

## Pharmacological and medicinal importance of saffron

Anil Kumar (Reg. No. 22012114014), Ankit (Reg. No. 22012114015) and Anup Kumar (Reg. No. 22012114019)

*Abhilashi College of Pharmacy, Ner Chowk Mandi H.P*

Miss Nancy Sharma

*Assistant Professor*

*Abhilashi Collehe Of Pharmacy*

*Nerchowk. Mandi, H.P.*

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### I. INTRODUCTION

**Mansotra R. et al. (2020);** In addition to its unique flavour, saffron has long fascinated people due to its profound cultural and historical significance. Saffron, one of the priciest spices in the world, is derived from the fragile stigmas of the *Crocus sativus* flower. Its stories span time and space, entwining with festivals, medicinal procedures, and culinary skills. The fascinating story of saffron is enhanced by knowing its origins. From the busy marketplaces of ancient Persia to contemporary kitchens, the spice has travelled through ancient civilizations. This

investigation is a voyage through human culture, economic tendencies, and the unwavering pursuit of quality rather than just botanical research.

Saffron is still associated with luxury and well-being because to the growing demand for organic and handcrafted cuisine. This essay will explore the history, growing techniques, and economic effect of this colourful spice, which has been embraced by many cultures.

Let's now examine the data that influence our comprehension of the history and importance of saffron.



Figure 1

Saffron is more than simply a spice; it symbolizes a diverse range of cultural and historical traditions. The results imply that its influence extends beyond its culinary applications. Its unique flavour and vivid colour have made it a highly sought-after commodity in numerous marketplaces, where quality determines its current market value.

Saffron requires a lot of labour to produce. Pricing and availability are under strain because only a few grams of the spice are produced from thousands of blossoms. The cultivation procedure is both an art and a science because harvesting is done by hand with great care. To make sure their crops thrive, farmers need to keep a close eye on the weather.

## 1.0 COMPARISON WITH PREVIOUS STUDIES

**Wani, A.B. *et al.* (2025);** Prior research on saffron mostly concentrated on its chemical characteristics or its use in conventional medicine. Our investigation reveals the intricacies of saffron trade dynamics in modern contexts, even though such elements are still crucial.

For example, a comparative study found that although Iranian saffron dominates international markets, new Indian producers, especially those in Kashmir, are improving their methods to increase quality and exposure. In order to appeal to a more discriminating consumer market, these growers are now utilizing both ancient and modern technologies. "In every pinch of saffron lies a reflection of its past, shimmering with stories of places and peoples."

As saffron finds its way into kitchens on a regular basis, it becomes evident that its story is one of tenacity and development, inextricably linked to the civilizations.

## 1.1 HISTORICAL OVERVIEW

**Rashid, A. *et al.* (2023);** The historical background of saffron enhances our comprehension of its deep cultural value. Saffron's evolution across time demonstrates both its economic significance and its symbolic meanings in various communities, from its use in medicine to its status as a luxury good in royal courts. This section explores the historical applications of saffron and its significance in well-known societies, shedding light on how this unique spice has influenced culinary and cultural traditions over time.

### 1.1.1 ANCIENT USES OF SAFFRON

Saffron has been used for thousands of years, mostly for its culinary and therapeutic uses. Its use in a variety of ways, from seasoning food to curing illnesses, is highlighted in ancient scriptures. The spice was used in ceremonies, medical treatments, and even cosmetics, according to records from ancient societies like the Persians and Egyptians.

This varied application highlights saffron's function as more than just a flavour enhancer; it was a valued ingredient that was used in both apothecaries and kitchens. Saffron was associated with richness and prestige in many cultures. This connection, which dates back to the Bronze Age, demonstrates how closely linked saffron was to human civilization.

Saffron was employed in culinary circles not only for its flavour but also for its vivid colour and fragrance. It was used into many traditional recipes, giving them a pleasing appearance in addition to being tasty. It is said that some of the oldest saffron dishes came from Persia, where it was frequently combined with stews or rice.

**Nehvi, F.A. *et al.* (2021);** Additionally, saffron was a crucial component of traditional medicine. It was thought to enhance circulation, help with digestion, and lessen depression. This all-encompassing approach to saffron's use demonstrates how ancient societies strove to integrate natural medicines into daily life and respected them.

