saffron / its drug etc qualities (*Guna*, *Rasa*, *Virya*, *Vipaka* etc.) and constituents of saffron (*Parthivadi Dravya* or normal or abnormal states of etiological factors (*Dosha*, *Dhatu*, *Mala*) and their effects and pathological changes in the body *vikara samprapti* have been emphasized in ancient books.

(6) There is emphasis given on relative dominance of properties and functions, (*Anshansha kalpana*); there is no clue or relevant accurate means and methods or techniques to express facts in figures. Due to this reason, no two *vaidyas* follow one procedure and drive the same conclusion.

(7) Modern science has established new methods, techniques and relevant precise instruments for verification of standards of drugs and diseases, but how they will find *Paraparaty* (low or high quality) in varying conditions i.e. *Triguna*, *Panchabhuta*, *Tridosha*, *Doshapaka*, *Dhatupaka*, *Ama*, *Agnibala* etc. in living organism and *Rasa*, *Guna*, *Veerya*, *Vipaka*, *Prabhava*, *Bhutotkarsha* and *Samanya* and *Vishesha* in drugs and diseases in complex problems.

Charaka describes regarding standardization as ; Bahuvidha pariksha, Bahavidham Parikshyam, Bahubhihi Parikshakaihi, Bahavidham Parikshyaha.

Ayurveda also says that new approach (modern scientific progress) should be accepted.

#### (B) Modern Science :

The approximate analysis of commercial saffron (the dried red stigma, *Crocus sativus* L.) has been reported Table No. 6. <sup>8, 18, 24-31</sup>

(1) The chemical analysis include the guarantee of correct botanical identification, the risk of partial adulteration, and the new presence of floral waste.

(2) It is probably inevitable that parts of the yellow-to-uncoloured style, anther, petals and leaves, are found.

(3) Various limit of floral waste (1%, 5%, 10%, 15%), depending on the declared quality category <sup>24,27, 32</sup>. Still some problems are present:

(a) Leaves should really not be present at all.

(b) Flowers picked once they have begun to wilt after their 2-3 days bloom can not be readily be separated into their constituent parts. <sup>33</sup>

(c) Separate analysis of styles, particularly their tops. <sup>31</sup>

(d) The presence of coloured positive-quality taste parameters.

(4) The value of reducing sugars (before and after inversion) have not fixed. <sup>8</sup>

(5) The colour of saffron was evaluated, in earlier days, by comparing the colour of the aqueous extract visually or photometrically. Commercial saffron was examined by Dubosque immersion coloremeter. <sup>34,35</sup>

(6) The colour intensity is expressed as the extinction (optical density) of a hypothetical 1% (w/v) solution at the wave length of its visible spectral maximum, in a 1 - cm cell and is written as  $E_{1\text{cm}}^{1\%}$ .  $E_{1\text{cm}}^{1\%}$  of category I commercial saffron is not less than 110 or 150 for hay and powdered (whose colour is presumably extracted more completely), in water at 440 nm. <sup>37</sup> For comparison, pure  $\beta$  - carotene at 451 nm in cyclohexane has as  $E_{1\text{cm}}^{1\%} = 2505$ . The precise wavelength at spectra peak of carotenoids tends to shift as a function of the solvent employed. <sup>38</sup>

(7) The lower concentration of water soluble and insoluble carotenoids have also effect of colour intensity. <sup>39-41</sup>

(8) The risk of adulteration, this is generally followed by TLC of aqueous control. <sup>24,26,42-50</sup> The chromatogram shall not show by other colour spots (particularly yellow - orange or red - spots) before spraying particularly at the starting point. These would correspond to a deterioration of the crocin and/or the presence of foreign colouring matter.

(9) High value of saffron, <sup>33</sup> many other types of adulteration have been attempted by unscrupulous dealers. <sup>8, 51-54</sup>

(10) All carotenoids have oxidising properties; C=C bonds opening to receive oxygen atoms and consequently diminishing the characteristic colour. This reaction is catalyzed by light. The conjugative nature of the bond chain provides some protection from oxidation, but on the other side, the reaction protects an organism from further oxidative damage.

