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A REVIEW OF GENUS CROCUS: PHENOLIC, NUTRIENT, MINERAL, ESSENTIAL OIL CONTENTS AND BIOLOGICAL ACTIVITIES

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ABSTRACT

Plants are a rich natural resource that serve many uses for people. Humans have long relied on plants for a wide range of needs, including sustenance, housing, and health care. People have been looking to nature for medical solutions since ancient times. He accomplished this by experimenting with and repurposing various organic materials. Plants are the most often utilized of these natural resources. Because of the potential for adverse reactions to synthetic medications, there has been a shift in recent years toward a greater reliance on natural goods. As such, it is crucial to learn which plants are active in certain biological processes. Our research focused on the phenolic, mineral, nutritional, and essential oil content of Crocus genus members as well as their biological activity. A number of crocus species have been demonstrated to have medicinal and nutritional value. Antioxidant, antibacterial, antiviral, and anticancer research has also seen a surge in recent years. Essential oils and phenolic chemicals are suspected to be present in this plant, making it a potential natural source.

Keywords: Antioxidant, antimicrobial, Crocuses, Croci, Medicinal Plants

INTRODUCTION

Many populations throughout time have looked to the natural world for answers on how to treat sickness. Like in animals, humans have an innate knowledge and understanding of how to utilise therapeutic herbs, which has been uncovered via trial and error (**Sevindik *et al.* 2017**). There has been a gradual but steady rise in the popularity of using certain medicinal plants to treat a range of illnesses (**Mohammed *et al.* 2020a; Cahyaningsih *et al.* 2021**). Since then, the usage of therapeutic herbs has shifted from an empirical to a more rational foundation. When compared to conventional medicine, complementary medicine draws on ancient human knowledge and practises. Many different types of fungi, animals, and plants are employed in the practise of alternative medicine (**Sevindik *et al.* 2018; Sharma *et al.* 2021; Bal *et al.* 2023**). Plants are particularly valuable among these natural resources. Because of the risks associated with synthetic medications, more individuals are turning to alternative medicine in search of safer, more long-lasting solutions (**Mohammed *et al.* 2021a; Romano *et al.* 2021**). Plants play a significant role here. When it comes to biological functions, plants are among the most versatile materials found in nature (**Mohammed *et al.* 2021b**). Secondary metabolites in plants have been demonstrated to have significant pharmacological effects in several investigations (**Abu-Odeh *et al.* 2021**). Antioxidant, anticancer, antimicrobial, antiaging, antiproliferative, antiinflammatory, antitumor, hepatoprotective, DNA-protective, and anti-allergic are only a few of the biological actions previously described for plants (**Mohammed *et al.* 2018; Mohammed *et al.* 2019; Korkmaz *et al.* 2021; Shikov *et al.* 2021; Zeidali *et al.* 2021; Unal *et al.* 2022; Uysal *et al.* 2023**). When looking for novel natural goods, plants may be a valuable resource. The biological activity, mineral and nutritional content, phenolic and essential oil contents of *Crocus* species were assembled in this research using published data.