### 1.1.2 SAFFRON IN ANCIENT CIVILIZATIONS

#### Persians

Saffron was highly valued by the Persians, who used it in their rituals and food. The spice, which reflected the opulence of Persian feasts, was essential to many traditional dishes. It was also utilized in ceremonial occasions, where its rich golden colour represented riches and richness. Unique recipes, like rice laced with saffron, demonstrate how this opulent spice enhanced the Persian flavour. Saffron's great value was also influenced by Persia's painstaking harvesting method, which required labour and accuracy that few could equal.

#### Egyptians

The Egyptians also held saffron in high regard because they thought it had sacred qualities. Its use

dates back to ancient graves, where saffron was incorporated into burial customs to commemorate the deceased, and it played a significant role in their rites. Because of its vivid colour and fragrant properties, saffron was frequently employed in Egyptian cosmetics. This versatile application highlights the adaptability of saffron as well as the ancient Egyptians' pursuit of spirituality and beauty.

### Greeks

Saffron was valued by the Greeks as well, both as a culinary and medicinal herb. They frequently used it in religious rites and marriage ceremonies because they saw it as a symbol of fertility and love. Greek doctors recognized the medicinal benefits of saffron and prescribed it for a number of conditions. With its distinct flavour and vivid colour, saffron's entrance to Greek cuisine has had a long-lasting impact on contemporary gastronomy. A monument to the diversity of ancient societies and their capacity to incorporate natural resources into their everyday lives, saffron is more than just a spice.

In conclusion, **Bahrami, A. et al. (2020)**; the history of saffron highlights how crucial it was to the development of many societies that appreciated its culinary, therapeutic, and symbolic qualities. The historical account provides a basis for further investigation into the ways in which geographic factors impact saffron production and cultivation, demonstrating the long-lasting relationship between saffron and human civilization.

### 1.1.3 GEOGRAPHICAL DISTRIBUTION

**Kazemi-Shahandashti, S.-S. et al. (2022)**; Because it illustrates the intricate relationships between climate, culture, and growth techniques, an understanding of saffron's worldwide spread is crucial. Saffron grows well in a variety of settings, including the sun-drenched plains of Spain, the mountainous fields of India, and the desert regions of Iran. This spice's general character is influenced by each place, so understanding its historical and cultural significance requires an understanding of its geographical mapping.

#### 1.1.3.1 PRIMARY SAFFRON-PRODUCING COUNTRIES

##### Iran

With 90% of the world's supply coming from Iran, the country is frequently referred to as the centre of saffron production. Because of its perfect climate, which includes a dry climate with distinct seasons,

the region known as Khorasan is especially well-known for its superior saffron. The saffron crocus thrives in this region because of its distinct topography, which includes high heights and ideal sunlight. This saffron is highly prized both locally and internationally due to its rich aroma and bright red colour.

Iran's economy benefits from its supremacy, but there are drawbacks as well. Export procedures can occasionally be complicated by trade sanctions and political concerns. However, the skill and long-standing family customs in saffron harvesting are unmatched, guaranteeing its position in international markets.

##### India

The main saffron-producing area in India is the state of Jammu and Kashmir, which is renowned for its colourful saffron fields that bloom in the fall. Known as "Kashmiri saffron," this regional variety is well-known for its rich colour and unique flavour. This area has a rich cultural tapestry due to the ancient agriculture methods that have been passed down through the generations.

However, climate change is posing serious challenges to saffron cultivation in India, which has a considerable impact on yield yields. Farmers who depend on particular harvesting dates and post-harvest processing techniques are facing a serious problem due to water constraint. Although using Kashmiri saffron in cooking gives food a beautiful scent, farmers frequently struggle to keep up with the changing weather.

Although using Kashmiri saffron in cooking gives food a wonderful scent, farmers frequently struggle to maintain their illustrious heritage due to weather-related issues.

##### Spain

Spain has made a name for itself in the saffron industry, especially with La Mancha saffron. This area is renowned for producing saffron that tastes a little earthier than its Iranian equivalent. Spanish saffron has gained popularity among chefs who value its culinary uses, particularly in risottos and paellas.

The Spanish saffron industry places a strong emphasis on genuine and high-quality processing techniques. Spanish farmers frequently sell directly to consumers, increasing their economic sustainability even though their production volume is lower than that of Iran. Additionally, Spain takes steps to guarantee fair trading practices among

farmers, shielding regional producers from changes in the market. Rising production costs and public knowledge of fake saffron, however, continue to pose a danger.

