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SAFFRON IN INDIA

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The Indian Spices Development Council at its Eigth Meeting recommended that the present state and future scope for development of saffron in India might be studied in detail by an expert team. Accordingly a Central Team comprising of Dr. J. P. Nauriyal, Director (Horticulture), Ministry of Agriculture and Irrigation, New Delhi, Dr. C.K. George, Director, Directorate of Arecanut and Spices Development, Calicut, Kerala and Dr. Rajendra Gupta, Project Coordinator (Medicinal and Aromatic Plants), Division of Plant Introduction, Indian Agricultural Research Institute, New Delhi was constituted by the Ministry of Agriculture to make a detailed study on the subject. The team visited the States of Jamnu and Kashmir, Himachal Pradesh and Uttar Pradesh in October, 1975 and had discussions with various State Government officials, organisations and private individuals on the problems concerning saffron development in India. A detailed account of the saffron industry, the future scope as well as the recommendations made by the Central Team in regard to the development of saffron are presented in the following pages. It is hoped that the information contained in this report will be helpful in planning the future course of action for the development of saffron in India.

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INTRODUCTION

The Saffron of commerce comprises of the female parts (Stigma and Style) of the flower of saffron plant. It is one of the few ancient delicacies which continue to command a very high price in the world of culinary. The plant (*Crocus salivus* Linn) is reported to be indigenous to Greece and Asia Minor. However, as a cultivated crop it extends all over the Mediterranean from Spain in the West spreading eastwards to Persia and Kashmir valley in India. It is now grown on a commercial scale in Spain, India, France, Greece, Algeria, Italy, Germany, Austria and Apsheron peninsula of U.S.S.R. The bulk of the world supply of saffron comes from Spain where it is grown extensively.

History and importance

Saffron was introduced in Spain in the 10th Century A.D. by Arabs and its cultivation spread later to neighbouring countries (Ingram, 1969). Substantial quantities of saffron were being grown in England at a place called Walden in Essex during the 18th century. The exact time when saffron was introduced into Kashmir is not known. However, it is definite that this took place quite early. Saffron is mentioned in ancient Indian literature such as medical prescriptions of Waghbhatta and Sushrutta who practised medicine at Padampur (now Pampore) in Kashmir around 500 B.C. (Gathercoal, E.N. and Wirth E.H. 1947). According to one legend a saffron bulb was gifted to the physician by Thakshak Nag—the chief of Nag tribe as a reward for his service to him. Poet Kalidas has described the use of saffron during the reign in Kashmir of King Lalitaditya in A.D. 717. Bava Prakash another renowned physician has described the virtues of 'Kum Kum' fluid which is made of saffron in water. Abul-Fazal, the official biographer of Emperor Akbar has described saffron fields of Kashmir in his treatise the Ain-I-Akbari.

In the ancient world, saffron held a unique position as a sacred plant. Poets were all charmed by it. Saffron attracted attention through the ages because of its sweet scent, exotic colour and shape of its blooms and above all its medicinal qualities. In ancient Ireland, the King's mantle and the shirts of the elite used to be dyed with saffron. It was the Royal colour in Greece, where even women's court dresses were dyed in saffron. Saffron was one of the precious gifts given to the Bishops of Rome by King Constantine. The colour of saffron is considered to signify 'renunciation' and even now the robes of Sanyasins and Yogies are dyed in saffron colour. Saffron is also a prominent colour in Indian National flag.

As a perfume, it was strewn in greek halls, courts and theatres and used in Roman Baths. The streets of Rome were sprinkled with saffron when Nero entered the great city.

Saffron is accredited with colouring, flavouring and medicinal properties. It is a natural colouring material and its chief application today is in culinary, bakery and confectionery preparations for imparting colour and flavour to the final product. In the past, its use found favour with aristocracy and the well-to-do class of people and consequently the use of saffron in dishes and delicacies began to be regarded as prestigeous. In India large quantities of saffron are also used in temples as offerings to God, besides its use in various religious rites.

A large number of workers [Wealth of India (1950); Kirthikar and Basu (1933); Ingram (1969); Munjal et al (1971)] have described numerous therapeutic properties of saffron. Used in small doses, it is reported to act as a sedative, stimulant, expectorant, stomachic, aphrodisiac and anti-spasmodic and anti-histeric. It was reported to strengthen the heart and was considered to be a specially good remedy for enlargement of liver and infection of kidneys. It used to be prescribed in fever and melencholia. If administered in high doses, saffron can induce unconsciousness in humans. Saffron corms are toxic to young animals also. Although Madan et al (1971) have reported that extensive studies revealed that saffron does not possess any of the therapeutic properties attributed to it, nevertheless, it continues to be an important ingredient of Ayurvedic and Unani systems of medicines in India.

Botany

The saffron plant (*Crocus sativus* Linn) belongs to Family *Iridaceae*. It is a perennial, stemless, low-growing herb with globular corms, about 4 to 5 cm. in diameter. The corms remain dormant during summer months and resume growth at about the end of the summer season. Each corm produces 6 to 9 narrow, needle-like, channelled leaves almost as tall as the flowers surrounded in the lower region by 4 to 5 membraneous whitish scales. The flowers are borne singly or in twos or threes. They are funnel-shaped having narrow, cylindrical tube of white to lialac colour about 7 to 8 cm. long. The perianth is made up of six segments in 2 series, violet or reddish purple or mauve in colour. Androecium consists of three stamens attached to the throat of the perianth. Filaments are short but anthers long and yellow in colour. The pistil is a bulbous tricarpellary, trilocular ovary with axile placentation. It bears elongated pale yellow exerted, filiform style, divided at the top into 3 brilliant orange red, thrice lobed stigma, 25 to 30 mm. in length. The three stigmas along with about 50 mm. long style when dried constitute the pure saffron of commerce. The cultivated saffron is a auto-triploid (2n = 24) with very irregular meiosis and this further contribute towards its sterility (Warburg, 1957).