GENUS CROCUS AND USAGE AREAS

One hundred or more bulbous plant species make up the genus *Crocus*, which blooms seasonally. Each species in this genus keeps its flower stems buried. It has enormous blooms that may be any colour, but most often are white, yellow, orange, or purple. A lot of plants are cultivated because of the attractive flowers they produce throughout the late autumn, winter, and early spring. Closed flower petals indicate that it is nighttime or a cloudy day. Saffron is harvested from the crocus flower. The dried stigmas of the *Crocus sativus* L. flower are the primary source of saffron. As both a flavouring and a colouring agent, saffron deserves its reputation as one of the world's most costly spices. Wooded areas, shrublands, and grassy fields are their natural homes. Members of the genus *Crocus*, however, may be easily multiplied either from seed or from the young bulbs that develop inside the old bulb. It has the potential to spread to many different parts of the world, including the Mediterranean, North Africa, Central and Southern Europe, the Aegean Islands, the Middle East, and Central Asia. Iran, in this sense, is the international capital of saffron (**Saxena, 2010; Gohari *et al.* 2013; Lim, 2014; Christenhusz and Byng, 2016; Gedik *et al.* 2017; Harpke *et al.* 2017**)
The majority of *Crocus* species are economically valuable in some way. A large percentage of this export demand has recently been met, 90% in particular by Iran. *Crocus* species are employed in a wide variety of contexts, as seen by the distribution of these flowers. Health-wise, it has been found to be effective in the following areas: treating inflammation, ulcers, asthma, immunomodulation, whooping cough, dysmenorrhea, gas colic, urinary issues, back pain, prostate cancer, ovarian cancer, atherosclerosis, and cardiovascular disease (**Ghorbani, 2007; Gonzalez *et al.* 2010; Idolo *et al.* 2010; Bhargava, 2011; Ulbricht *et al.* 2011; Cardone *et al.* 2020**). The food industry, animal feed, food additives, and decorative plants are just some of the places it has been reported to be employed outside of the medical industry (**Valizadeh, 1988; Mati and de Boer, 2011; Wiersema and Leon, 2013**).

NUTRITIONAL AND MINERAL CONTENTS

There are studies on the nutritional and mineral contents of *Crocus* species in the literature. Findings from these studies are shown in tab 1 and tab 2.

Table 1 Nutritional Contents of Crocus

Nutritional Composition	Values (%)	Values (mg/100g)
Protein	10.20-23.6	8.17-24.05
Lipids	5.3-7.42	2.22-10.73
Carbohydrate	20.0-66.00	33.8-64.90
Ash	5.01-9.50	6.16-11.43
Mouisture	9.01-12.50	3.84-10.76
Caloric energy (kcal/100 g)	375.03 - 378.51	-

Table 2 Mineral Contents of Crocus

Mineral Composition	Values (mg/100g)
Mg	2.93-2849.17
K	15.890-553.20
Na	25.75-94.0
Fe	17.99-255.3
Ca	589.12-4070.0
Zn	1.80-94.205
Cu	0.87-18.2
Mn	68.15-1173.0

Numerous chemicals and minerals vital to human health may be found in plants (Sevindik, 2020; Baba et al., 2020). Our research collated data on the mineral and nutrient content of *Crocus* species that had previously only been published in scattered sources (Table 1 and Table 2). In this context, *Crocus* members are found in the literature as a percentage of protein (10.20-23.6%), lipids (5.3-7.420%), carbohydrates (20.0-66.0%), ash (5.010-9.5%), mouisture (9.01-12.50%) and caloric energy (375.03-378.51 kcal/100 g) values have been reported. In addition, these nutrients include protein (8.17-24.05 mg/100g), lipids (2.22-10-73 mg/100g), carbohydrate (33.8-64.9 mg/100g), ash (6.16-11.43 mg/100g) and mousture (3.84-Levels of 10.76 mg/100g) have been reported (**Sani *et al.* 2013; Serrano-Díaz *et al.* 2013; Muzaffar *et al.* 2016**).

When we look at the mineral contents, Mg (2.93-2849.17 mg/100g), K (15.890-553.20 mg/100g), Na (25.75-94.0 mg/100g), Fe (17.99-255.3 mg/100g), Ca (589.12-4070.0 mg/100g), Zn (1.80-94.205 mg/100g), Cu (0.87-18.2 mg/100g) and Mn (68.15-1173.0 mg/100g) contents have been reported (**Fahim *et al.* 2012; Sani *et al.* 2013; Zaazaa *et al.* 2021; Ibourki *et al.* 2022**).