### 1.1.3.2 SAFFRON CULTIVATION REGIONS

**Rashid et al., 2023**); The story of saffron is enhanced by knowing where it is grown. In addition to offering a variety of flavours, major producing regions also highlight distinctive harvesting methods and cultural relevance. Geographical elements, such as topography and climate, are fundamental in determining the traits of saffron grown in various regions. Furthermore, the quality and reputation of the spice are frequently significantly impacted by regional customs about cultivation and harvesting techniques.

Saffron is still fascinating due to its culinary uses as well as its cultural significance and economic ramifications. Saffron is a genuinely worldwide

treasure since each place tells a unique tale behind the same golden threads.

### 1.2 ECONOMICAL VALUE WHY IT IS MOST EXPENSIVE SPICE?

**Lachguer, M., et al. (2025)**; A pound of saffron costs between \$5,000 and \$10,000 since it takes 75,000 to 200,000 hand-picked *Crocus sativus* flowers to harvest. At morning, each delicate stigma must be removed one at a time; mechanization is not an option. Saffron is the costliest spice in the world by weight due to this labour-intensive procedure, which takes 40 hours per ounce.

The cost of saffron is determined by human labour and biology, not by chance. Only three red stigmas are produced by each purple crocus bloom (*Crocus sativus*). Harvesters in Iranian fields, which produce 90% of the world's supply, must harvest 150,000–200,000 blossoms before midday when flowers close. They must work in predawn darkness. It takes 40 hours of painstaking hand labour to produce one ounce, or 2.5 full workweeks.

Spice	Flowers/Units per Pound	Harvest Labour Required	Price per Pound (USD)
Saffron	75,000-200,000 flowers	40+ hours hand picking	\$5,000-\$10,000
Vanilla	3,000 orchid pods	Hand-pollination + 9 months curing	\$200-\$600
Cardamom	5,000-7,000 greens pods	Hand- harvesting before ripening	\$30-\$100

Table 1

The severe production burden of saffron is confirmed by this table. Vanilla's orchid pods yield more per plant, but careful pollination is necessary. Because of its fragility, saffron cannot be mechanized; Wikipedia describes how machinery would crush the fragile stigmas.

➤ **Botanical Source:** *Crocus sativus* L., family Iridaceae.

➤ **Plant Part Used:** Dried red flower stigmas.

## II. LITERATURE REVIEW

The pharmacognostic profile of saffron (*Crocus sativus* L.) is well-documented. Its dried red stigmas, which are rich in bioactive chemicals like crocin, picrocrocin, and safranal, contribute to its colour, flavour, and aroma. Its phytochemistry and therapeutic promise in neurological, cardiovascular, and metabolic illnesses are highlighted in contemporary literature.

### 2.1 PHARMACOGNOSTIC PROFILE OF SAFFRON

**Sahoo, M.R. et al. (2023)**;

- **Macroscopic Features:**
  - Bright red-orange stigmas that resemble threads.
  - unique bitter flavour (caused by picrocrocin).
  - Iodine or hay-like scent (caused by safranal).
- **Microscopic Features:**
  - Cuticle-striated epidermal cells.
  - Pigment granules and oil globules are present.
- **Geographical Distribution:** It is mostly grown in Iran, but it is also produced in Greece, Spain, and India (Kashmir).

#### 2.1.1 CULTIVATION OF SAFFRON

- **Climate Requirements**
  - It thrives in temperate regions with dry summers and chilly winters.
  - Frost tolerance is crucial; the ideal temperature range for growth is 15 to 20°C.
- **Soil Conditions**
  - Soil should be rich in organic matter but not waterlogged.
  - Prefers sandy or loamy soils with a pH of 6–8 that drain well.
- **Propagation**
  - Grown from corms, which resemble bulbs, rather than seeds.
  - In late summer (August–September), corms are planted.
- **Flowering**
  - Because each flower only produces three red stigmas during its October–November bloom, saffron is incredibly uncommon and expensive.

- **Regions in India**
  - **Jammu & Kashmir:** Saffron production, both traditional and high-quality.
  - **Himachal Pradesh, Uttarakhand, Maharashtra:** New experimental cultivation in controlled environments.