The stigma is 3 to 4 mm. thick on its upper edge, reddish in colour, hairless, of greasy lusture, curled in the form of a tube and is broader on the funnelled upper part. It has strong smell and bitter aromatic taste. There is found a single conducting bundle on the base of the stigma which branches out upwards repeatedly until it forms a bunch of 20 bundles on the white upper part.

Mother corms reproduce annually and give rise to new cormlets (daughter corms). The young corm is onion shaped or a little compressed, white and fleshy; the solid bulbous part is covered with fibrous sheaths externally. The corms formed in a year die after giving flowering shoots in the following year; in so doing it withers and sinks to feed the developing new corms. New corms are developed each year to replace the older ones. They arise from about 2 cm. higher in the soil from those of the previous year and might almost reach close to the surface within a few years.

REVIEW OF LITERATURE

Soil: Saffron requires a well drained sandy to loam soil free from clay. A medium grade well drained light soil is preferred to rich fertile soils, since the latter tends to increase vegetative growth at the expense of reproductive growth. It is necessary to have adequate surface drainage for corm develop-

ment. Madan et al. (1966) have suggested that saffron crop has preference for siliceous-orgillaceous-ferruginous chalky soils. The corms tend to rot in humid or water-logged soils.

Datta et al. (1956) have examined soil profile of Pampere valley where saffron is traditionally grown (Field 1) and compared with similar adjacent localities (Field 2) where it is not cultivated. These authors found downward leaching in the Field 1 with accumulation of $CaCo_3$ in the layer between 36th and 42nd inches depth possibly due to free surface drainage whereas Field 2 was characterised by high content of $CaCo_3$ throughout the profile. The available P_2O_5 content in Field 1 was much higher than that in Field 2, and available K_2O also showed a similar trend. As regards micronutrient status the Field 1 was found to possess higher active manganese and copper in its top layers as compared to Field 2. On the contrary zince was found to be more in top layer of Field 2 than in the Field 1. It may be noted that this top layer of the soil forms root zone of saffron plants. It thus appears that high $CaCo_3$ content in the Field 2 is responsible for lower values of available P_2O_5. This may partly be attributed to the differences in the drainage conditions of the two profiles which is also reflected in comparatively larger values of sand content upto a deph of 15 ft. in profile of the Field 1 as compared to that of the Field 2. Even though the organic carbon content of the two profiles and, C/N ratio were not balanced as they should be in fertile soils, these do not seem to play any prominent role in growth of saffron plants. This study has thus indicated that higher calcium carbonate content in soil profile of the Field 2 may be a limiting factor in successful growth of saffron.

Climate.—Saffron thrives best in warm sub-tropical climate. In Spain, it is reported to be grown in dry temperature conditions with annual rainfall rarely exceeding 40 cm. annually. In Kashmir, it is found to flourish upto 2140 m. elevation. Mathur (1973) has reported its preference for cool sunny situations between 1300 and 2300 m. elevation above the sea level. He further noted that an elevation of 2000 m. was found as best for good flowering; higher altitudes were stated to delay flowering, affecting crop yield. Flowering is also found to be delayed when the crop is raised over northern aspects at the same elevation. The best situation for its cultivation may be found on eastern and south-eastern slopes in the hills. Photo-period exert a considerable influence on the flowering of saffron, an optimum period of 11 hrs. illumination is desirable. Temperature too exert its effect on flowering but unusually low temperature coupled with high humidity during short period of flowering adversely affect flowering in the crop.

Spring rains are considered favourable for boosting production or new corms; a second spell of rain at the end of summer or beginning of autumn helps the blossom and ultimate crop yield. A dry and moderately humid weather conditions at flowering time is ideal; frost or rain during flowering damage the crop yield. There should be low humidity at the harvest time to enable good production of flower crop.

Land Preparation and Planting: The soil is ploughed 25-30 cm. deep, harrowed and cleared of all weed growth, penetrating roots and stones from March to May months. Planting is done from July to mid August in small beds such that deep drains are laid out after every 6 to 8 rows to enable good drainage. Seed rate is about 8 tons p.ha. and corms of 2.5 cm. dia or above are selected for planting. The corms are planted between 12 to 18 cm. or 15 to 20 cm. apart in rows (Madan et al, 1966) and at a distance of 10 cm. in a row. The depth of planting is 7.5 to 10 cm. (Mathur, 1973). There is no further cultivation operation done till the following June month when soil between the rows is lightly turned over from a depth of 6-7 cm. without disturbing the corms.

Manures and Fertilizers: Srivastava (1973) considered a general dressing of 15 to 22 tons of FYM per ha. essential at land preparation under Chaubhatia (Ranikhet) conditions. He has recommended a dressing of 50-10-50 kgs. of N, P and K, as Ammonium sulphate, Super Phosphate and Potash per ha. in succeeding years. Immediately after the harvest, the soil amongst the rows is dug out at a depth of 15 cm. and applied with manures (Ingram, 1969).

Irrigation: Saffron is grown as a rainfed crop in Kashmir and therefore July to September rains are beneficial to the crop. On the contrary, it is grown under irrigated conditions in Spain. Light irrigation during early autumn months help to accelerate blooming and increase crop production.