(11) The undried fresh stigma have a strong attractive odour to bees and humans. Bees found in *crocus* flowers are frequently soporific. The odour of commercially dried saffron has been identified as principally due to an aldehyde, safranal, but it is not known whether the identity holds for the fresh odour as well. Safranal boils at 172°C at atmospheric pressure <sup>55</sup> and is sufficiently volatile at lower temperature to be lost if given enough time. <sup>55, 56</sup> Other odoriferous volatiles are also present, in different concentration from 2 to 29% relative to safranal. <sup>57</sup>

(12) The bitter but pleasant taste of saffron <sup>28</sup> is due to a glucoside (a glycoside with glucose as the sugar) picrocrocin, which can be broken down by heating <sup>58</sup> or enzymatically <sup>56,59</sup> into approximate 4% picrocrocin, also known as saffron bitter. <sup>60-62</sup> The structural difference between the  $\beta$  - and  $\alpha$  - configurations of D-glucose/ other sugars :  $\beta$  of  $\beta$  - carotene has an entirely different connotation.

(13) Different methods of cultivation, harvesting and processing.<sup>63-68</sup>

(14) Uses of manure, fertilizers and pesticides.<sup>63, 69-78</sup>

(15) Environmental effects, humidity and packing.<sup>79-95</sup>

(16) Different methods for estimation of compounds.<sup>63,64, 96,97</sup>

(17) Dose is also a matter of dispute probably arising from the wide composition-range of the commercial product i.e. large enough dose can be toxic, in excess depresses appetite, unspecified overdose are narcotic. About 0.5 gm is for death's door and 1.5 gm has proved fatal. 10 g. dose was also used for treatment. One side the effect of saffron is poisoning and another side it is no toxic effects - possibly the results of quite different doses.<sup>98-106</sup>

(18) Crocin, crocetin and picrocrocin can be determined by TLC method, mobile phase (1-butanol : acetic acid : water, 4 : 1 : 1 v/v), but not volatile safranal component can be detected.<sup>107,108</sup>

(19) Quality grading is using colour as the main variable in grading and detection of adulteration of saffron. Picrocrocin, safranal and crocin content are estimated from the UV - absorption maxima 257, 330, 440 nm, respectively. Purified standards of these compounds, however, exhibit absorption maxima under UV-spectroscopy of 250.5 nm of picrocrocin, 311 nm of safranal and 443 nm of crocin. Recent investigation indicate that the UV maxima at 257 and 330 nm closely correspond to glycosidic bonds of crocin and cis-crocin respectively, and make the use of absorption at 257 nm for safranal and 330 nm of picrocrocin unreliable indices of these chemicals. Instead, the absorption at 257 nm and 330 nm would appear to be related to colour indicates rather than aroma and bitter indices.<sup>108-112</sup>

(20) Saffron secondary products extracted from stigmas were quantified using a Kitachi U - 2001 UV - visible, double - beam spectrophotometer. The absorption maxima and extinction coefficients used were : crocin, 443 nm - 89,000 mole<sup>-1</sup> cm<sup>-1</sup>; picrocrocin, 250.5 nm- 10,1001 mole<sup>-1</sup> cm<sup>-1</sup>; crocetin, 424 nm -30328 I mole<sup>-1</sup> cm<sup>-1</sup> and safranal, 311 nm - 9280 I mole<sup>-1</sup> cm<sup>-1</sup>.<sup>113</sup>

(21) The chromatogram shall not show any other colour spots (particularly yellow- orange or red spots) before spraying, particularly at the starting point. These would correspond to a deterioration of the crocin and or the presence of foreign colouring matter.<sup>20</sup>

### Abandonce :

The traditional medicinal uses of saffron have been gradually abandoned by some countries. In Italy, the saffron entry was first omitted from the Pharmacopoeia Ufficiale Italiana in 1964.<sup>114</sup>

