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**Chemical Composition of Safflower  
(*Carthamus tinctorius* L.) Petals and Their Use in  
the Food Industry**

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## INTRODUCTION

Safflower (*Carthamus tinctorius* L., Family: Asteracea or Compositae) is an important oilseed crop that has been cultivated since ancient times (Emongor, 2010; Li et al., 2023). There are approximately 25 species of the *Carthamus* genus distributed worldwide, of which only *C. tinctorius* is cultivated (Arslan, 2018). Safflower is cultivated primarily for its seeds, which are used for edible oil, bird food, or for its flowers, which are used as a dye source and for medicinal purposes (Labdelli et al., 2019; Li et al., 2023).

Safflower seeds contain between 35-48% oil and approximately 20% protein. Safflower oils are rich in unsaturated fatty acids (C18H34O2-oleic acid and C18H32O2-linoleic acid) (Assefa et al., 2021; Kurt et al., 2025). This makes them a popular choice among consumers conscious of healthier eating. Furthermore, the growing global demand for organic farming and organic products is increasing the popularity of safflower production. There is significant interest in developing safflower-based products, particularly in the food and cosmetics industries.

Safflower is a temperate zone plant that grows in arid and semiarid regions of the world (Zemour et al., 2021). India, one of the countries with the largest safflower cultivation area in the world, is used for oil production and is also used in traditional medicine and as a spice. In Mexico, one of the countries with the largest commercial production of safflower, its flowers are used for natural dye production and cooking oil production (Erbaş and Mutlucan, 2023).

In the USA, safflower is used for high-quality cooking oils and paints, while in China, safflower is widely used in the pharmaceutical and cosmetic sectors, both as a source of oil and as an important plant used in traditional Chinese medicine (Emongor, 2010; Cheng et al., 2024). Ethiopia, a leading center for safflower production in Africa, is used for traditional food and oil production (Kemale and Hailu, 2019).

Kazakhstan, with its extensive agricultural lands, has significant safflower cultivation potential and is used for oil production and feed (Didorenko et al., 2025). Safflower cultivation is also practiced in countries such as Australia, Canada, Russia, Argentina, Iran, Afghanistan, and Pakistan. Türkiye, which ranks 7th among safflower producers globally, has seen a steady increase in safflower cultivation in recent years (Anonymous, 2025). Production is being supported to increase agricultural diversity, meet biofuel production, and meet cooking oil needs. In recent years, climate change, drought, and the increasing demand for biofuels have increased the importance of safflower cultivation. Türkiye, Kazakhstan, and some African countries are expanding their cultivation areas thanks to this plant's drought resistance.

While safflower is traditionally known as an oilseed crop, its petals of flowers also contain important bioactive compounds. The natural pigments, phenolic compounds, and flavonoids derived from the petals are valued in the food industry as additives, colorants, and functional ingredients (Adamska and Biernacka, 2021). Due to the potential health risks associated with synthetic additives, interest in natural and sustainable sources is increasing. In this context, safflower flowers offer a valuable alternative.

The primary objective of this study was to examine the potential use of safflower petals in the food industry based on scientific evidence. The bioactive compounds found in safflower petals, their significance, and the potential use of safflower flowers in the food industry were evaluated.

## **1. THE FLOWERS OF SAFFLOWER**

The flowers are in a small sepal at the end of the main stem and side branches. The sepal diameter is 2-5 cm. The number of sepals per plant ranges from 5-50. The sepal contains between 20-180 flowers, which varies depending on the variety and environmental conditions.

The sepal is surrounded by green bracts. The outermost row of bracts has sharp spines at the tips in spiny varieties. Inside the bracts, the sepals and petals are fused, forming a tube. Flower colors range from whitish yellow to orange-yellow and orange red (Figure 1). Safflower flowers have five stamens and one pistil. Flowers bloom in the sepals on the first side branches of the safflower plant, followed by secondary branches. Therefore, the flowering period of a plant can range from 10-40 days. Flowering progresses from the outside of the sepal to the center, and flowering is complete within 3-5 days (Dajue and Mündel, 1996; Emongor, 2010; Sharma et al., 2022).



**Figure 1:** Safflower flowers and petals.

## **2. CHEMICAL COMPOSITION OF PETALS**

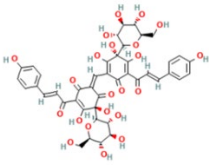
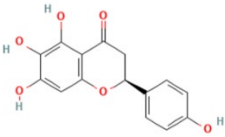
Safflower petals are quite rich in chemical composition (Adamska and Biernacka, 2021). They contain macro and microelements. The total element content of the petals was determined to be 3507.01 mg/100 g, and they are rich in K (2040 mg/100 g) and Ca (680 mg/100 g). Safflower petals contain protein, oil, and crude fiber (Barashovets and Popova, 2016; Kim et al., 2000).

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Safflower petals contain two important color pigments: carthamin and carthamidin. Basic information about these pigments (PubChem, 2025) is presented in Table 1.

