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Edible Flowers: Super Foods with Potential Health Benefits

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.Abstract

Edible flowers have become popular in recent years as a unique and visually tempting addition to culinary creations. This review article explores the assorted world of edible flowers, focusing on their potential health benefits, bioactive compounds, and associated toxicological risks, with particular attention to the anti-nutritional compounds and toxic flowers. Edible flowers from different plant species provide a variety of bioactive compounds that contribute to their flavor, aroma, and potential health benefits. These bioactive compounds, including antioxidants, vitamins, minerals and phytochemicals, make edible flowers not only beautiful but also nutritious. Incorporating them into your diet can improve the overall nutritional content of your meals. However, consuming edible flowers is not without risks. Some flowers contain anti-nutrient compounds, such as oxalates and phytates, which can interfere with the absorption of essential minerals and lead to nutritional deficiencies over time. Therefore, it is important to practice moderation when consuming certain edible flowers, especially for those with pre-existing medical conditions or prone to mineral imbalances. However, it is essential to pay attention to anti-nutritional compounds that can affect mineral absorption and the potential toxicity of certain flowers. When used judiciously and safely, edible flowers can be a delicious and healthy addition to a balanced diet. Careful selection and proper preparation are essential to reap the benefits while minimizing the risks associated with these beautiful flowers. This review serves as a valuable resource for consumers, chefs and nutritionists, providing insight into the world of edible flowers and their bioactive compounds as well as considerations regarding anti-nutritional compounds and their toxicity.

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Keywords: Edible flowers, bioactive compounds, anti-nutritional compounds, toxicity

10 **1. INTRODUCTION**

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12 Edible flowers are the flowers of any plant that are generally safe for humans. These
13 flowers are becoming increasingly popular, as evidenced by the increasing number
14 of edible flowers used in cookbooks, cooking magazine articles, and political
15 television shows (Roberts, 2014). Many flowers play a prominent role in food
16 preparation, adding fragrance, flavor and aesthetic value, such as roses (*Rosa* spp.
17 L.), which were used in ancient Rome to increase the flavor and sweetness of
18 foods in drinks, salads, purees, desserts, etc. People in China, the Middle East, and
19 India also use this flower because it originated in ancient civilizations (Deka and
20 Nath, 2014). Today, sales of fresh flowers for human consumption are increasing
21 around the world. In addition, these products, suitably packaged in bags, boxes,
22 etc., will be sold directly in farm stores or through various specialized sales outlets
23 (Mlcek and Rop, 2011). Curiosity about edible flowers is a result of the search for
24 new natural food products. Consumers are increasingly choosing food products
25 containing natural ingredients due to concerns about the negative health effects of
26 synthetic compounds. However, processing and preservation aspects have only
27 been explored for a few edible flowers and could be applied more widely. The
28 commercialization of value-added products from this flower is still very far away due
29 to the lack of scientific reports. The potential of these flowers as superfoods can
30 also be explored.

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32 **2. Edible flowers**

33 **2.1 Edible flowers as a source of bioactive substances**

34 Edible flowers typically contain 70-95% water, petals, nectar, and pollen, making
35 them an important source of metabolites, vitamins, and minerals. Edible flowers are
36 also rich in antioxidant molecules (such as polyphenols and pigments) that can help
37 prevent certain diseases. Edible flowers are important for human health as they are
38 rich in nutrients and bioactive compounds and offer opportunities for further
39 commercialization (Anderson *et al.*, 2012). Previous studies have reported many
40 species, genera, and families that produce edible flowers, but no official list has
41 been published by any international organization, and to date only a small number
42 of them have been published. is being researched. Several scientific reports have

43 focused on bioactive substances used as food sources. Some of them are shown
 44 below.