#### 2.1.2 POST-HARVESTING PROCESS

Sharma, M.M. *et al.* (2025);

- **Flower Picking**
  - To avoid withering, flowers are gathered early in the morning.
  - Every year, the harvest season barely lasts three to four weeks.
- **Stigma Separation**
  - The flowers' red stigmas are meticulously removed by hand.
  - For one kilogram of saffron, thousands of blooms are needed because each flower only produces three stigmas.
- **Drying**
  - Stigmas are dried in controlled environments using dehydrators, charcoal heat, or sunlight.
  - To maintain crocin (colour), picrocrocin (taste), and safranal (aroma), proper drying is essential.
- **Grading & Packaging**
  - Saffron is rated according on its purity, aroma, and colour intensity.
  - Stored in **airtight containers** away from light and moisture to maintain potency.

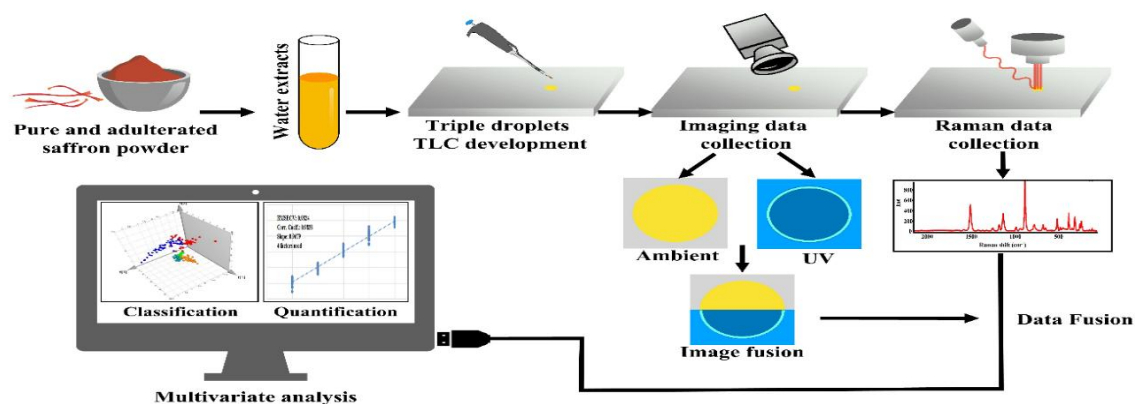


Figure 2

### 2.1.3 QUALITY CONTROL

While adulteration often with turmeric, safflower, or artificial dyes remains a significant concern, saffron quality control focuses on guaranteeing purity, colour strength, and aroma. To ensure authenticity, contemporary detection techniques include spectroscopy, chromatography, and AI-based imaging.

#### ✓ Quality Control Parameters

- **ISO 3632 Standard:** International standard for the quality of saffron.
  - **Colour strength:** Crocin content (absorbance at 440 nm) is used to measure.
  - **Taste:** based on the levels of picrocrocin.

- **Aroma:** Safranal concentration is essential.

- **Physical Tests:**

- Moisture content: less than 12%.
- Inorganic adulterants are indicated by the ash content.
- Analysing stigmas under a microscope.

- **Chemical Tests:**

- UV-Vis spectrophotometry for safranal, picrocrocin, and crocin.
- TLC, or thin-layer chromatography, is used to detect dyes.

- **Sensory Evaluation:** Colour, flavour, and scent in relation to benchmarks.

### COMMON ADULTERANTS

Adulterant	Purpose	Detection Method
Turmeric powder	Adds yellow colour	TLC, LC-MS
Safflower petals	Mimics saffron threads	Microscopy, Raman spectroscopy
Synthetic dyes (e.g., Sudan dyes)	Enhances colour	HPLC, UV-Vis
Maize cob fibres	Thread like substitute	Microscopy
Other Plant parts	Bulk filler	DNA barcoding