Interculture: In the succeeding June month before the plants resume growth, the soil in between the rows are dug out by the help of hoe at right angle to the rows laid out during planting; this helps to facilitate the new growth. The soil is broken again before the blossom appear in October.

Crop rotation: In Spain the corms are uprooted after every 4th harvest. This is done usually during May month when corms are well developed. In Kashmir the crop, once planted remain in field for 10 to 12 years (Madan, 1966).

Harvesting and Drying: Saffron plants come in bloom at about mid October which continue till early November. Each plant however remains in bloom for about 15 days and produce on an average five flowers. In the west, the flowers are picked in early morning hours to avoid withering in warm autumn sun. All flowers that have bloomed during the morning are picked during the same day. Thereafter the long red stigmas are broken-off alongwith about 50 mm. of the style and this produce is dried in sieves over low charcoal heat, either loosely or between layers of paper and under the pressure of thick boards which shapes the mass into cakes. This loose stuff is called the 'hay saffron' (Iqbal Kaul, 1971).

The drying of fresh saffron is a must to preserve its colour; during the process it improves its aroma. The characteristic odour is produced when bitter *picrocrocin* splits during drying, releasing the volatile aldehyde *safranal*. There are two methods of drying (i) Sun drying and (ii) drying by heat from a fire place. Sun drying is not as efficient as fire drying and if the produce is not thoroughly dried it is more liable to become mouldy at a later stage. The toasting process is delicate and over it depends the quality of the end product. The stigmas are usually dried on silk screens having a diameter of about 30 cm. Small bunches of material are spread in a layer 2 to 3 cm. thick and the screen is placed over a small fire of wood charcoal. Screens may be stalked on top of the other, to give proper drying throughout; the fresh stigmas stick to the silk because they are damp but on becoming dry they slip over the fabric. Other means of drying are small, specially designed earthen ovens and revolving cylindrical containers, over a charcoal fire. The dried warm saffron is then allowed to cool in a dry place (Ingram, 1969).

Yield: The number of flowers and the time of blooming is dependent upon the temperature regime prevalent in spring and autumn and the amount of rainfall. A warm spring and long autumn are condusive to early flowering (Madan et al, 1966). In the first year, the yield of saffron is negligible but it increases gradually and during 3rd year of flowering an annual yield of 1800 to 2500 gm. of saffron is received per ha. (Srivastava, 1963). Fotedar (1935) has reported a maximum yield upto 6 kgs. of saffron per ha. while Jalali (1962) and Iqbal Kaul (1971) report 5 to 6 kgs. and 2.5 kg. of saffron per ha. respectively as average crop yield at Pampere. It may be of interest to note that about 1,47,000 flowers give 5 kgs. of fresh stigma that go into to make a kg. of pure dry saffron. Ingram (1969) reports an yield of 10 kgs. of saffron p. ha., produced from about a million blossom. It is suggested that proper irrigation and use of fertilizers etc. account for this higher yield (Wealth of India, 1950).

Market Grades of Saffron: Iqbal Kaul (1971) described 'Shahi Saffron' as the top grade saffron which contains the sun dried stigmas. The long white dried base of the stigma has been termed as 'Mengra' and this forms the second quality. The remaining dried flowers are generally beaten with care and immersed in water; of this, the heavier part like styles sink while petals and stamens float. This process is repeated till only the fibrous material is left which is discarded; the balance material thus collected is called 'laccha' and is the most inferior grade. The low grade material is dyed and touched up and is used as adulterant to the top grade material.

Ingram (1969), on the other hand, has classified market samples of saffron in the following types on the basis of length of thread (stigma with style attached), colour and aroma.

Very select: Stigma length over 30 mm., with styles 23-24 mm., hard brilliant colour and strong aroma.

Select: Stigma length 30 mm, with style length 23 mm, brilliant dark red colour, thick thread with good odour.

Superior: Stigma length 28 mm, with style length 22 mm; whole strong threads, dark red colour.

Medium: Stigma length 25 mm with style length 21 mm; good odour, colour and appearance.

Ordinary: Stigma length generally 20-24 mm with same length of style having a pleasant odour.

Slack: Broken stigmas, dark in colour and less than 20 mm. in length. It includes all saffron which even if the thread is longer, lacks many of the properties of the better types.

Composition: The chief pigment of saffron is its yellowish-red glycoside *crocin,* which on hydrolysis yields the sugar *gentiobiose* and *Crocetin,* a heptanedicarboxylic acid. *Picrecrocin* is the bitter tasting principle and it too is a glycoside; on hydrolysis, it yields glucose and the aldehyde safranal. According to Wehmer (1935), the average percentage composition of commercial saffron is water 15.6%, starch and sugar 13.15%, essential oil 0.6%, fixed oil 5.63%, total N free extract 43-64%, crude fibre 4.43%, ash 4.27%, rich in potassium and phosphorus with traces of boron.

Adulterants: Sometimes stigmas of safflower and plants belonging to family compositae are found adulterated in commercial samples of saffron. These adulterants are easily detected by chemical test reproduced below (IS: 5453, 1969).

Take a little quantity of saffron in a shallow percelain dish containing solution of 0.1 g. of diphenylamine in 20 ml. of sulphuric acid and 4 ml. of water. Pure saffron shall immediately produce blue colour and the colour shall rapidly turn to brown-red. The blue colour shall persist in the presence of nitrates.

Field test: When a little quantity of genuine saffron is put in a glass of water, it retains its original colour. On the other hand the colour of the spurious stuff will run over and the later thus will be instantaneously exposed (Iqbal Kaul, 1971).

