# Prospects of saffron cultivation outside its niche area in Kashmir valley and comparative assessment with saffron cultivated in niche and non-niche areas

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**Abstract:**
*Saffron (Crocus sativus L.) is one of the costliest spices in the world known to produce a unique set of compounds crocin, picrocrocin, & safranal. The cultivation of Crocus plant is restricted to specific regions and in India it is a niche crop of Pampore karewas in Jammu & Kashmir. In this study we investigated the prospects of saffron cultivation outside niche areas and comparative assessment of saffron spice cultivated in niche and non-niche sites.*

**Keywords:** Saffron**,** Kashmir, Spice, Apocarotenoids, Karewas

**Introduction:**

Saffron is a sterile, triploid species that does not produce seeds and reproduces by means of corms. Its dried stigma is used in bio-medicine, dyes and perfumes. More recently, Saffron's use as an antitumor, cardiovascular protective agent and use of extract of Saffron corms against malignant cells indicate the importance of this plant. Due to its unique biological, physiological and agronomic traits, saffron is able to exploit marginal land and can be included in low-input cropping systems, representing an alternative viable crop for sustainable agriculture. Indeed, the main obstacles to saffron production are: (1) the limited areas of cultivation (Pampore belt in Kashmir) (2) lack of genetic variability (3) very high cost of the spice. Saffron is considered a niche crop with its cultivation restricted to specific ecological niche areas which in India is Pampore karewas in Kashmir valley. There has been a myth that this crop can grow only in the Pampore belt of Kashmir due to its soil specificity. However, in recent years efforts are being made to cultivate saffron outside its niche area so that the crop area can be expanded resulting in an increase in overall crop production. In this perspective we intend to undertake preliminary field trials of this crop in Baramulla region of Kashmir valley and do the

comparative assessment of the crop in its niche and non-niche areas.

**Methodology:**

**Study site**

In this study corms of *C. sativus* were cultivated niche site (Pampore) and non-niche site (Baramulla) (longitude: 34. 215959°; latitude: 74. 381466° and altitude 1585 masl) f (Figure 1). The consent was sought from land owners. The soil samples were collected at suitable depth in fields in Z pattern and sampling was undertaken through the Department of Agriculture Baramulla. The status of soil health was ascertained and parameters like organic carbon, presence of macro and micro nutrients were worked out. The recommendations of soil chemists were strictly followed and augmentation of fields was undertaken prior to saffron cultivation.

**Field preparation and saffron cultivation**

In niche site (Pampore karewas) saffron is cultivated in raised beds, however in non-niche site (Baramulla) experimental plots were designed in ridges and grooves. Rodenticide like Aluminum phosphide was used to prevent rodent attack. The site was fenced properly by way of installation of mesh wire fencing. The hoeing of soil was undertaken by digging up to one feet depth. The graded saffron corms (weighing more than 8grams) were sown in line sowing pattern at a depth of 8 inches and spacing of 6 to 8 inches in ridges.

**Measurement of growth and phenological parameters**

Morphological parameters like corm size, number of secondary cormlets, floral characters were measured. Saffron flowering was observed and one day old flowers are plucked in morning hours. The stigmas along with style are separated carefully and subjected to shade drying. The parameters like flower weight, stigma length and weight were recorded.

**Sample preparation and HPLC analysis**

A total of 20 µL of each sample (saffron extracts) were injected into an Agilent 1200 HPLC chromatograph) equipped with a 150 × 4.6 mm inner diameter, 5 µm Phenomenex Luna C18 column that was equilibrated at 30 °C. The eluents were water (A) and acetonitrile (B) with the following gradient: 20% B, 0−5 min; 20−80% B, 5−15 min; and 80% B, 15−20 min. The flow rate was 0.8 mL/ min. The DAD detector was set at 250, 330, and 440 nm for picrocrocin, safranal, and crocetin detection, respectively. All of the analyses were performed in duplicate, and two measurements were taken for each replicate.