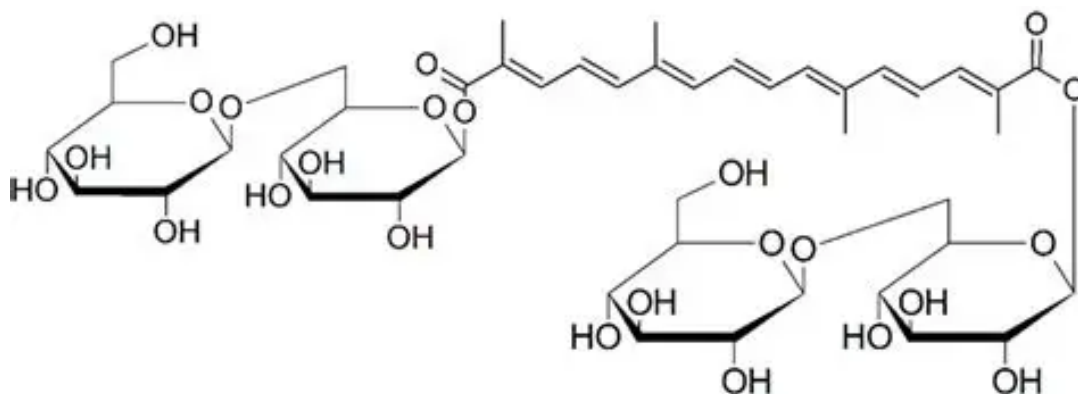
Table 2

## 2.2 PHYTOCHEMISTRY [Ziani, A. *et al.* (2025);]

### 2.2.1 MAJOR PHYTOCHEMICAL CONSTITUENTS

#### A. Crocin

- **Type:** Carotenoid glycoside.
- **Function:** In charge of the antioxidant action and rich red colour of saffron.
- **Structure:** produced by esterifying crocetin with gentiobiose sugars.
- **Bioactivity:** Neuroprotective, anti-cancer, and vision-enhancing.



Crocin

Figure 3

#### B. Picrocrocin

- **Type:** Monoterpene glycoside.
- **Function:** Gives saffron its bitter taste.
- **Structure:** Glycoside of HTCC (4-hydroxy-2,6,6-trimethyl-1-cyclohexene-1-carboxaldehyde).
- **Bioactivity:** Precursor of safranal during drying.

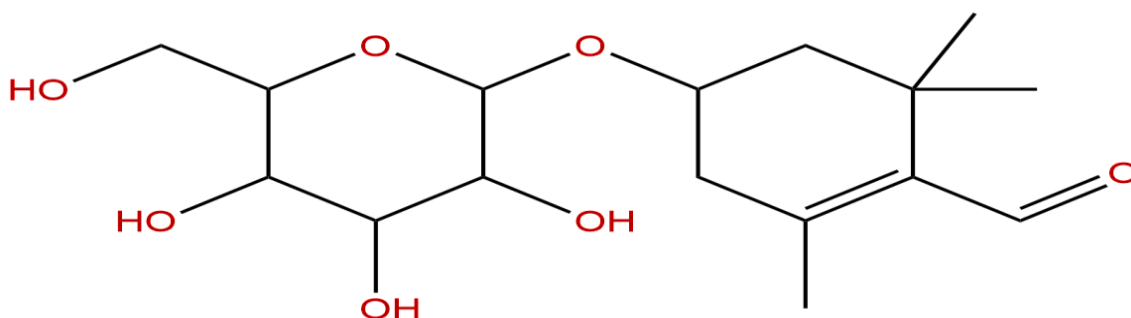
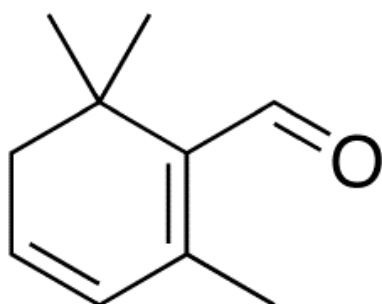


Figure 4

#### C. Safranal

- **Type:** Volatile aldehyde.
- **Function:** Provides saffron's characteristic aroma.
- **Structure:** Formed from picrocrocin degradation.
- **Bioactivity:** Antioxidant, anticonvulsant, and neuroprotective.



## Safranal

Figure 5

### D. Other Compounds

#### ✓ Flavonoids

- **Examples:** Kaempferol, quercetin.
- **Structure:** Polyphenolic backbone (C6-C3-C6).
- **Bioactivity:** Antioxidant, anti-inflammatory, vascular protective.

#### ✓ Phenolic Compounds

- Includes tannins and phenolic acids.
- Contribute to antioxidant potential.

#### ✓ Vitamins

- **Vitamin C:** Present in small amounts, supports immune function and collagen synthesis.
- **B-complex vitamins:** Trace amounts, important for energy metabolism.