Pests and diseases: A fungal disease *Rhizectonia violacea* is reported to infect the corms by penetrating through its outer sheath. This could be avoided by peeling off the outer covering and dipping the corms in 5% copper sulphate solution before planting. All infested corms should be dug out and destroyed (Ingram, 1969) *Phoma crocophila* is also reported to attack the corms transferring their flesh from white to yellow and finally turning black, resulting in destruction of the entire corm.

Pharmacopoeial Standard: Spanish Saffron yield 7 to 8 per cent of its own weight as ash and its phosphoric acid content varies between 13 and 14 per cent. (Pizzarro; et al. 1953). According to Spanish pharmacopoeia a good genuine saffron sample has a maximum of 14% loss of weight by drying and give about 8% of its weight as ash. The British Pharmacopoeal Codex (1949) has prescribed following standard for pure saffron:

1. Not more than 8% of it should consist of the style and filament of the anthers and not more than 2% foreign matter.
2. It should not yield more than 7.5% of total ash or more than 1% of acid insoluble ash.
3. It imparts a yellow colour to water, alcohol, methanol, ether and chloroform but not to xylene, benzene or carbon tetrachloride. Filteration through charcoal removes this colouration.
4. The loss of drying should not be more than 14%.
5. When pressed between two blotting or filter paper, no translucent spot should appear.
6. Other floral parts like ligulate or tubular florets, spinose pollen grains etc. should be absent.
7. 0.02 g. Saffron should impart a colour intensity to 100 ml. of water not less than that of 0.1% solution of potassium dichromate.
8. In sulphuric acid, the saffron stigmas immediately become blue, the colour gradually changing to deep violet or purple and finally to a purplish red (deep wine colour).
9. The nitrogen content of the saffron is remarkably constant at about 2.22 to 2.43% and a Kjeldah estimation is therefore a good test of purity.

Market samples of Kashmir saffron is reported to contain 8.0—10.2% moisture, 5.9—13.3% ash, 1.0—2.4% nitrogen and to have tinterial power 20-30 times that of potassium dichromate solution (Budhiraja, 1942).

SAFFRON CULTIVATION IN JAMMU AND KASHMIR

Cultivation

Cultivation of saffron in India is confined to the State of Jammu and Kashmir. There is about 2,200 ha. under the crop in the Pampore valley and about 100 ha. at Koel Kareve in the adjoining area. The crop has also been introduced in Kishtwar

district where another 140 ha. is currently under its cultivation.

The soil of the valley is known to have formed from glacial lake deposits and is therefore deep and friable with sub-soil rich in bases but free from stones. The soil texture generally is loamy having excellent moisture retaining capacity. The pH ranges from neutral to moderately Alkaline (7.5). The climate of the valley is marked with distinct seasonal variations; it received spring in March-April when the average temperature is around 13°C and spring rains are common. The temperature rises with the advance of summer in May and continues to be high (30°C) till July, this period is usually dry with relative humidity ranging from 35-78%. August and September are warm months when temperature goes down due to occasional rains, about 15 cm. in all. October marks the beginning of autumn characterised by dry season and low relative humidity. The valley receives snow before the end of November and continues till the end of February. The saffron fields are thus covered with about one metre thick snow which keeps the soil underneath warm and protects growing young green leaves from severe cold weather.

The land preparation in the valley starts early in March-April. The field is ploughed 3 to 4 times to a depth of 30-35 cm. and about 5 to 6 tonnes of FYM per ha. is incorporated into the soil. Another ploughing is given in May and the fields are levelled.

The planting season of saffron corms extends from mid July to end of August in the valley. The fields are laid out into small beds. Two methods of planting are recommended. The first is age old method, the *furrow planting* where the corms are planted in 12 to 14 cm. wide furrows in two parallel rows side by side at 8-10 cm. depth. After closing the furrow the field is planked and laid into small beds of about 2.5 m. Thereafter 20 cm. wide and 10 cm. deep drainage channels are laid all-round the beds. The corms so recovered during the laying out of drainage channels are replanted elsewhere. The other method of planting is *strip method* recommended by State Agricultural Department. It is less laborious, saves on labour expenses and avoids damage to corms during the lay out of drainage channels. All along the length of the field, 2.5 cm. wide strips are made and the seed corms are dibbled in the strip in rows 10 cm. apart, keeping corm to corm distance at 6 cm. The seed rate is 8 tonnes of corms per ha. For this purpose corms of 2.5 cm. and above are selected from amongst healthy disease-free ones and the outermost covering is removed before planting. The State Agricultural Department recommends dipping of the seed corms in 5% solution of copper sulphate as a prophylactic treatment.

Saffron is grown as a rainfed crop in Kashmir and therefore failure of showers in July-August substantially reduces the crop yield. The planted fields are not disturbed till the following June when clods are broken and first hoeing is given; the drainage channels are dug out to facilitate aeration. May to August is the dormant period for the crop and if the moisture regime of the soil during this period is high, the decay of corms set in. Another hoeing is given in early September i.e. 30 days after bud formation. The hoeing operation is done carefully upto a depth of 8 to 10 cm. only to avoid possible damage to the growing corms. A light dressing of FYM is given with the second hoeing. The fields are again hoed after picking of the flower crop in late autumn when another light dressing with FYM is given. This schedule of cultural operations is followed for 6 to 8 years, when the crop remains in the field. On an average, 20 tonnes of corms are received when the fields are dug out at the end of 6 to 8 years and about 50 per cent of these corms are of suitable size after planting. Inorganic fertilizers are not given to this crop in Kashmir. Experiments now conducted on nutrient requirement of the crop by State Agricultural Department suggest that a low dose of N along with P_2O_5 may boost the yield; this work is continuing.