BIOLOGICAL ACTIVITY

Plants are a vital resource because of their various therapeutic uses. Innumerable research have elucidated the varying qualities of plants (**Mohammed *et al.* 2020b**). Many functioning plants are very active biologically because of the secondary metabolites they contain (**Selamoglu, 2017; Mohammed *et al.* 2021c**). Members of the genus Crocus have their biological functions catalogued in this investigation. Alcoholic, aqueous, ethanol, methanol, hydroalcohol, ethyl acetate, water, hexane, and double-distilled water extracts were all employed in *in-vitro* and *in-vivo* biological activity research. Table 3 displays the results of biological activity studies published in the scientific literature.

Table 3 Biological activity of Crocus

Plant species	Biological activity	Extraction	References
C. abantensis T.Baytop & B.Mathew	Antimicrobial	Alcoholic, aqueous	**Türker *et al.* 2009**
C. ancyrensis (Herb.) Maw	Antimicrobial	Alcoholic, aqueous	**Türker *et al.* 2009**
C. alatavicus Regel & Semen.	Antimicrobial, antiviral, anticancer, antioksidan	Ethanol, methanol	**Satybaldiyeva *et al.* 2015; Allambergenova *et al.* 2022**
C. antalyensis B.Mathew	Antitümör	Methanol	**Tokgun *et al.* 2012**
C. cancellatus Herb.	Antimicrbial	Ethanol	**Ismael, 2021**
C. cancellatus subsp. *damascenus* (Herb.) B.Mathew	Anticarcinogenic, antidiyabet, antioxidant	Ethanol	**Loizzo *et al.* 2016; Shakeri *et al.* 2022**
C. caspius Fisch. & C.A.Mey. ex Hohen.	Antioxidant, antimicrobial, hepatoprotective, cytotoxic	Ethanol, methanol, hydroalcohol	**Asadi, 2016; Khalili *et al.* 2016; Tofighi et *al.* 2017; Shokrzadeh *et al.* 2019; Samadzadeh *et al.* 2022**
C. chrysanthus (Herb.) Herb.	Antioxidant, antimicrobial	ethyl acetate, methanol, water	**Ilçım *et al.* 1998; Zengin *et al.* 2019**
C. mathewii Kerndorff & Pasche	Antioxidant, antikolinesteraz	hexane, ethyl acetate, methanol, water	**Yıldıztekin *et al.* 2016**
C. sativus L.	Antimicrobial, antioxidant, cytotoxic, antidiyabet, antimalaryal, antileishmanial	Aqueous, methanol, ethanol, water, double-distilled water	**Assimopoulou *et al.* 2005; Pintado *et al.* 2011; De Monte *et al.* 2015; Parray *et al.* 2015; Carradori *et al.* 2016; Okmen *et al.* 2016; Bagherzade *et al.* 2017; Kakouri *et al.* 2017; Jadouali *et al.* 2018; Ahmadi-Shadmehri *et al.* 2019; Azizian-Shermeh *et al.* 2020; Zaazaa *et al.* 2021**
C. speciosus M.Bieb.	Antioxidant	methanol	**Mykhailenko *et al.* 2022a**
C. vernus (L.) Hill	Antioxidant, antimicrobial, cytotoxic, antiviral	aqueous, ethanol	**Bilal *et al.* 2020; Horozić *et al.* 2020**