### 2.3 PHARMACOLOGICAL AND THERAPEUTIC ACTIVITIES

#### 2.3.1 NEUROPROTECTIVE EFFECTS

- **Mechanisms:** Safranal and crocin suppress apoptosis, lower oxidative stress, and alter neurotransmitters including dopamine and serotonin.
- **Alzheimer's disease:** In mild to moderate cases, it enhances memory and cognition and prevents the formation of amyloid- $\beta$  plaque.
- **Parkinson's disease:** In animal models, it lessens motor dysfunction and maintains dopaminergic neurons.

- **Clinical Evidence:** Research indicates that saffron supplements reduce anxiety and depression while having fewer negative effects than SSRIs.

#### 2.3.2 OCULAR HEALTH

- **Crocin** enhances photoreceptor function and retinal blood flow.
- **Age-related macular degeneration (AMD):** Supplementing with saffron improves vision and delays the progression of disease, according to clinical research.
- **Mechanism:** Modulation of mitochondrial function and antioxidant defence of retinal cells.

#### 2.3.3 METABOLIC SYNDROME

- **Effects:** Increases insulin sensitivity, lowers blood sugar, and lowers cholesterol and triglycerides.
- **Mechanisms:** Lowers inflammation, improves mitochondrial function, and modifies lipid metabolism.
- **Clinical Potential:** May aid in the management of problems associated with type 2 diabetes and obesity.

#### 2.3.4 ANTIOXIDANT & ANTI-INFLAMMATORY PROPERTIES

- **Crocin and flavonoids:** Eliminate reactive oxygen species (ROS).
- **Safranal:** inhibits pro-inflammatory cytokines (IL-6, TNF- $\alpha$ ).
- **Impact:** Prevents neurodegeneration, cardiovascular disease, and chronic inflammation.

#### 2.3.5 EMERGING RESEARCH

Campos, C. *et al.* (2026);

##### ➤ Alzheimer's Disease

- **In vitro & clinical studies:** Saffron has similar effects to donepezil, enhances cognition, and decreases amyloid aggregation.

- **Mechanisms:** Neurotransmitter regulation, anti-inflammatory signalling, and antioxidant defence.
- **Cancer Therapy (In Vitro Studies)**
  - **Crocin and safranal:** inhibit proliferation of cancer cell lines (lung, breast, colon).
  - **Mechanisms:** Induce apoptosis, inhibit DNA synthesis, reduce angiogenesis.
  - **Potential:** Chemo-preventive role due to strong antioxidant activity.

✓ **Summary Table**

Domain	Key Compounds	Effects
Neuroprotection	Crocin, Safranal	Antioxidant, anti-apoptotic, neurotransmitter modulation
Ocular Health	Crocin	Retinal protection, improved vision in AMD
Metabolic Syndrome	Crocin, Flavonoids	Insulin sensitivity, lipid regulation
Antioxidant/Anti-inflammatory	Crocin, Safranal, Flavonoids	ROS neutralization, cytokine suppression
Alzheimer's	Crocin, Safranal	Amyloid inhibition, cognitive improvement
Cancer Therapy	Crocin, Safranal	Apoptosis induction, anti-proliferative

Table 3

2.4 TOXICOLOGY AND SAFETY

Gohari, A.R. *et al.* (2022);

- **Culinary use:** Safe at 1–1.5 g/day (typical dietary amounts).
- **Therapeutic use:** Clinical studies generally use 20–60 mg/day of standardized extract.
- **High doses (>5 g/day):** Can cause toxicity (vomiting, dizziness, uterine stimulation).
- **Lethal dose:** Estimated around 20 g/day, far above therapeutic ranges.
- **Pregnancy:** High doses may stimulate uterine contractions, raising miscarriage risk.

✓ **SUMMARY TABLE**

Domain	Effective Dose	Response Pattern
Depression	30 mg/day	Plateau beyond 60 mg/day
Ocular Health	20–30 mg/day	Threshold effect
Metabolic Syndrome	30–60 mg/day	Dose-dependent, plateau
Antioxidant	Moderate doses	Linear, high doses may be pro-oxidant
Alzheimer's	30 mg/day	
Cancer (in vitro)	Dose-dependent	Cognitive improvement

Table 4

2.4.1 DOSE-RESPONSE RELATIONSHIP

- **Antidepressant/Neuroprotective:** Effective at **30 mg/day**; plateau beyond 60 mg/day.
- **Ocular Health (AMD):** Benefits at **20–30 mg/day**; higher doses show no added effect.
- **Metabolic Syndrome:** improvements in the lipid profile and insulin sensitivity at 30–60 mg/day; after that, there is a plateau effect.
- **Antioxidant Activity:** At moderate concentrations, there is a linear rise; at very high doses, they may paradoxically behave as pro-oxidants.