Intercropping and crop rotation

The State Agricultural Department advocates planting of Almend trees at 6M × 6M spacing in saffron fields. Almond sheds its leaves in August, by which time saffron plants resume annual growth and therefore does not compete for sunlight. Further saffron is surface feeder and therefore there is limited competition for nutrients. The combination is reported to give substantial additional income to the farmers.

As a crop rotation practice the old saffron fields are kept fallow (after digging out corms) in the first year and then wheat or mustard crop is taken in the second year followed with planting of saffron crop again.

Pests and diseases

The crop in Kashmir is generally free from pests and diseases. Rats are sometimes found to damage the underground corms.

Harvesting and processing

Saffron does not blossom in the first year of planting. From the second year onwards it produces flowers. The flowering season is from the middle of October to middle of November. The flowers are picked early in the morning after the dew has disappeared and the stigma along with part of style is trimmed. The stigma so collected are dried in the sun till its moisture content is reduced to 8 to 10%. The quality of the produce depends greatly on the methods of collection and processing. The stigmas collected early from newly opened flowers and dried in the sun produce better quality of saffron.

Saffron in flowering
Photo by Shri M. N. Sitarama Iyengar, M.Sc.(Ag.)

In Kashmir the saffron is prepared in different ways. In one method the flowers are dried in the sun as such and the stigmas are picked by hand from the dried flowers. The stigmas which are deep red form the top grade quality, the 'Shahi' saffron. The long white dried bases of the stigmas form the second grade quality called 'Mongra'. The remaining of the dried flowers are gently beaten with a cane and immersed in water. While the heavier stuff like the style sinks, the petals and the stamens fleat. The sunken stuff is separated and dried. This process is repeated, till only the fibrous material is left which is discarded. The saffron thus collected is called 'Laccha' and is most inferior.

There is another method of preparing saffron, that is by making 'Gucchi'. In this the entire style with the stigma is bound in a small bundle or 'Gucchi' soon after harvesting of the flowers and dried in the sun.

Yield

The average yield of saffron in Kashmir (Mongra and Gucchi) is around 2 kgs/ha. This is very low in comparison to the yield in other producing countries.

Storage

Care has to be taken to prevent deterioration of the quality of saffron while in storage. For this the dry stigma is stored in cloth bags or butter paper and packed in closed tins or in air tight wooden boxes. It is found that packing of saffron in polythene bags and keeping it in air tight tins maintains the quality of saffron ever extended periods. However, it is necessary to dry saffron properly before storage. Saffron when stored for more than a year sometimes turns dark in colour and lose its characteristic taste and aroma.

Marketing

Method of marketing saffron in Kashmir continues to be quite traditional. The produce is generally sold by the growers themselves to the itinerary merchants or to the wholesalers direct. Sometimes the producer sells the produce direct to the merchant and barter other family requirements. There are no regulated markets for saffron.

At present the Handicrafts (S & E) Corporation, Srinagar has been directed by the Government to buy stock of saffron from the farmers. The Corporation deals with only 'Mongra' grade and has not made the desired impact in the orderly marketing of saffron. Although there is a co-operative marketing society established about 12 years ago it is learnt that it could not function properly for various reasons.

Adulteration

Adulteration of saffron with other parts of the flower is sometimes practised. In Kashmir the Shahi Zaffron is adulterated with other parts of the flower. In other countries, adulteration of saffron

is often done with the stigma of safflower and flowers of other *compositae*. Experienced saffron tasters of Kashmir can correctly estimate the degree of adulteration in a given quantity.

Novertheless checking the purity of saffron is simple. A little quantity of genuine saffron if put in a glass of water will retain its colour. On the other hand the colour of the spurious saffron will run quickly and the stuff will be instantly exposed. Good quality saffron stigma sinks in water.

The second grade 'Standard' as specified by Indian Standards Institution allows very high percentage of flower waste i.e. 15% of the produce. Th! gives a chance to the traders to adulterate the pure saffron obtained from the growers with its floral waste.

Economics

Information on economics of cultivation of saffron is rather meagre. According to the available information a net return of around Rs. 6,000 per ha. is obtained in Kashmir from the third year onwards till the sixth year. The yield declines from the sixth year onwards.

INDIAN STANDARD SPECIFICATION FOR SAFFRON IS: 5453—1969

Foreword

This Indian Standard was adopted by the Indian Standards Institution on 20 December 1969, after the draft finalized by the Species and Condiments Sectional Committee had been approved by the Agricultural and Food products Division Council.

Saffron (KESAR) is obtained from flowers of various cultures of *Crocus sativus* Linnacus. It is one of the costly colouring agents and a flavouring substance mainly used in various food preparations. It is also used for preparing indigenous medicines. Commercial saffron contains crocin and crocetin of carotenoid group. The value of saffron as a colouring agent is mostly determined by the quantity of crocin it contains.

At present only two grades of saffron are sold by the cultivators; one is selected quality and the other unselected quality. Selected quality, also known as MONGRA, is all red and consists mainly of broken stigmas of the flower of *Crocus sativus* Linnacus. The unselected quality, generally known as LACHCHA, contains some yellow filaments besides the stigmas and floral wastes. On the basis of these two grades prevalent in the trade, this standard also prescribes two grades of saffron, namely, Special and Standard.

In the formulation of this specification, due consideration has been given to the prevailing trade practices in the country and international standards, proposed by France for consideration by the International Organization for Standardization (ISO). However, this standard is subject to the restrictions imposed under the Prevention of Food Adulteration Act, 1954, and the Rules framed thereunder, wherever applicable.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2—1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Scope

This standard prescribes the requirements, method of sampling and the identification tests for saffron (*Crocus sativus* Linnacus).