Antioxidant Activity

Reactive oxygen species may cause damage, however antioxidant activity can mitigate or even prevent these consequences (**Krupodorova and Sevindik, 2020**). High concentrations of reactive oxygen species cause oxidative stress in living things. Cancer, heart disease, Parkinson's, and Alzheimer's are just few of the illnesses that may develop as a consequence of oxidative stress in humans (**Akalın and Selamoglu, 2019; Bal *et al.* 2019**). When it comes to mitigating the harmful effects of oxidative stress, the antioxidant defence system is crucial. Supplemental antioxidants assist keep organisms alive when their natural antioxidant defence system is unable to do so (**Nageen *et al*. 2020; Selamoglu *et al.* 2020**). Plants, with their high levels of antioxidant activity, are particularly helpful here. In this analysis, we obtained data on the antioxidant activity of *Crocus* species from the published literature (TaB. 3). Antioxidant activity was measured using the DPPH assay in earlier research using various *C. alatavicus* extracts. The greatest impact was found to be 65.5% in an ethanol extract, according to the findings (**Satybaldiyeva *et al.* 2015**). In contrast, DPPH, ABTS, and iron reduction ability tests showed that *C. cancellatus* subsp. *damascenus* had excellent antioxidant activity (**Loizzo *et al.* 2016**). Using the ABTS assay, another research found that *C. speciosus* had an antioxidant effect of 50.08±4.5 μmol/g (**Mykhailenko *et al.* 2022a**). Additionally, *C. vernus, C. mathewii, C. sativus, C. chrysanthus,* and *C. caspius* have been found to exhibit antioxidant activity in the literature utilising FRAP, DPPH, and ABTS assays (**Assimopoulou *et al.* 2005; Asadi, 2016; Khalili *et al.* 2016; Okmen *et al.* 2016; Kakouri *et al.* 2017; Jadouali *et al.* 2018; Ahmadi-Shadmehri *et al.* 2019; Zengin *et al.* 2019; Wali *et al.* 2020; Horozić *et al.* 2020; Zaazaa *et al.* 2021**).

Antimicrobial activity

There has been a rise in infections caused by microbes in recent years. These infections are treated with antibiotics (**Sevindik, 2021**). Subconsciously using antibiotics has led to the rise of bacteria that are resistant to treatment in recent years (**Saridogan *et al.* 2021; Mohammed *et al.* 2023**). Natural antimicrobial resources have been favoured over the synthetic antimicrobial medications currently in use due to their lack of potential adverse effects (**Eraslan *et al.* 2021; Islek *et al.* 2021; Sevindik *et al.* 2023**). The focus of this research was on the genus *Crocus* because of the prevalence of its members with antibacterial properties (Table 3). Researchers have shown that the disc diffusion technique is effective in detecting the antimicrobial effects of both *C. abantensis* and *C. ancyrensis* against *Aeromonas hydrophila*, *Yersinia ruckeri, Streptococcus agalactia, Lactococcus garvieae*, and *Enterococcus faecalis* (**Türker *et al.* 2009**). *Staphylococcus aureus, S. epidermidis, Bacillus cereus, Cutibacterium acnes, Escherichia coli, Candida albicans,* and *C. glabrata* were all shown to be significantly inhibited by *C. alatavicus* in a separate investigation (**Allambergenova *et al.* 2022**). Another research found that *C. alatavicus* had a significant impact on strains of *Staphylococcus aureus, Bacillus subtilis,* and *B. cereus* (**Satybaldiyeva *et al.* 2015**). The effectiveness of *C. cancellatus* extracts against several *Candida* was studied, and it was shown to be greatest against *C. krusei* (**Ismael, 2021**). Strains of *Bacillus megaterium, B. subtilis, B. brevis, Escherichia coli, Klebsiella pneumoniae, Enterobacter aerogenes, Pseudomonas aeruginosa, Staphylococcus aureus, Listeria monocytogenes, Candida albicans,* and *Saccharomyces cerevisiae* have all been shown to be susceptible to *C. chrysant* (**Ilçım *et al.* 1998**). In addition, *C. vernus, C. caspius,* and *C. sativus* extracts have been shown to exhibit antibacterial properties against various bacterial and fungal strains, according to the literature (**Pintado *et al.* 2011; Parray *et al.* 2015; Asadi, 2016; Carradori *et al.* 2016; Okmen *et al.* 2016; Bagherzade *et al.* 2017; Kakouri *et al.* 2017; Jadouali *et al.* 2018; Ahmadi-Shadmehri *et al.* 2019; Azizian-Shermeh *et al.***

2020; Horozić *et al.* 2020; Wali *et al.* 2020; Zaazaa *et al.* 2021; Samadzadeh *et al.* 2022). Antimicrobial action against various strains of bacteria and fungi is shown by members of the genus *Crocus*, as can be observed from the data in the literature. Many members of the genus *Crocus* have shown antimicrobial activity in laboratory settings, thus they may be useful here.