**Table 1:** Basic information about color pigments in safflower petals

| Compounds   | Molecular Formula                               | Structure                                                                         | Uses                                                                                                                                                                                                          |
|-------------|-------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Carthamin   | C <sub>43</sub> H <sub>42</sub> O <sub>22</sub> |  | It is the most important pigment in safflower flowers. It is a red color, is insoluble in water, and is soluble in alcohol and alkaline solutions. It is used as a natural red colorant in the food industry. |
| Carthamidin | C <sub>15</sub> H <sub>12</sub> O <sub>6</sub>  |  | It is a yellow, water-soluble pigment used primarily in baked goods and beverages.                                                                                                                            |

Petals contain numerous phenolic compounds. Phenolic compounds are divided into two groups: phenolic acids and flavonoids. Most identified phenolic substances are natural flavonoids. Flavonoids are polyphenolic antioxidants found naturally in herbal teas, fruits, and vegetables. Phenolic acids found in foods influence color, aroma, odor, bitterness, astringency, and oxidative stability. Phenolic acids have gained significant importance in recent years due to their potential to protect against fatal diseases, particularly cancer and coronary heart disease.

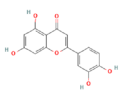
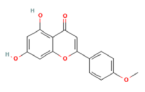
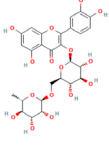
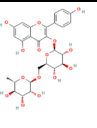
Safflower flower petals contain high amounts of flavonoids, particularly apigenin and luteolin derivatives. Flavonoids are widely distributed throughout the plant kingdom. They constitute the largest

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group of polyphenols and are thought to be responsible for the color and flavor of many fruits and vegetables. A variety of biological activities, including antioxidants, anti-inflammatory, estrogenic, antimicrobial, and antitumor properties, have been reported for flavonoids (Hussien, 2017). Cartamin, the primary constituent of safflower flowers, is a flavonoid-type dye (Shirwaikar et al., 2010). The structure and biological activities/effects of some important flavonoids in safflower petals are given in Table 2 (PubChem, 2025).

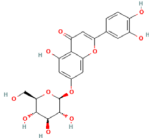
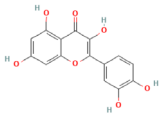
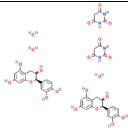
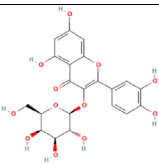
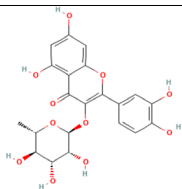
**Table 2:** Some flavonoids in safflower petals and their biological effect potential

| Compounds                                             | Molecular Formula                                    | Structure                                                                           | Biological Activity/Effect                    |
|-------------------------------------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------|
| Luteolin<br>[5280445] <sup>1</sup>                    | C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>       |    | antioxidant<br>anti-inflammatory<br>antitumor |
| Acacetin<br>[5280442]                                 | C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>       |   | anticonvulsant effect                         |
| Rutoside syn: Rutin<br>[5280805]                      | C <sub>27</sub> H <sub>30</sub> O <sub>16</sub>      |  | antioxidant                                   |
| Nictoflorin<br>Kaempferol-3-O-rutinoside<br>[5318767] | syn: C <sub>27</sub> H <sub>30</sub> O <sub>15</sub> |  | antioxidant                                   |

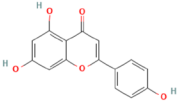
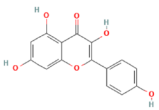
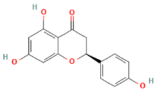
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**Table 2:** Some flavonoids in safflower petals and their biological effect potential (Cont.)

|                                                                  |                                                                |                                                                                     |                                                                                        |
|------------------------------------------------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Cinaroside<br>Luteolin 7-glucoside<br>[5280637]                  | syn: C <sub>21</sub> H <sub>20</sub> O <sub>11</sub>           |    | antioxidant                                                                            |
| Quercetin<br>[5280343]                                           | C <sub>15</sub> H <sub>10</sub> O <sub>7</sub>                 |    | antibacterial agent<br>antioxidant<br>protein kinase inhibitor<br>antineoplastic agent |
| Epicatechin<br>[168346974]                                       | C <sub>38</sub> H <sub>42</sub> N <sub>4</sub> O <sub>21</sub> |    |                                                                                        |
| Resorcinol<br>[5054]                                             | C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>                   |   | antiseptic<br>disinfectant<br>antithyroid                                              |
| Quercetin-3-galactoside<br>syn: Hyperin, Hyperoside<br>[5281643] | C <sub>21</sub> H <sub>20</sub> O <sub>12</sub>                |  | hepatoprotective activity                                                              |
| Quercetin-3-rhamnoside<br>syn: Quercitrin<br>[5280459]           | C <sub>21</sub> H <sub>20</sub> O <sub>11</sub>                |  | antioxidant<br>antileishmanial agent                                                   |