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### REFERENCES

- 1 Lele, R.D., 1999, Molecular Pharmacology : The theme of the 21<sup>st</sup> century, Pharma Times. 31, 7, 15.
- 2 Saxena, R.B., 2002, Relation between Anupans and Pharmaceutical Aspects of Abhrak bhasma, Sachitra Ayurved. 54, 11, 852 - 855.
- 3 Saxena, R.B., 2002, Molecular Pharmacology : A new interface between Ayurved and Modern Medicine, Sachitra Ayurved. 53, 2, 141 - 144.
- 4 Saxena, R.B., 1997, Bhartiya kimiyyagar or Rasayana, Sachitra Ayurved. 49, 10, 729.
- 5 Diwedi, V., 1966, Drugs in Ayurveda and their classification, Institute for Ayurvedic studies and Research - Jamnagar. 5 P.
- 6 Saxena, R.B., 2002, A review on saffron, (Crocus Sativus Linn.) Vol 2, Series Recent progress Report in Medicinal Plants, SCI TECH pub., U.S. A.. 295 - 306 P.
- 7 Sharma, P.V. and K. C. Chunekar, 1956, Dravyaguna Vigyan, Vol. 1 - 3, Chowkhamba Vidya Bhavan Chowk, Banaras.
- 8 Sampathu, S. R. S. Shivashahan and Y.S. Lewis, 1984, Saffron (crocus sativus Linn) - cultivation, processing, chemistry and standardisation, CRC Crit. Rev. Food Sci. Nutr. 20, 123 - 157.
- 9 Chaturvedi A, 2003, Aushada-Parikshana-Prachin and Arbachin, Sachitra Ayurved. 55, 8, 580 - 584.
- 10 Jacobs. M. B., 1951, The chemical analysis of Foods and Food products, Vol. 2, 2<sup>nd</sup> ed. Van Nostrand, New York. 589 P.
- 11 Code of Federal Regulation, 1978, 21 Foods of Drugs, Part 100 to 199, U.S. Office of the Federal Register, Washington, D.C.
- 12 Food colour, 1971, National Academy of Science, Washington, D.C.