Other activities

Plants are an invaluable natural resource that facilitate several biochemical processes. As a result of these characteristics, plants are valuable resources for supplementary medicine. We collated information from the literature on the biological functions of species in the genus Crocus (Table 3). Here, it's been revealed that *C. alatavicus* inhibits the replication of herpes simplex virus 1 (HSV-1) and coxsackievirus B3 (CVB3) (**Allambergenova *et al.* 2022**). Prostate cancer cell lines (PC-3, DU145, LNCaP) and a skin fibroblast cell line (BJ) have been shown to be susceptible to *C. alatavicus*'s anticancer activities (**Allambergenova *et al.* 2022**). Researchers found that *C. antalyensis* inhibited the growth of MCF-7 breast cancer cells (**Tokgun *et al.* 2012**). Anti-cancer effects of *C. cancellatus* subsp. *damascenus* on MB-231 and MCF-7 breast cancer cell lines have been observed (**Shakeri *et al.* 2022**). The antidiabetic activity of both *C. sativus* and *C. cancellatus* subsp. *damascenus* has been documented (**Loizzo *et al.* 2016; Wali *et al.* 2020; Zaazaa *et al.* 2021**). It has been observed that *C. vernus, C. sativus,* and *C. caspius* all exhibit cytotoxic effects (**Tofighi *et al.* 2017; Ahmadi-Shadmehri *et al.* 2019; Bilal *et al.* 2020; Wali *et al.* 2020**). The hepatoprotective activity of *C. caspius* has been shown (Shokrzadeh et al., 2019). The anticholinesterase action of C. mathewii has been documented (**Yıldıztekin *et al.* 2016**). Antimalarial and antileishmanial properties of C. sativus have been described (**De Monte *et al.* 2015**). Several studies have shown that *C. vernus* may inhibit the replication of potato virus Y (PVY) (**Bilal *et al.* 2020**). *Crocus* species, in particular those with anticancer and antiviral effects, have been the subject of intensive research and, as a result, represent a valuable natural resource, as shown by an analysis of the available literature. It may also have anticholinesterase, antiparasitic, anti-diabetic, and hepatoprotective properties.

ESSENTIAL OIL CONTENT

In the literature, essential oils included in the Crocus species have been reported in many studies. The data obtained are shown in Table 4. It is seen that aerial parts of plant species are used when determining essential oil contents.

Table 4 Essential oil contents of Crocus

Plant species	Geographic regions	Essential oil content	References
C. cancellatus subsp. *damascenus* (Herb.) B.Mathew	Iran	2, 3-dihydro-3, 5-dihydroxy-6-methyl-4H-pyran-4-one (2.2%), eucarvone (3.32%), 2-furancarboxaldehyde, 5-(hydroxymethyl) (10.22%), 2, 6, 6-trimethyl-4-oxo-2-cyclohexen-1-carboxaldehyde (14.52%), methylcyclohexane (2.4%), 2, 4-bis (1,1-Dimethylethyl) phenol (2.14%), D-allose (3.71%), palmitic acid (14.36%), linoleic acid (14.24%), stearic acid (3.04%)	**Shakeri *et al.* 2022**
C. pestalozzae Boiss.	Turkey	heptacosane (18.2%), pentacosane (17.0%), nonacosane (13.1%), heneicosane (7.2%), 1-docosanol (5.3%)	**Şen *et al.* 2018**
C. sativus L.	China, Iran, Japan, Italy, Turkey	2-ısopropylidene-3-methylhexa-3,5- (4.45%), α-ısophorone (5.57%-16.3%), 2,6,6-trimethyl-1,3-cyclohexadiene-1- (49.3%-81.82%), n-tetradecane (6.17%), hexadecanoic acid (15.65 %-33.32%), palmitic acid ethyl ester (11.21%), octadecadienoic acid (4.74 %-27.55%), pentanoate (25.8-62.15%), dihydro- β- ionol (17.7-34.79%), hexadecyl acetate (4.9-9.4%), 2(5 H)-furanone (59.80 %), (E)-2-methyl-2-butenal (8.44 %), 2-phenylethyl alcohol (15.0%), tetracosane (10.5%), ethyl hexadecanoate (10.0%), heptadecane (9.6%), β-Isophorone (6.4% - 8.4%)	**Tirillini *et al.* 2006; Hou *et al.* 2008; Kosar *et al.* 2017; Masuda *et al.* 2021; Kianimanesh *et al.* 2021**
C. vernus (L.) Hill	Japan	(Z,Z)-9,12-octadecadienoic acid (51.21 %), hexadecanoic acid (42.53 %), octacosane (2.55 %), hexacosane (1.02 %), nonadecane (28.09 %), octacosane (10.46 %), tetracosane (8.05 %), decanol (5.11 %)	**Masuda et al., 2021**