**Table 2:** Some flavonoids in safflower petals and their biological effect potential (Cont.)

|                         |                                                |                                                                                   |                                                              |
|-------------------------|------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------|
| Apigenin<br>[5280443]   | C <sub>15</sub> H <sub>10</sub> O <sub>5</sub> |  | Inducing autophagy in leukemia cells<br>antineoplastic agent |
| Kaempferol<br>[5280863] | C <sub>15</sub> H <sub>10</sub> O <sub>6</sub> |  | antioxidant<br>anticancer<br>antibacterial<br>anti-aging     |
| Naringenin<br>[439246]  | C <sub>15</sub> H <sub>12</sub> O <sub>5</sub> |  | antineoplastic agent                                         |

<sup>†</sup> PubChem CID

Safflower petals have high medicinal value due to their chemical composition. Safflower flowers are an important medicinal ingredient used in prescriptions for cardiovascular health problems, cerebrovascular diseases affecting blood vessels and blood flow to the brain, and gynecological diseases (Zhou et al., 2009). Safflower petals contain an essential oil ranging from 1.2% to 1.6% (v/w, fresh weight basis). The essential oil obtained by water distillation is yellowish in color. Heptacosane, nonanoic acid, undecanoic acid, dec-2-en-1-ol, 2-pentadecanone, 1-hydroxy-3-propyl-5-(4-methyl-pentene)-2-methylbenzene, 2,5,5-trimethyl-3-propyl, tetrahydro 1-naphthol, benzaldehyde, caryophyllene oxide and lauric acid were identified as important components in the essential oil (Ziarati et al., 2012; Turgumbayeva et al., 2018).

### 3. USE OF SAFFLOWER FLOWER PETALS IN THE FOOD INDUSTRY

While traditionally safflower known as an oilseed crop, its flowers contain numerous important bioactive compounds with potential applications in various sectors. Natural pigments, phenolic compounds, and flavonoids derived from the flowers are used in the food industry as additives, colorants, and functional ingredients. Due to the potential health risks of synthetic additives, interest in natural and sustainable resources is increasing. In this context, safflower flowers offer a remarkable alternative (Barashovets and Popova, 2016; Adamska and Biernacka, 2021; Gomashe et al., 2021). The uses of safflower flower petals in the food industry are summarized in Table 3.

**3:** The uses and importance of safflower flower petals in the food industry

| Uses                               | Function / Importance                                                             | Sample Areas                                            | Application |
|------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------|-------------|
| Natural colorant                   | An alternative to synthetic dyes, a healthy and natural pigment source            | Dessert, baked goods, yogurt, ice cream, drinks         |             |
| Functional food additive           | It gives functional properties to foods with antioxidants and phenolic compounds. | Healthy snacks, functional drinks                       |             |
| Herbal tea and beverage production | It is used in teas due to its aromatic properties and health benefits.            | Safflower tea, herbal blend teas                        |             |
| Spices and flavor additives        | It gives light aroma and color to dishes.                                         | Soups, sauces, meat dishes                              |             |
| Saffron alternative                | Low-cost natural colorant                                                         | Rice dishes (pilaw, etc.), desserts, traditional dishes |             |

Red and yellow pigments obtained from safflower flowers are used as dyes. Safflower petals contain approximately 30% yellow pigment. The proportion of red pigment (0.80%) is considerably lower than that of red pigment (Machewad et al. 2012). Both pigments are used as natural and safe colorants in foods.

Safflower flowers have been added to various food products (rice, sauces, soups, meat dishes, bread, pickles, etc.) as a spice to add flavor, aroma, and color since ancient times. Dried safflower flower petals are added directly to dishes. They are particularly used to impart a yellow color to rice pilaw (Ekin, 2005). It was first cultivated because of the yellow or yellow-red pigments in its petals. This pigment is used to add color and flavor to dishes, especially soups. Due to the high cost of saffron, safflower flowers are considered "false saffron" and offer a more economical color source (Erbaş and Mutlucan, 2023). Today, red pigments are widely used in the food industry to color foods. The red pigment, carthamin, has low water solubility. Therefore, it is particularly useful in chocolate production. Because the yellow pigment, carthamidin, is easily soluble in water, it is used in the production of fruit juices, juice mixes, energy drinks, soda, jelly, and candies. It adds color and enhances the visual quality of dairy products (yogurt, cheese, and milk desserts), baked goods, and confectionery (Popescu et al., 2022; Wu et al., 2024).

Safflower petals are also consumed as herbal tea. Safflower petal tea has a unique flavor, color, and aroma. It is used in herbal tea formulations as a color, flavor, and functional additive (Adamska and Biernacka, 2021).

Safflower petals are rich in phenolic compounds, flavonoids, and antioxidants. These compounds provide antioxidant properties to food, slowing lipid oxidation and extending shelf life. They neutralize free radicals and support the immune system, benefiting human health. Therefore, they are a natural resource suitable for the development of functional foods.

In recent years, consumer interest in natural, clean-label products has increased. Safflower flowers, with their high potential for domestic production, are an economical and environmentally friendly additive that can meet this demand. Thus, they provide added value to domestic agriculture and contribute to the natural-focused development of the food industry.

The importance of using safflower flowers as food goes beyond simply providing color and aroma. They are also noteworthy for their functional compounds, health benefits, and their ability to offer a natural and sustainable alternative. Therefore, safflower petals are an important crop resource that will continue to be utilized in the food industry as a natural additive, sweetener, and functional ingredient.

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