- 13 The prevention of Food Adulteration act. 1954, 1980, 5<sup>th</sup> ed. (including 3<sup>rd</sup> amendment), Eastern Book, Lucknow, 91 P.
- 14 The British Pharmaceutical Codex, 1949, Pharmaceutical press, London, 276 P.
- 15 The Indian Pharmaceutical Codex, Vol. 1, 1953, Council of Scientific and Industrial Research, New Delhi. 83 P.
- 16 Draft International standard, 1978, Saffron - specification ISO/DIS 3632.2, International Organisation for Standardisation (Final Standard - ISO 3632 of 1980).
- 17 Draft International Organisation or ISO, 1980, Specification for Saffron - 3632. Identical, 1981. British Standard, BS 6145.
- 18 Indian Standard Specification for Saffron. IS, 5453 - 1969, Indian Standards Institution, New Delhi.
- 19 French Standard, 1976, spices and Condiments, saffron; specification France (AFNOR) NFV 32 - 120 (in French).
- 20 Indian Standard, 1966, saffron IS 5453 part I and II, Bureau of Indian Standard, New Delhi, 1-3 & 1 - 12 P.
- 21 Winton, A.L. and K.B. Winton, 1939, The structure and composition of Foods, Vol.4, John Wiley and Sons, New York 278 P.
- 22 Goliaris, A.H., 1999, Saffron cultivation in Greece, Medicinal and Aromatic plants - Industrial Profiles, Harwood Academic Publishers, Singapore. 78 - 86 P.
- 23 Thakar, V.J. 2003, Standardisation and Quality Control of Ayurvedic Drugs, Souvenir, 4<sup>th</sup> International Seminar on Ayurvedic Education, Research & Drug Standardisation - A Global perspective, Gujarat Ayurved University, Jamnagar. 29 - 30.
- 24 International Standards Organization, 1970, Saffron, 3<sup>rd</sup> draft proposal, ISO/TC 34/SC 7, 215 E, Geneva.
- 25 Melchior, H. and H. Kastner, 1974, Gewarza, Verlag Parey, Berlin, 147 - 150 P.
- 26 Baskar, D. and Negbi, 1985, Crocetin equivalent of saffron extracts : Comparison of three extraction methods, J. Assoc. Pub. Analysis, 23, 65 - 69.
- 27 Nicholls, J.R., 1945, Aid to the Analysis of Food and Drug, 6<sup>th</sup> Edn, Bailliere, Tindall and Cox, London, 195 P.
- 28 Sastry, L.V.L., M. Shrinivasan and V. Subrahmanyam, 1955, Saffron (*Crocus sativus* Linn.), J. Sci. Ind. Res. (India), 14 - A, 178 - 184.
- 29 Triebold, H.O. And L.W. Aurand, 1963, Food composition and analysis, Van Nostrand Company, Inc. Princeton, N.J., 464 P.
- 30 Stecher, P.G. (Ed), 1968, The Merck Index, 8<sup>th</sup> Edn Merck and Co., Inc. Rahway, N.J., 831 928 P.
- 31 Skrubis B., 1990, The cultivation in Greece of *crocus sativus* L., In F. Tammaro and L. Marra, Eds., Lo Zafferance Proc. Internat. Conf. of saffron, L' Aquila, Italy, Universita Della Studi L' Aquilae Accademia Italiana Dell Cucina, L' Aquila, 171-182 P.
- 32 Krogh, G. and K. Akenstrand, 1980, Saffron - authentic or adulterated?, Var Foda, 33 -346 -353 (in Swedish).
- 33 Baskar, D., 1993, Saffron, The costliest spice: drying and quality, supply and price, Acta Hort., 344 , 86 -97.
- 34 Moewas, F., 1940, Carotenoid derivatives as sex-determining substances of algae, Biol. Zentr., 60, 143.
- 35 Fischer, G. G., 1933, Colorimetric investigations of certain saffron tests, Apoth Ztg., 48, 747.
- 36 Booth, V.H., 1957, carotene; its determination in Biological Materials, Heffer, Cambridge.
- 37 International Standards Organization, 1980 a, Saffron specification, ISO 3632, Geneva.
- 38 Issler, O. and P. Schudal, 1963, SunthesaUnd Markierung von caritunen und carotinoiden. In K. lang , (Chairman), Carotene and carotinoide symposium, Wissenschaftliche veroffentlichungen der Deutsche Gasellschaft fue Ernährung, Mainz, October 1961, Steinkopff verlag, Darrustadt.
- 39 Pfander, H. and F. Wittwer, 1976 a, Untersuchungen zur carotenoid - zusammensetzung in saffron II, Helv. Chim. Acta., 58, 1608 - 1620.
- 40 Pfander, H. and F. Wittwer, 1975 b, Untersuchungen zur carotenoid - zusammensetzung in saffron III, Helv. Chim. Acta., 58, 2253 - 2236.
- 41 Dhingra, V.K. ,T.R. Seshadri and S.K. Mukerjee, 1975, Minor carotenoid glycosides from saffron (*crocus sativus* Linn.) , Indian J. Chem., 3, 339 - 341.
- 42 International Standards Organisation, 1980 b, Spice and condiments Determination of cold water extract. ISO 941, Geneva.
- 43 Hanson, N.W. (Ed), 1973, Official, Standardised and Recommended Methods of Analysis (2<sup>nd</sup> Edn), Society for Analytical Chemistry, London, 647 P.
- 44 Kalia, K. 1932, Evaluation of saffron, Pharmacia, 10, 3.
- 45 Huss, H., 1922, Saffron and its colour value, Tek-Tid., 52,56.
- 46 Karrer, P. and H. Solomon, 1927, Colouring matter of saffron, Helv. Chim. Acta., 10, 397.
- 47 Foppen, F.H., 1971, Tables for identification of carotenoid pigments, Chromatogr. Rev., 14, 133-298.
- 48 Parvaneh, V., 1972, A note on the assessment of purity of saffron colour, J. Assoc. Publ. Analysis., 10, 31 -32.
- 49 Zweig, G. and J. Sharma, 1972, Handbook of chromatographic CRC press, Cleveland, OH, 540 P.
- 50 Dhar, D.N. and S.C. Suri, 1974, Thin Layer chromatographic detection of dyes as adulterants in saffron, J. Inst. Chemists ( India), 46, 130 - 132.
- 51 Hordh, U., 1934, Saffron and its adulteration, An. Assoc. Quim Argent 22,45.
- 52 Pliny (the Elder) , 1887, (1<sup>st</sup> Century CE) Natural History, Bostock, J. and H.T. Riley (Trans), Bohn.
- 53 Lowell, G., 1964, Saffron adulteration., J. Assoc. Office. Agric. Chemists., 47, 538.
- 54 Encyclopaedia judaica, 1973, Keter Publishing House, Jerusalem, 14,631 P.
- 55 Furia, T.F. and N. Bellanca., 1975, Fenaroli's Handbook of Flavour Ingredients, CRC Press, Inc., Cleveland, OH 2, 515 P.
- 56 Guenther, E., 1952, The essential Oils, Van Nostrand Company, Inc., New York, 6 , 105 P.
- 57 Zarghami, N.S. and D.E. Heinz, 1971, monoterpene aldehydes and Isophorone - related compound of saffron, Phytochemistry, 10, 2755-2761.
- 58 Stahl, E. and C. Wagner, 1969, TAS - method for the microanalysis of important constituents of saffron, J. Chromatog., 40, 308.
- 59 Zarghami, N. S., 1970, The volatile constituents of saffron (*crocus sativus* Linn.) Ph.D. Thesis, Univ. Calif Davis., 83 P.
- 60 Lutz, H.E. W, 1930, Picrocrocin, the bitter principal of saffron, Bio-chem. Z., 226, 97.
- 61 Buchecker, R. and C.H. Eugster, 1973, Absolute configuration of picrocrocin, Helv. Chim. Acta., 56, 1121 - 1124.