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47 **Table 1. List of common edible flowers, their bioactive compounds**
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Scientific Name	Common Name	Bioactive Compound	Reference
<i>Sambucus nigra</i> L.	Black elder	(poly) phenolic compounds, terpenoid.	Liu <i>et al.</i> (2022)
<i>Viola tricolor</i> L.	Pansy	Flavones (apigenin glycoside), anthocyanin (cyanidin và delphinidin)	Espinoza <i>et al.</i> (2020)
<i>Centaurea cyanus</i> L.	Cornflower	Cinnamic acid, Flavanols, Benzoic acid, Vitamin C, Tocopherols	Demasi <i>et al.</i> (2021) Pires <i>et al.</i> (2019)
<i>Dendranthema</i> spp.	Chrysanthemum	Caffeoylquinic acids,	Sha <i>et al.</i> (2021)
<i>Cucurbita pepo</i> var. <i>giromontiina</i>	Zucchini	Carotenoids, Polyphenols	Grzeszczuk (2007)
<i>Cichorium intybus</i> L.	Chicory	Polyphenols, inulin, oligofructose, sesquiterpene lactones	Perovic (2021)
<i>Cucurbita pepo</i> L.	Pumpkin	carotenoids, polyphenols	Grzeszczuk (2007)
<i>Viola odorata</i> L.	Sweet violet	Eugenol, gamma-sitosterol, tetradecanoic acid, Phytol, Octacosanol.	Jasim <i>et al.</i> (2018)
<i>Forsythia</i> Vah	Forsythia	Forsythiaside, Rutin and Forsythin	Qu <i>et al.</i> (2008)
<i>Fuchsia</i> L.	Fuchsia	Flavonoids, Phenolic acids, Anthocyanins, Tannins	Csepregi <i>et al.</i> (2020)
<i>Hibiscus</i> L.	Hibiscus	Hydroxycitric acid, Anthocyanins, Flavonoids, Phenolic acid	Ojulari <i>et al.</i> (2019)
<i>Lamium</i> L.	Dead-nettle	Phenolic acids (chlorogenic, caffeic acids), Flavonoids (rutin).	Danila <i>et al.</i> (2015)

<i>Jasminum L.</i>	Jasmine	Saponin, Flavonoid, Quinine, Protein, Steroids	Prakash <i>et al.</i> (2019)
<i>Echinacea Moench</i>	Coneflower	Alkylamides, Polysaccharides, Glycoproteins, Flavonoids and Phenolic compounds	Burlou-Nagy <i>et al.</i> (2022)
<i>Trifolium L.</i>	Clover	Flavones, Flavonols, Isoflavones, Pterocarpans, Cyanogenic glucosides, Saponins, Condensed tannins	Ahmad <i>et al.</i> (2021)
<i>Lavandula L.</i>	Lavender	Linalool, Limonene, Perillyl alcohol, Linalyl acetate, Cis-smine, Terpene, Coumarin, Tannin, Caffeic acid	Haban <i>et al.</i> (2023)
<i>Papaver rhoeas L.</i>	Common poppy	Phenolic compounds, alkaloids, flavonoids, organic acids and coumarins	Hmamou <i>et al.</i> (2023)
<i>Calendula off. L.</i>	Common marigold	Terpenoids, Terpenes, Carotenoids, Flavonoids	Silva <i>et al.</i> (2021)
<i>Tropaeolum L.</i>	Nasturtium	Anthocyanins, polyphenols and vitamin C	Jakubczyk <i>et al.</i> (2018)
<i>Impatiens L</i>	Impatiens	Phenolic acids and flavonoids	Pires <i>et al.</i> (2021)

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50 **2.2 Health benefits of edible flowers**

51 Edible flowers provide a palatable blend of aesthetics and nourishment, making
52 them a one-of-a-kind harmonize to culinary creations. Aside from their visual beauty,
53 these blossoms can benefit our overall health and well-being in different ways. First,
54 most edible flowers are rich in antioxidants, such as flavonoids and polyphenols,
55 which fight oxidative stress and reduce the risk of chronic disease. (Zhang *et al.*
56 *al.*2015). In addition, these flowers often contain vitamins and minerals like as
57 vitamin C, which benefits in immune function, and potassium, which aids in the
58 maintenance of appropriate blood pressure levels (De, 2020).