- **Cancer (in vitro):** Safranal and crocin exhibit dose-dependent cytotoxicity against cancer cells, but this is purely experimental.

#### 2.4.2 CONTRAINDICATIONS

- **Pregnancy & Lactation:** Avoid high doses; culinary use is generally safe.
- **Allergies:** Although rare, hypersensitivity to saffron or related plants (Iridaceae family) may occur.
- **Bleeding Disorders:** Because saffron may prevent platelet aggregation, patients using anticoagulants should use caution when using it.
- **Hypotension:** A little reduction in blood pressure; use caution when taking antihypertensive medications.
- **Psychiatric Medications:** Possible synergistic effects with MAO inhibitors or SSRIs (serotonin modulation).

### III. AIM AND OBJECTIVES

**3.1 AIM-** Review on 'Pharmacological and Medicinal significance of Saffron.'

#### 3.2 OBJECTIVES-

- To research saffron's traditional and contemporary medical applications.
- To assess the main bioactive compounds found in saffron, including picrocrocin, crocin, crocetin, and safranal.
- To evaluate saffron's antibacterial, anti-inflammatory, antioxidant, and anticancer qualities.
- To research saffron's potential for treating neurological conditions, anxiety, depression, and memory issues.
- To look at how saffron affects metabolic diseases, diabetes, and cardiovascular health.
- To evaluate saffron's usage in wound healing, skin care, and cosmetics.

- To investigate the safety, toxicity, dose, and side effects of using saffron medicinally.

- To contrast saffron's pharmacological importance with those of other natural remedies.

- To comprehend saffron's potential in pharmaceutical research and drug development in the future.

### IV. PLAN OF WORK

#### 4.1 BACKGROUND RESEARCH

##### 4.1.1 LITERATURE REVIEW

The many facets of saffron's significance, including agronomy, post-harvest management, phytochemistry, and therapeutic potential, have been highlighted in recent reviews. While **Thakur et al. (2025)** concentrate on advancements in drying and storage, **Lachguer et al. (2025)** highlight sustainable agriculture and production challenges. **Aissa et al. (2023)** emphasize quality control and medicinal applications, while **Abdian et al. (2024)** investigate the neuroprotective functions of crocin, crocetin, and safranal. **Abu-Izneid et al. (2022)** highlight the wide pharmacological potential of saffron and need for further clinical confirmation.

##### 4.1.2 REGULATORY STANDARD REVIEW

**ISO 3632-1:2025** establishes international standards for the quality, purity, and categorization of saffron filaments, cut filaments, and powder. To guarantee authenticity and stop adulteration, these criteria assess the levels of crocin, picrocrocin, and safranal. Food safety, pollutants, and identity are further regulated by Codex Alimentarius and European and Indian pharmacopoeial monographs, and national laws are in line with ISO for export compliance.

#### 4.2 OBJECTIVES

##### 4.2.1 MAIN OBJECTIVE

Primary goal is to compile and evaluate current information about *Crocus sativus* L., with a focus on its pharmacognostic profile, post-harvest procedures, and legal requirements. In doing so, the review seeks to:

- Emphasize the distinctive botanical and phytochemical properties of saffron.
- Evaluate adulteration hazards and quality control procedures.
- Analyse post-harvest procedures that affect medicinal efficacy.
- Establish a thorough regulatory framework that includes national laws, pharmacopoeias, ISO, and Codex.

This guarantees a comprehensive comprehension of the medical, economic, and regulatory importance of saffron, directing future studies, business procedures, and policy formulation.