- 62 Parry, J.W., 1962, Spices their morphology, history and chemistry, Chemical Publishing Company Ind., New York, 208 P.
- 63 Saxena, R.B., 2002, A review on cultivation of saffron (*crocus sativus* Linn.), Series Recent Progress in Medicinal Plants, vol. 5, SCI TECH pub. U.S.A., 295-320 P.
- 64 Saxena R. B., 2002, A review on Harvesting, Processing and yield Of saffron, series Recent progress in Medicinal plants, vol 5, SCT TECH Pub. U.S.A., 295-320 P.
- 65 Negbi, M., 1999, Saffron cultivation, Past, present and Future Prospects, Medicinal and Aeromatic Plants, Industrial Profiles, vol. 8 Hardwood Academic Publ. 1 Overseas Publ. Assoc. Amsterdam, 1- 17 P.
- 66 Tamaro, F., 1999, The present state of saffron cultivation and Technology in Italy, Medicinal and Aeromatic Plants-Industrial profiles, vol. 8, Harwood Academic Publ 1 Overseas Publ.Assoc. Amsterdam, 53 - 62.
- 67 Bhaskar D., 1999, Saffron Technology, Medicinal and Aeromatic Plants Industrial profiles, Vol.8, Harwood Academic Publ. 1 Overseas Publ. Assoc. Amsterdam, 95 - 102 P.
- 68 Galigani, P.F. and F.G. Pegna, 1999, Mechanized saffron cultivation, including harvesting, Medicinal and Aeromatic Plants - Industrial profiles, vol.8, Harwood Academic Publ. 1 overseas Publ. Assoc. Amsterdam, 115 - 126 P.
- 69 Giyal, H.R., P.C. Sharma. O.P. Gupta and M.R. Uniyal, 1995, Experimental cultivation of saffron, Central Council for Research in Ayurved and Siddha, New Delhi, 32 -34 P.
- 70 Madan, C.L., B.M. Kapur and U.S. Gupta, 1966, Saffron, Eco. Bot., 20, 4, 377 - 385.
- 71 Ingram, J.S., 1969, Saffron (*crocus sativus* Linn.), Tropical Science, 11, 3, 177 -184,
- 72 Escauriaza, R.D., 1926, The cultivation of saffron and its importance in Spain, Spice Mill., 49, 11, 2092 - 2095.
- 73 Shrivastava, R.P., 1963, Cultivation of saffron in India, Fertilizer News., 8, 9, 7 - 11 P.
- 74 Behzad, S., M. Razavi and M. Mahajeri , 1992 b, The effect of mineral nutrients (N.P.K.) on saffron production, Acta Horticulture, 306, 426 - 430 P.
- 75 Behzad, S.M. Razavi and M. Mahjери, 1992 a, The effect of various amounts of ammonium phosphate and urea on saffron production, Acta Horticulturae, 306, 306 - 339 P.
- 76 Chungoo, N.K. and S. Farooq, 1984, Influence of gibberellic acid and naphthalen-acetic acid on the yield and on growth in saffron (*C. sativus*). Indian Journal of plant physiology, 27, 201 - 205.
- 77 Dhar, A.K., R. Sapru and K. Rekha, 1988, Studies on saffron in Kashmir I. variation in natural population and its cytological behaviour, Crop improvement, 15, 48 - 52
- 78 Xiue, X.H. et.al., 1986, Effect of increasing yield of gibberellin treated *crocus sativus* , Bulletin of Chinese Materia Medica, 11, 650 - 652 (in Chinese)
- 79 Najar, S.V., F.O. Bobbio and P.A. Babbio, 1988, Effect of light, air, antioxidants and pro-oxidants on annato extracts (*Bixa orellana*) Food Chem. 29, 283 - 289 P.
- 80 Tsimidou, M. and C.G. Biliaderis, 1997, Kinetic studies of saffron. (*crocus sativus* L.) quality deterioration, J. Agric. food Chem. 45, 2890 - 2898.
- 81 Pesek, C.A. and J. J. Warthesen, 1990, Kinetic modal for. Photo-isomerization and concomitant photodegradation of  $\beta$ -carotenes, J. Agric. Food Chem., 38, 1313 - 1315.
- 82 Chou, H.E. and W.M. Breena, 1972, Oxidative decoloration of  $\beta$ -carotene in low moisture model system, J. Food Sci. 37, 66 - 68 P.
- 83 Tsimidou, M. and E. Tsatsaroni, 1995, Stability of saffron pigments in aqueous extracts, J. Food Sci., 1073 - 1075.
- 84 Pfsnder, H. and H. Schurtenberger, 1982, Bio-synthesis of C20 carotenoids, in *crocus sativus* Linn. Phytochemistry, 21, 1039 - 1042.
- 85 Tsimidou, M. and C.G. Biliaderis, 1997, Kinetic studies of saffron (*crocus sativus* L.) quality deterioration, J. Agric. Food Chem., 45, 2890- 2898.
- 86 Manitto, P., G. Speranse, D. Monti and P. Gramatica, 1987, Single oxygen reactions in aqueous solution. Physical and Chemical quenching rate constants of crocin and related carotenoids, Tetrahedron Lett., 28, 4221 - 4224.
- 87 Watt, G., 1908, The commercial products on India, John Murray London, 430 P.
- 88 Molden., H.N. and A.L. Moldenke, 1952, Plants and the Bible, Chronica Botanica Company, Waltam, M.A., 87 P.
- 89 Ward, C.R., 1988, Flower are mine for a spice more precious than gold, Smitbsonian, 19, 5, 104-111.
- 90 Roden, C., 1975, A Book of Middle Eastern Food, Penguin Books, Hamondsworth, 36 P.
- 91 Munnino, S. And G. Amelotti, 1977, Determination of the optimum huminidity for storage of saffron, Revista della sodeta Italiana di scienza dell Alimentazione, 6, 95 - 98 { in Italian).
- 92 A bdullaev, F.I., 1993, Biological effects of saffron, Bio factors, 4., 83 - 86.
- 93 Akhund - Zada, I.M. and R. Sh. Muzaferova, 1975, Study of the effectiveness of gamma irradiation of the saffron, Radiobiologiya, 15, 319 - 322.
- 94 Alonso, G.L., R. Varon, R. Gomez, F. Navaro and M.R. Salinas 1990, Auto-oxidation in saffron at 40°C and 75 % humidity. J. Food Science, 55, 595 - 596.
- 95 Plessner, O., M. Negbi, M. Ziv. and D. Baskar, 1989, Effect of temperature on the flowering of the saffron crocus (*crocus sativus* L.), Induction of hysteranthy, Israel Journal of Botany, 38, 1-7.
- 96 Saxena R .B., A. review on chemistry of saffron, Under publication.
- 97 Alonso, G.L., R. Varon, M.R. Salinas and F. Navarro, 1993, Autoxidation of crocin and picrocrocin in saffron under different storage conditions, Boll. Chem. Farm., 132, 46-120.
- 98 Saxena, R.B., 2004, Adulteration in saffron- A review, Tradition and traditional knowledge of the Central Himalayas by Nishen Singh Mahendra Pal Singh - Dehra Dun, 245-280 P.
- 99 Stevens, S.D. and A. Klarnier, 1980, Deadly Doses, Writer's Digest Book, Cincinnati, OH.
- 100 Maimonides, M. ( 12<sup>th</sup> century CE), 1974, On the causes of symptoms, Leibo witz, J.O. and S. Mareus (Eds), Univ. Calif. Press, Berkeley, CA., 125 P.
- 101 Encyclopaedia Britannica, 1974, Encyclopaedia Britannica Inc., Chicago 11, Macropaedia, vol. 9, 891 P.
- 102 Gerard, J. 1633, The Herbal or General History of Plants, reprinted, 1975, Dever Publications Inc, New York, 154 P.
- 103 Culpeper, N., 1692, Quated by Silberrad and Lyall, 1909.
- 104 Fasal, P. and G. Wachher, 1933, Wein. Klin. Wscbr., 45, 745, Quoted by Blacow, 1972.