**Quality control evaluation**

Quality evaluation of saffron crop harvested from non-niche site was conducted as per International standard procedure (ISO3632-2-2010(E)) for saffron spice. Briefly, 3 gms of saffron spice was weighed and taken in an 1000ml flask to which 900 ml of distilled water (analytical grade) was added. Stir with a magnetic stirrer (1000r/min) for 1 hour, away from light. Remove the magnetic stirrer and make up the mark with distilled water. Close with a glass stopper and homogenize. Take an aliquot of 20µl and transfer it into a 200 ml volumetric flask and make up the volume with distilled water. Filter the solution, rapidly and away from light, through a membrane so as to obtain a clear solution. Adjust the spectrometer and record the absorbance of the filtered solution between 200 nm and 700 nm using distilled water as the reference liquid. The results are obtained by direct reading of the specific absorbance at three wavelengths, as follows:

$A^{1\%}_{1\ cm}$ (257 nm): absorbance at about 257 nm ($\lambda_{max}$ of picrocrocin)

$A^{1\%}_{1\ cm}$ (330 nm): absorbance at about 330 nm ($\lambda_{max}$ of safranal)

$A^{1\%}_{1\ cm}$ (440 nm): absorbance at about 440 nm ($\lambda_{max}$ of crocin)

**Results and discussion:**

**Soil Analysis Results**

Comparative soil analysis indicated higher content of average organic carbon, and macronutrients (particularly NPK) in non-niche site than niche site (Table 1). However, the pH and average content of micronutrients is almost the same, in both the niche and non-niche site. Soil analysis reveals that nutrient status of soil in non-niche site (Baramulla) is better than soil in niche site (Pampore) and this could be possibly due to continuous cultivation of saffron in niche site resulting in low nutrient status of soil in niche site areas.

Table 1: Comparison of soil samples of niche site (Pampore) and non-niche site (Baramulla)

| Nutrient status | pH | OC (%) | Av N (kg/ha) | Av P (kg/ha) | Av K (kg/ha) | Av Cu (ppm) | Av Mg (ppm) | Av Ca (ppm) | Av Zn (ppm) | Av Mn (ppm) | Av Fe (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Niche site (Pampore)** | 7.92 | **0.97** | **240** | **9** | 168 | 4.304 | **105** | **336** | 3.056 | 18.1 | 38.44 |
| **Non niche site (Baramulla)** | 8.0 | **1.75** | **350** | **18** | **174** | 3.29 | **149** | **409** | 1.842 | 18.53 | 45.26 |

**Morphological and physiological parameters**

The Crocus plants were studied for various growth parameters with more emphasis on corm characteristics, rooting system, and flowering traits. It was observed that total biomass and number of secondary cormlets was almost the same in niche and non-niche site. Since the stigma part of the flower is the actual source of apocarotenoids, it was observed that there was no significant difference in the length of stigmas, dry weight of stigma in saffron flowers collected from niche site (Pampore) and non-niche site (Baramulla) (Table 2).

Table 2: Comparison of morphological characters at niche site (Pampore) and non-niche site (Baramulla)

| Morphological characters | Niche site (Pampore) | Non-niche site (Baramulla) |
|---|---|---|
| Total biomass (g plant$^{-1}$) | 10.25±0.68 | 10.36±0.73 |
| Number of secondary cormlets | 3.9±1.1 | 4.5±0.5 |
| Length of stigma (cm) | 1.79±0.33 | 2.7±0.11 |
| Weight of stigma (mg) | 3.41±1.22 | 3.35±0.95 |

**Quantification of apocarotenoid and their comparative assessment between nice and non-niche sites**

*C. sativus* is known for the production of apocarotenoids, viz. crocetin, picrocrocin, & safranal in its stigma part of the flower. Therefore, it was necessary to investigate the production of apocarotenoids in saffron cultivated in non-niche site and compare it with the saffron cultivated in niche site. It was observed that the production of crocetin was significantly higher in non-niche site as compared to the niche site saffron flowers, however the production of picrcrocin and safranal was higher in niche site saffron flowers (Figure 1).