#### 4.2.2 SPECIFIC OBJECTIVES

- ✓ To record the botanical, morphological, and phytochemical traits of saffron (*Crocus sativus* L.) as well as its pharmacognostic profile.
- ✓ To examine the effects of post-harvest procedures on the quality and medicinal potential of saffron, including collection, drying, and storage.
- ✓ To assess national laws, pharmacopoeias, ISO 3632, and other regulatory requirements pertaining to the safety, purity, and quality of saffron.
- ✓ To determine obstacles and dangers in the production and trading of saffron, such as adulteration, inappropriate storage, and compliance expenses.
- ✓ To draw attention to saffron's potential and research gaps in pharmacology, nutraceuticals, and international market regulation.

#### 4.3 DATA COLLECTION

The methodical gathering of secondary data from peer-reviewed publications, pharmacognosy textbooks, and scientific databases including PubMed, Scopus, Web of Science, and Google Scholar will serve as the foundation for this review. We shall consult regulatory materials such as Codex Alimentarius guidelines, Pharmacopoeial monographs, and ISO 3632 standards. To provide thorough coverage, national reports and latest

evaluations on saffron cultivation, post-harvest procedures, and trading will also be covered.

#### 4.4 DATA ANALYSIS

To find important patterns, parallels, and discrepancies in the pharmacognostic profile, post-harvest procedures, and quality standards of saffron, a critical analysis of the gathered literature and regulatory documents will be conducted. Pharmacopoeial monographs, national regulations, and ISO 3632 specifications will all be compared. In order to provide a thorough understanding of saffron's medicinal and regulatory relevance, the analysis will also highlight gaps, difficulties including adulteration, and future research prospects.

### V. RESULT AND DISCUSSION

#### ➤ Phytochemistry

Saffron contains more than 150 volatile and aromatic compounds. The most studied are:

- **Crocin:** carotenoid glycoside responsible for colour and antioxidant activity.
- **Picrocrocin:** glycoside imparting bitterness, precursor of safranal.
- **Safranal:** volatile aldehyde responsible for aroma, with neuroprotective properties.
- **Other compounds:** flavonoids (kaempferol, quercetin), phenolic acids, terpenes, and vitamins (notably vitamin C and B-complex).

#### ➤ Pharmacological Activities

- **Neuroprotective:** Crocin and safranal protect neurons via antioxidant, anti-inflammatory, and anti-apoptotic mechanisms.
- **Ocular Health:** Crocin improves retinal function, beneficial in age-related macular degeneration.
- **Metabolic Syndrome:** Improves insulin sensitivity, lowers glucose and lipids.
- **Antioxidant & Anti-inflammatory:** Strong free radical scavenging and cytokine suppression.
- **Emerging Research:**
  - **Alzheimer's disease:** Inhibits amyloid- $\beta$  aggregation, improves cognition.

- **Cancer therapy (in vitro):** Crocin and safranal induce apoptosis and inhibit proliferation in cancer cell lines.

➤ **Toxicology and Safety**

- **Safe range:** 20–60 mg/day of standardized extract.
- **Culinary use:** Safe at 20–50 mg/day.
- **High doses (>5 g/day):** Toxic (nausea, dizziness, uterine stimulation).
- **Contraindications:** Pregnancy, bleeding disorders, hypotension, drug interactions (SSRIs, anticoagulants).

✚ **CONCLUSION**

**Sharma, M.M. et al. (2025);** Saffron is a unique spice with a complex phytochemical profile. Its bioactive compounds—crocin, picrocrocin, safranal, and flavonoids—contribute to diverse pharmacological effects, including neuroprotection, ocular health, metabolic regulation, and anti-inflammatory activity. Clinical evidence supports its use in depression and age-related macular degeneration, while preclinical studies highlight potential in Alzheimer’s and cancer therapy. Importantly, saffron demonstrates a clear dose–response relationship, with therapeutic benefits at moderate doses and toxicity at very high doses.

✚ **FUTURE PERSPECTIVES**

- **Clinical Trials:** Larger, long-term studies are needed to confirm efficacy in Alzheimer’s, Parkinson’s, metabolic syndrome, and cancer.
- **Standardization:** Development of standardized saffron extracts with defined crocin/safranal content to ensure reproducibility.
- **Drug Development:** Potential for saffron-derived compounds as adjunct therapies in neurology and oncology.
- **Mechanistic Studies:** Further exploration of molecular pathways (neurogenesis, mitochondrial function, immune modulation).
- **Safety Monitoring:** Establishing clear guidelines for safe therapeutic dosing, especially in vulnerable populations (pregnant women, patients on anticoagulants).

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