- 105 Lust, J.B., 1978, The Herb Book, Bantam Books Inc., New York, 341 P.
- 106 Holkar, S.R. and S.D. Holkar, 1975, Cooking of the maharajas, Viking Press, Inc., New York, 249P.
- 107 International Standards Organisation, 1990, Spices and Condiments saffron - tests method. Draft International Standard ISO/DIS - 3632-2, Geneva..
- 108 ISO ed , 1993, Saffron (crocus sativus Linn.) ISO 3632 - 1 & 2 specification and test methods, International Organisation for standardisation, Geneva, 1-6 & 1-12 P.
- 109 Himeno, H. and K.Sano, 1987, Synthesis of crocin, picrocrocin and safranal by saffron stigma - like structures proliferated in-vitro, Biol. Chem.,51, 2395 - 2400.
- 110 Tarantilis, P. A., G. Tsoupras and M. Polissiou, 1995, Determination of saffron (crocus sativus L.) components in crude plant extract, using HPLC -UV Visible photodiode - array detection - mass spectrometry, J. Chromatogr., 699, 107 - 118.
- 111 Tarantilis, P. A., M. Polissiou and M. Manfait, 1994, Separation of picrocrocin, cis- trans - Crocin and safranal of saffron using HPLC with photodiode array detection, J. Chromatogr., 664, 55 - 61.
- 112 Orfanou, O. and M. Tsimidou, 1995, Influence of selected additives on the stability of saffron pigments in aqueous extracts, Developments in Food Sci., 37 A , 881 - 894.
- 113 Sujata, V., G. A., Ravishankar and L.V. Venkateraman, 1992, Methods for the analysis of the saffron metabolites crocin, crocetin, picrocrocin and safranal for the determination of the quality & the spice using TLC, HPLC and GC., Journ. Chromatography, 624, 497 - 502.
- 114 Bergaglio G.C., 1990. Note storiche medico-pharmaceutical sullo zafferano. In F. Tammara and L. Marra, 223- 232 P.