Terminology

For the purpose of this standard, the following definitions shall apply.

Floral Waste: Yellow filaments, pollen, stamens, part of ovary and other parts of the flower of *Crocus sativus* Linnacus.

Foreign Matter: Sand, earth, dust, leaf, stem, chaff and other vegetable matter.

Grades

3.1. Saffron shall be of two grades, namely, Special and Standard. The grading shall be done according to the colour, floral waste content and foreign matter as indicated below:

Grade	Colour	Floral Waste Content, Percent, Max	Foreign Matter, Percent, Max
Special . .	Deep red	5	0.5
Standard . .	Light reddish to bright red.	15	1.0

*Rules for rounding off numerical valves (revised)

Requirements

Description: The saffron in the whole form shall be the dried full stigmas about 2 cm long, dark red or dark orange in colour. In the cut form, stigmas shall be cut and rolled in cornets, serrated or indented at their distal end. The stigmas may be isolated or joined in twos and threes at the end of a small portion of the yellow styles.

Identification Test—Sulphuric Acid-Diphenylamine Test: Take a little quantity of saffron in a shallow porcelain dish containing solution of 0.1 g of diphenylamine in 20 ml of sulphuric acid and 4 ml of water. Pure saffron shall immediately produce blue colour and the colour shall rapidly turn to brown red. The blue colour shall persist in the presence of nitrates.

NOTE:—The diphenylamine used for the test should not give colour with sulphuric acid; sulphuric acid should be of analar grade.

Taste and Flavour: Saffron shall have the characteristic strong, aromatic, pleasant and slightly iodinated smell. Its taste shall be bitter and slightly pungent. It shall be free from any foreign taste or smell, specially the musty smell or taste.

Freedom from Moulds, Insects, etc.: Saffron shall be free from living insects, moulds, and shall be practically free from dead insects, insect fragments and rodent contamination visible to the naked eye (corrected, if necessary, for abnormal vision) with such magnification as may be necessary in any particular case. In case the magnification exceeds x 10, this fact should be stated in the test report.

Foreign Matter: Saffron shall not contain any added foreign colouring matter.

Floral Waste Content: The proportion of the floral waste, when determined by the method given in Appendix A, shall be as specified in 3.1.

Saffron shall also comply with the chemical requirements given in Table 1.

Packing and Marking

Packing: Saffron, whether in full or cut form, shall be packed in water tight, sound and clean packings made of suitable material.

Marking: The following particulars shall be marked or labelled on each container:

(a) Name of the material, its commercial form and trade-name or brand name, if any;

(b) Name and address of the packer;

(c) Crop year;

(d) Net weight; and

(e) Any other marking required by the purchaser.

TABLE 1—*Chemical Requirements for Saffron*
(Clause 4.7)

Sl. No.	Characteristic	Requirement:	Method of Test	
			(Ref. to Cl No. of IS: 1797-1961*)	Other standards
1	2	3	4	5
(i)	Matter volatile at 103°C, @percent by weight, Max	14	15	..
(ii)	Total ash, percent by weight, Max . .	8	7	..
(iii)	@Ash insoluble in hydrochloric acid, percent by weight, Max . .	1.5	9	..
(iv)	@Aqueous extract, percent by weight, Min. .	55	17	..
(v)	@Total nitrogen, percent by weight, Min. .	2	..	IS:5194-1969£

*Methods of sampling and test for spices and condiments

@On dry basis, that is, moisture and Volatile matter free basis, as calculated from Sl. No. (i).

£Method for determination of nitrogen—Kjeldahl method.

Sampling

Representative samples for testing the conformity of the final product to this specification shall be drawn according to 3.3.1 of IS: 1797-1961*.

Tests

Tests shall be carried out by the appropriate methods referred to in col 4 and 5 of Table 1, and Appendix A.

APPENDIX A

(Clauses 4.6 and 7.1)

Determination of Floral Waste

Procedure

Weight 5 g of saffron from the sample in a watch-glass. Spread out the product on a sheet of white paper and pick by means of a small tweezer all the free yellow filaments and other loral wastes found therein. Transfer them to dry, tared watch-glass

*Methods of sampling and test for spices and condiments.

and weigh on an analytical balance. The difference between the two weights gives the quantity of floral waste in the quantity of product weighed, which may be expressed as percent by weight.

WORLD TRADE IN SAFFRON

No reliable statistics relating to the production of saffron in different countries are available. In Spain which is the biggest saffron producing country in the world, an area of about 4605 ha. was reported to have been under the crop in 1974 producing about 38.42 tonnes of saffron. According to the available information the area under cultivation and production of saffron in Spain and India from 1970-74 were as follows:

Name of the country	Year	Area in ha.	Production in Kg.	Yield Kg/ha.
Spain*	1970	5,219	39,201	7.51
	1971	5,989	60,700	10.14
	1972	5,765	58,100	10.09
	1973	5,311	41,296	7.76
	1974	4,605	38,418	8.34
India**	1971-72	1,625	4,000	2.47
	1972-73	2,023	5,500	2.72
	1973-74	2,047	5,600	2.74

**Source* : Commonwealth Secretariat, London.

***Source* : Director of Agriculture, Jammu & Kashmir.

Turkey produces about 10 to 12 kg. of saffron per year in a place known as Saffronbela near Beach Sea Coast.