In the literature researches, it has been reported that *C. cancellatus* has the highest 2, 6, 6-trimethyl-4-oxo-2-cyclohexen-1-carboxaldehyde (14.52%) and the lowest 2, 4-bis (1,1-Dimethylethyl) phenol (2.14%) in essential oil contents (Shakeri, et al., 2022). It has been reported that the highest heptacosane (18.2%) and the lowest 1-docosanol (5.3%) are the main components of the essential oil content of *C. pestalozzae* (**Sen *et al.* 2018**). In studies conducted by different researchers, it has been reported that the main components in the essential oil content of *C. sativus* species have different values. The value ranges of the compounds reported in this context are 2-isopropylidene-3-methylhexa-3,5- (4.45%), α-isophorone (5.57%-16.3%), 2,6,6-trimethyl-1,3-cyclohexadiene-1 - (49.3%-81.82%), n-tetradecane (6.17%), hexadecanoic acid (15.65%-33.32%), palmitic acid ethyl ester (11.21%), octadecadienoic acid (4.74%-27.55%), pentanoate (25.8- 62.15%), dihydro- β-ionol (17.7-34.79%), hexadecyl acetate (4.9-9.4%), 2(5 H)-furanone (59.80%), (E)-2-methyl-2-butenal (8.44) %), 2-phenylethyl alcohol (15.0%), tetracosane (10.5%), ethyl hexadecanoate (10.0%), heptadecane (9.6%), and β-Isophorone (6.4% - 8.4%) (**Tirillini *et al*. 2006; Hou *et al.* 2008; Kosar *et al.* 2017; Masuda *et al.* 2021; Kianimanesh *et al.* 2021**). The main components in the essential oil content of *C. vernus* species were reported to be the highest (Z,Z)-9,12-octadecadienoic acid (51.21%) and the lowest hexacosane (1.02%) (**Masuda *et al.* 2021**).

PHENOLIC CONTENT

Plants' secondary metabolites allow them to carry out their biological functions. Medically useful but nutritionally inert substances are called secondary metabolites. To conduct this research, we gathered data on the phenolic component composition of *Crocus* species from the literature. Researchers here provided phenolic compound values in ug/mg, %, ug/g, mg/g, and ug/mL. Results are shown in Table 5.