**Qualitative evaluation of saffron**

Saffron collected from non-niche sites were subjected to quality control evaluation as per International standard procedure (ISO3632-2-2010(E)). The saffron spice was evaluated for four parameters, viz. moisture and volatile matter content, flavor strength as Picrocrocin, aroma strength as safranal, & colouring strength as crocetin, and the average value of these four chemical constituents recorded were 11.38±0.03, 84.63±9.64, 33.47±1.4, and 230.32±21.82, respectively, which were in the required specifications of grade I saffron as per ISO3632-1-2011 (Figure 3, Table S1). The above findings suggest the saffron spice from non-niche site conforms to grade I quality as per ISO3632-1-2011.

**Conclusion and future perspectives:**

The above findings suggest a good prospect of extension of saffron cultivation in non-niche sites especially in Kashmir valley. The Department of Agriculture should carry out extension activities in different areas and inform people about saffron cultivation. This could be achieved by designating a piece of karewa land at suitable spot for cultivation of saffron crop. The designated saffron farm shall be a demonstration site for saffron cultivation where villagers/progressive farmers could get first hand skill knowledge about various aspects of saffron cultivation. Periodic soil analysis of soil samples of villagers which would enable farmers to enrich their fields with particular nutrients.

The department of agriculture should ensure irrigation supply by way of facilitating construction of bore wells/Overhead tanks so that

saffron corms get assured moisture in the month of September or after sowing.

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*Figure 1: Field preparation and saffron cultivation in non-niche site (Baramulla)*

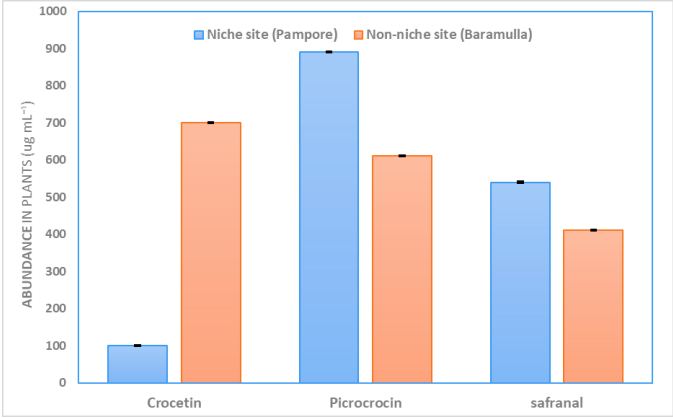


*Figure 2: Quantification and comparative assessment of apocarotenoids (Crocetin, Picrocrocin, & safranal) production in saffron cultivated in niche and non-niche sites*

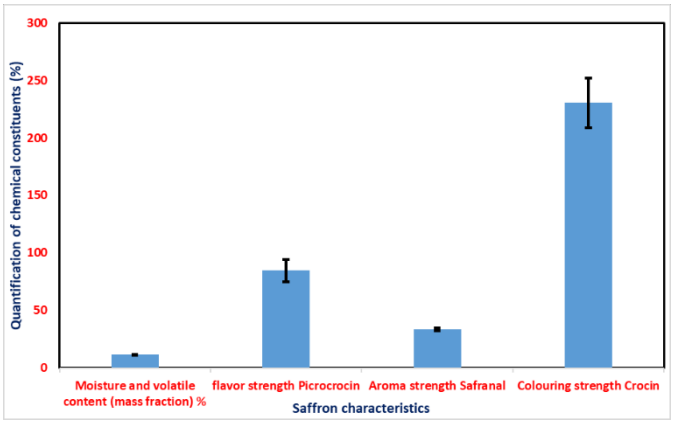


*Figure 3: Quantification of chemical constituents in saffron collected from non-niche sites.*