In the world export trade of saffron, Spain continues to be the major contributor. During the years 1970-74 it has exported the following quantities:

Year	Export in tonnes	Export as % of production
1970	28	71
1971	37	61
1972	56	96
1973	34	82
1974	27	70

Source : Commonwealth Secretariat, London.

Saffron is exported from Spain in six grades viz. Mancha, Sierra and Rio, ground saffron, prepared saffron and saffron siftings. Of these the first three are unprocessed saffron grades of different quality. On an average about 80% of the total exports from Spain is accounted for by Mancha and Sierra and Rio grades. These are exported mainly to countries like France, West Germany, Italy, Switzerland, Pakistan, Japan, Sweeden etc.

France is the major importer of saffron. During the year 1972-74 it has imported the following quantities mostly from Spain and Greece.

[*Quantity in tonnes*] [*Value in Francs*]

Year	Neither ground nor crushed		Crushed or ground		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1972	5	3,460	1	922	6	4,382
1973	6	3,634	2	1,288	8	4,922
1974	3	4,047	2	2,022	5	6,069

Source: Embassy of India, Paris.

Eventhough the production of saffron in India is very low when compared to Spain it also exports saffron to European countries like France, Germany, Italy, Japan etc. Statistics relating to the export trade of India from 1968 to 1975 are given in Table 1.

The saffron export from India recorded its maximum in the year 1969-70, and thereafter it dwindled down and reached the level of zero export during the year 1974-75. The importing countries like France, Germany, Italy and Japan have almost discontinued purchasing saffron from India since 1970-71, perhaps due to the fact that they could meet their requirements from the major producing country, Spain.

Prices

Saffron is the most expensive spice in the world. The market prices for 10 gms. of saffron in Kashmir for different years are given below:

Year	Mongra grade	Lachcha grade
1971-72	35.00	17.40
1972-73	22.00	15.40
1973-74	22.00	14.00
1974-75	37.00	..
1975-76*	46.00	..

Source: Director of Agriculture, Jammu and Kashmir.

*Handicrafts (S & E) Corporation, Srinagar.

TABLE 1—*Export of saffron from India*

(Quantity in Kgs.) (Value in '000 Rs.)

Year	France		G.D.R.		Italy		Japan		U.K.		U.S.A.		Others		Total	
	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
1967—68 . . .	165	208	194	234	4	4	194	261	5	4	10	11	26	27	598	749
1968—69 . . .	340	300	900	747	32	30	69	71	6	7	32	36	106	127	1,485	1,318
1969—70 . . .	75	40	149	128	..	..	1	1	5	8	29	24	..	..	259	201
1970—71 . . .	..	..	25	17	..	..	..	..	5	6	..	..	..	..	30	23
1971—72 . . .	..	..	25	18	..	..	..	..	..	..	..	..	6	6	31	24
1972—73 . . .	..	..	..	..	..	..	..	..	..	..	..	..	6	5	6	5
1973—74 . . .	22	5	..	..	..	..	1	2	..	..	..	..	..	..	23	7
1974—75 . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Source : Director General of Commercial intelligence and Statistics, Calcutta.

Detailed information on the prices of saffron in the foreign markets are not available. However as per the statistics supplied by the Commenwealth Secretariat, London and Embassy of India, Paris, it is seen that 10 gms. of saffron of Mancha superior grade was costing about Rs. 25.00 in London market in October, 1975, while France, a major importing country sold saffron at about Rs. 30.00 per 10 gms. in the international market. It may not be correct to compare the price of Indian saffron with that of Spain as information on the quality is not available.

DEVELOPMENT

Present position

As stated in earlier chapters, commercial cultivation of saffron is at present confined to the State of Jammu and Kashmir where about 2440 ha. is currently under cultivation of the crop. In recent years attempts were made to introduce its cultivation in other States like Himachal Pradesh and Uttar Pradesh under conditions more or less similar to that in Kashmir. The details of work done in this direction and the results obtained are as given below:

Himachal Pradesh

In Himachal Pradesh saffron was first introduced in the middle of Second Five Year Plan at Sangla in Kinnaur District under the Black Jeera and Saffron scheme. The important factor which came in the way of cultivation of saffron was the early onset of winter in certain areas which hinder flower production in this region. Even though multiplication of corms has been noticed they did not develop to their full size.

Experiments were conducted in the Midhill elevations from Simla down to Shogi, Kyarighat, Kandaghat, Chail, Solan, Kasauli and Dharampur. Flowering was observed in the first year but only about 30% plants flowered in the subsequent years. The irregular flowering at these levels might be due to faulty method of planting, little or too much moisture in the soil and the lack of proper development of corms. Corms attaining the size of 2.5 cm. diameter produce flowers, but under the Midhill elevations new corms from the mother corms did not grow rapidly to this size to achieve flowering. Such corms produced vegetation and gave out only new corms rather than flowers.

Trials conducted at Kinnaur District have shown that for successful cultivation of saffron good drainage of soil and proper cultural and manurial practices are essential. Saffron has been grown with certain amount of success in areas situated on the banks of Sutlej river in Kinnaur District getting 75 to 100 cm. well distributed rain with snow in winter. Attempts made indicate that it might be possible to grow saffron in Solan, Kandaghat and Kasauli of Solan District and the Khani area of Bharmaur Tahsil of Chauba District.

Uttar Pradesh

Saffron was introduced in the State in the year 1966 at the Hill Fruit Research Station, Chaubattia and the field station of Central Council of Research for Indigenous Medicine and Homoeopathy, Ranikat. The work carried out so far revealed that the acidity of the soil (pH ranging 5.5 to 6) at Chaubattia adversely affects the corm production and flowering. At

Ranikat where the soil is almost neutral the plant puts more vegetative growth and corm development was poor and the flowering sparse and irregular. An interesting feature noted here is that saffron plants flower early in Uttar Pradesh and the foliage dry up by the end of June as compared to May in Pampore.