Studies have reported that *C. alatavicus* contains kaempferol 3-O-dihexoside (150.76 µg/mg) and kaempferol 3-O-acyltetrahexoside (80.04 µg/mg) (**Allambergenova *et al.* 2022**). It has been reported that chicoric acid (26.2%), chlorogenic acid (14.8%), syringic acid (17.6%), kaempferol (37.99%) and apigenin (38.6%) in *C. pallasii* (**Moudi *et al.* 2020**). It has been reported that *C. baytopiorum* contains p-coumaric acid (25.36 µg/g), apigenin-glucoside (33.97 µg/g), rosmarinic acid (82.66 µg/g), quercetin (56.36 µg/g) and campferol (35.06 µg/g) (**Acar *et al.* 2010**). In another study, it was reported that *C. cancellatus* has gallic acid (46965.14 µg/g), quinic acid (1935.71 µg/g), malic acid (3831.37µg/g), vanillic acid (138.2 µg/g), protocatechuic acid (116.87µg/g), ferulic acid (51.17µg/g), quercetin (20.56 µg/ g), p-coumaric acid (12.8 µg/g), chlorogenic acid (2.51 µg/g) and salicylic acid (1.56 µg/g) in its body (**Ismael, 2021**). It has also been reported that *C. chrysanthus* contains apigenin-8-C-glucoside (22.22%-22.36%), kaempferol-3-O-glucoside (24.66%-26.00%), kaempferol-7-O-rutinoside (26.09%), cirsiliol (29.94%), tricin (29.88%-29.97%), phytosphingosine (39.38%), camphene (48.88%), homovanillic acid (16.28%), tuberonic acid glucoside (17.64%), N-acetylphenylalanine (18.56%), quercetin-3-O-glucoside-7-orhamnoside (18.85%-24.48%), spiraeoside (18.92%)), eriodictyol-7-Oglucoside (18.16%), luteolin (20.68%), tamarixetin-3-Orutinoside (22.55%-22.56%), scoparin (22.83%), isorhamnetin-3-Orutinoside (25.30%-26.27%), capillaricin (26.21%-26.22%), α-Linolenic acid (44.81%), spiraeoside (18.92%) and fisetin (24.88%) (**Zengin *et al.* 2019**). It has been reported by different researchers that *C. sativus* contains catechol (2.085 µg/g), vanillin (1.106 µg/g), salicylic acid (2.845 µg/g), cinnamic acid (0.512 µg/g), p-hydroxybenzoic acid (1.294 µg/g), gentic acid (5.693 µg/g), syringic acid (2.084) µg/g), p-coumaric acid (4.816 µg/g), gallic acid (0.416 µg/g), ferulic acid (2.254 µg/g), caffeic acid (14.125 µg/g), gallic acid (0.11 mg/g)), caffeic acid (0.37 mg/g), chlorogenic acid (0.32 mg/g), p-coumaric acid (0.17mg/g), ellagic acid (0.21 mg/g), ferulic acid (0.07 mg/g), myricetin (012 mg/g), naringenin (1.64 mg/g), kaempferol (0.49 mg/g-0.52 mg/g), pinocembrin (0.39 mg/g), chrysin (0.26 mg/g), quercetin (0.21 mg/g)), apigenin (0.15 mg/g - 3.18 mg/g) and luteoil (0.10 mg/g-0.67 mg/g) (**Esmaeili *et al.* 2011; Nayik and Nanda, 2016; Mykhailenko *et al.* 2022b**). In addition, it has been reported that *C. speciosus* contains chlorogenic acid (5.75-46.00 µg/mL), mangiferin (9.06-145.00 µg/mL), isoorienthin (0.73-46.42µg/mL), hyperoside (3.433-26.915 µg/mL), Isoquercitrin (5.57-44.56 µg/mL) and kaempherol (2.29-18.32 µg/mL) (**Mykhailenko *et al.* 2022a**). In this context, it has been observed that there are important secondary metabolites produced within the Genus Crocus species. As a result, it is thought that Genus *Crocus* species may be natural sources for reported phenolic compounds.