## हिन्दी सारांश

### केशर का मानकीकरण - एक पुनर्निरीक्षणात्मक अध्ययन

आर. बी. सक्सेना

केशर (सुगन्धित द्रव्य का राजा : फेमिली-ईरीडेसी) के गुणवत्ता नियंत्रण का मानकीकरण उसकी प्रकृति, यौगिक औषधि, प्राप्ति का स्थान आदि पर निर्भर होता है। आज के युग में वैश्वीकरण और शहरीकरण होने से केशर की कोश रचना पर ज्यादा ध्यान दिया जा रहा है। क्योंकि इस समय में स्थानापन्न और मिलावट ज्यादा बढ़ गई है। इस कारण परम्परागत औषधि (केशर) की वैज्ञानिक यन्त्र कलाओं द्वारा २० वीं सदी के मध्य में मानकीकरण की आवश्यकता ज्यादा बढ़ गई है। इस आवश्यकता को देखते हुए प्रत्येक देश अपने विशिष्ट लक्षण समूह बनाकर उसे उपयोग करने लगे। भारत तथा स्पेन ने केशर के मानकीकरण मूल्य ठीक तरह से तैयार किये। वैश्वीकरण होने के कारण विशिष्ट लक्षण पद जो अन्तरराष्ट्रीय सिद्धान्त संस्थान द्वारा लिये गये हैं, वह मूल-लिपि के आधार से हैं। आधिकारिक आवश्यकताओं के सन्दर्भ में केशर के अलग-अलग मानकों तथा आक्षेपों का पुनर्निरीक्षण प्रस्तुत लेख में किया गया है।

गुजरात आयुर्वेद युनिवर्सिटी