In spite of being a very valuable and rate commodity having much export potential, no tangible work have so far been done for the improvement of saffron cultivation in India. As a result of this, the saffron cultivation in Jammu and Kashmir still continues to be in the most traditional ways. There has been only neligible increase in the area under cultivation of the crop in the past. The major limiting factors in extension of area appears to be as follows:

(1) Low rate of multiplication of corms.

(2) Inability of plants to produce seeds.

(3) Higher initial investment especially on corms (8 tonnes per ha. costing Rs. 8,000 to 10,000).

(4) Lack of organised marketing channels.

(5) Lack of technical guidance to the growers.

(6) Lack of scientific information on crop physiology and crop husbandry.

Recommendations

From the experience of saffron cultivation initiated in other States, it is found that there is little scope for development of its cultivation immediately in these areas. In the case of Himachal Pradesh, low elevations seem to favour flowering and higher elevations are found suitable for the development and multiplication of corms. Flowering for 3 years in continuity has been achieved in the Midhill district of Solan. However multiplication of desired sized corms have not so far been achieved in the Midhills. An important aspect which requires a thorough investigation is to see whether in addition to the mother corms the sister corms can also attain the desired size for flowering. However even in the likely suitable areas multi-location trials have to be laid out to assess the feasibility of commercial cultivation.

Under the above circumstances Jammu & Kashmir seems to be the only place where the saffron cultivation can be concentrated at present. In the State fairly significant scope for extending saffron cultivation exists in the neighbouring tracts which are not otherwise suited for some crops for want of adequate water facilities. Scanty rains received during September to October if conserved properly can boost up the production. Hence suitable soil - moisture conservation measures are called for. Under the circumstances considerable scope exist for extending cultivation as well as for intensive cultivation in the existing areas. Having considered the present position of saffron industry in the country, the following recommendations are given which may go a long way in increasing saffron production.

1. *Introduction of improved varieties from abroad*

The main limiting factor in the research and development of saffron seems to be the lack of sufficient germplasm for evolving improved varieties through breeding and selection. Eventhough few corms have been obtained from Spain, no systematic study has been conducted to assess their performance. Introduction of improved varieties grown in Spain, Italy, France etc. may be thought of to enrich the germplasm collection and to facilitate early release of improved varieties.

2. *Multiplication of planting materials*

The availability of quality planting material at reasonable rate is an important factor to widen the input-output rates in saffron cultivation. At present an amount of Rs. 8,000 to 10,000 are to be spent for obtaining planting material alone required for one hectare. Large scale corm production and distribution are all the more important for increasing the area under saffron cultivation. Setting up of Central Corm Production Unit in Pampore Valley of Jammu and Kashmir for multiplication and distribution of seed corms for supplying to saffron growers in Jammu & Kashmir as well as for trial cultivation in potential areas in Himachal Pradesh and Uttar Pradesh therefore must receive top priority.

3. *Establishment of a Research centre*

Establishment of a Research centre in Pampore with one Sub-station each in Himachal Pradesh and Uttar Pradesh is necessary. The studies should cover nutritional and physiological requirement of the crop to initiate faster corm growth. Since clonal variation exists in plant material and could also be induced by various means, research work may be taken up to explore possibilities of clonal selection. It should also have a tissue culture laboratory to develop ways and means for faster multiplication including meristem culture in an overall effort to improve flowering and stigma yield by various means.

Since cultivable area in Kashmir is limited, it is important that maximum returns should be obtained from the saffron fields for which inter and multiple cropping programmes should also be worked out and practised. The advantage of rotating saffron with other crops like wheat, barley etc. requires further investigation. It is reported recently that a borer pest is found attacking saffron bulbs and thus reducing yield. The rats are found to be another serious menace to saffron crop in Kistwar. Hence investigation on plant protection aspects also must receive attention.

4. *Investigation on post-harvest techniques*

Processing of saffron is an important factor which attributes to the quality of end products. It is said that quality of saffron produced in India is superior to saffron produced in other countries and can be further improved if more attention is paid on processing side. It is reported that in the West processing of saffron is done by a more refined method. This has to be studied thoroughly and necessary modifications recommended to improve the quality of Indian saffron.

Scope of the use of saffron in cosmetic, pharmaceutical, culinary and confectionary industries are immense. As such initiation of research projects on these aspects is of utmost importance. Research project to find out the various uses of saffron as well as its quality have to be initiated at the Central Food Technological Research Institute, Mysore and at the Central Drug Research Institute, Lucknow.

5. *Improvement of marketing facilities*

Lack of organised marketing facilities stands in the way of getting profitable returns to the saffron growers in no small measure. Too many middlemen in the trade also reduces the chance of getting a reasonable price to the growers. Undertaking the marketing of saffron by organisations like State Marketing Federation may ensure fair returns to the growers and quality products to the consumers. These organisations may also undertake the export of saffron to potential markets in Middle East, Sudan, Thailand, Yugoslavia etc.

6. *Re-examination of the Grade Specifications*

Like any other commodity saffron is also subjected to adulteration. Hence re-examination of the grade specifications of saffron by the Indian Standards Institution is necessary to prevent adulteration.

7. *Publication of Extension literature*

Saffron growers are not much aware of the available scientific information on this crop to improve their cultivation as well as to obtain better returns. It is therefore necessary that package of practices on this crop are brought to their notice through proper extension literature.

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