Table 5 Phenolic contents of Crocus

Plant species	Value (µg/mg, %, µg/g, mg/g, µg/mL)	References
C. alatavicus Regel & Semen. (µg/mg)	Kaempferol 3-O-dihexoside (150.76 µg/mg), kaempferol 3-O-acyltetrahexoside (80.04 µg/mg)	**Allambergenova *et al.* 2022**
C. pallasii subsp. *haussknechtii* (Boiss. & Reut. ex Maw) B.Mathew. (%)	Chicoric acid (26.2%), chlorogenic acid (14.8%), syringic acid (17.6%), kaempferol (37.99%), apigenin (38.6%)	**Moudi *et al.* 2020**
C. baytopiorum B.Mathew (µg/g)	p-coumaric acid (25.36 µg/g), apigenin-glucosid (33.97 µg/g), rosmarinic acid (82.66 µg/g), quercetin (56.36 µg/g), kampferol (35.06 µg/g)	**Acar *et al.* 2010**
C. cancellatus Herb. (µg/g)	Gallic acid (46965.14 µg/g), quinic acid (1935.71 µg/g), malic acid (3831.37µg/g), vanillic acid (138.2 µg/g), protocatechuic acid (116.87µg/g), ferulic acid (51.17µg/g), quercetin (20.56 µg/g), p-coumaric acid (12.8 µg/g), chlorogenic acid (2.51 µg/g), salicylic acid (1.56 µg/g)	**Ismael, 2021**
C. chrysanthus (Herb.) (%)	Apigenin-8-C-glucoside (22.22%-22.36%), kaempferol-3-O-glucoside (24.66%-26.00%), kaempferol-7-O-rutinoside (26.09%), cirsiliol (29.94%), tricin (29.88%-29.97%), phytosphingosine (39.38%), camphene (48.88%), homovanillic acid (16.28%), tuberonic acid Glucoside (17.64%), N-acetylphenylalanine (18.56%), quercetin-3-O-glucoside-7-orhamnoside (18.85%-24.48%), spiraeoside (18.92%), eriodictyol-7-Oglucoside (18.16%), luteolin (20.68%), tamarixetin-3-Orutinoside (22.55%-22.56%), scoparin (22.83%), ısorhamnetin-3-Orutinoside (25.30%-26.27%), capillarisin (26.21%-26.22%), α-Linolenic acid (44.81%), spiraeoside (18.92%), fisetin (24.88%)	**Zengin *et al.* 2019**
C. sativus L. (µg/g, mg/g)	catechol (2.085 µg/g), vanillin (1.106 µg/g), salicylic acid (2.845 µg/g), Cinnamic acid (0.512 µg/g), p-hydroxybenzoic acid (1.294 µg/g), gentisic acid (5.693 µg/g), syringic acid (2.084 µg/g), p- coumaric acid (4.816 µg/g), gallic acid (0.416 µg/g), ferulic acid (2.254 µg/g), caffeic acid (14.125 µg/g), gallic acid (0.11 mg/g), caffeic acid (0.37 mg/g), chlorogenic acid (0.32 mg/g), p-coumaric acid (0.17mg/g), ellagic acid (0.21 mg/g), ferulic acid (0.07 mg/g), myricetin (012 mg/g), naringenin (1.64 mg/g), kaempferol (0.49 mg/g-0.52 mg/g), pinocembrin (0.39 mg/g), chrysin (0.26 mg/g), quercetin (0.21 mg/g), apigenin (0.15 mg/g -3.18 mg/g), luteoiln (0.10 mg/g-0.67 mg/g)	**Esmaeili *et al.* 2011; Nayik and Nanda, 2016; Mykhailenko *et al.* 2022b**
C. speciosus M.Bieb. (µg/mL)	Chlorogenic acid (5.75 µg/mL-46.00 µg/mL), mangiferin (9.06 µg/mL-145.00 µg/mL), ısoorienthin (0.73 µg/mL-46.42µg/mL), hyperoside (3.433 µg/mL-26.915 µg/mL), Isoquercitrin (5.57 µg/mL-44.56 µg/mL), kaempherol (2.29 µg/mL-18.32 µg/mL),	**Mykhailenko *et al.* 2022a**

CONCLUSION

In this study, many studies in the literature belonging to Genus *Crocus* were compiled. In this context, the nutrient, mineral, phenolic and essential oil contents of the species belonging to the genus were evaluated. In addition, their biological activities were emphasized. According to the results obtained, it was observed that the Genus *Crocus* species had important biological activities. It has also been found to be a source of many phenolic compounds and essential oils. As a result, Genus *Crocus* species are thought to be an important natural resource.

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