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60 Furthermore, a number of edible flowers, such as calendula and chamomile,
61 have anti-inflammatory effects and can be ingested or applied topically to relieve
62 digestive discomfort or skin irritations (Swarna, 2023). Edible flowers add a rush of
63 colourful flavours and smells to dishes, improving the sensory experience and
64 potentially decreasing the need for excessive salt or sugar (Mouritsen, 2018).
65 Furthermore, integrating edible flowers into your diet can develop a connection to
66 nature and a deeper appreciation for the beauty and diversity of the natural world,
67 both of which can benefit your mental health. However, while hunting or purchasing
68 edible flowers, it is critical to exercise caution to ensure that they are pesticide-free
69 and safe for consumption. Edible flowers, when utilized wittily and correctly, may be
70 a delectable and health-enhancing addition to the culinary selection.

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72 **Table 2. Potential health benefits of common edible flowers**

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Common name	Scientific name	Health benefits	Reference
Black elder	<i>Sambucus nigra</i> L. (Black elder)	Antioxidant, antibacterial, bone protection, healing, anti-inflammatory and pain relief	Agalar (2019)
Pansy	<i>Viola tricolor</i> L.	It is used to treat scabs, itching, ulcers, eczema, and psoriasis, as well as lung and chest infections such as bronchitis and asthma.	Hellinger <i>et al.</i> (2014)
Cornflower	<i>Centaurea cyanus</i> L.	It has antibacterial, anti-inflammatory, neurological, antioxidant, diuretic, gastroprotective, and many other effects.	Al-Snafi (2015)
Chrysanthemum	<i>Dendranthema spp.</i>	Easing stress and anxiety. Improving cardiovascular, health and protect against oxidative damage. Inhibit inflammation and support healthy immune function.	Shahrajabian <i>et al.</i> (2019)
Zucchini	<i>Cucurbita pepo var. giromontiina</i>	The antioxidant activity of Cucurbitaceae appears to be of great interest in many application areas, including CVD	Rolnik A <i>et al.</i> (2020)

		(cardiovascular diseases) associated with oxidative stress.	
Chicory	<i>Cichorium intybus L.</i>	Relieves symptoms associated with mild digestive disorders (such as bloating, flatulence, and indigestion) and temporary loss of appetite.	Street <i>et al.</i> (2013)
Pumpkin	<i>Cucurbita pepo L.</i>	Heal and purify fatigue and thirstblood.Cure colds and relieve pain. Seeds treat irritable bladder, prostate complain, anthelmintic, acaricide. Treatment of gastritis, burns, enteritis, and feverdisease. Increase hemoglobin content in the blood.	Ratnam <i>et al.</i> (2017)
Sweet violet	<i>Viola odorata L.</i>	Anti-inflammatory, analgesic, antioxidant, and diuretic effects, as well as other positive effects such as antihypertensive, antihyperlipidemic, diaphoretic, antipyretic, and antifungal effects, as well as weight loss effects, etc.	Feyzabadi <i>et al.</i> (2014)
Phlox	<i>Phlox L.</i>	Antioxidant and antimicrobial activity	Farinas <i>et al.</i> (2019)
Forsythia	<i>Forsythia Vah</i>	Antipyretic and anti-inflammatory activity in the treatment of bacterial infections and upper respiratory ailments	Zeng <i>et al.</i> (2017)
Freesia	<i>Freesia sp.</i>	inhibiting sympathetic nervous excitement and reducing blood pressure	Xu <i>et al.</i> (2023)
Hibiscus	<i>Hibiscus L.</i>	Antihypertensive effect, antilipidemia effect, hypoglycemic effect, body fat reduction effect, renal protection effect, antianemia effect, antioxidant effect, anti-inflammatory effect, antistromal effect	Montalvo-Gonzalez (2022)

Dead-nettle	<i>Lamium</i> L.	Antimicrobial, antiviral, anti-inflammatory, anti-nociceptive activity, and pain therapy and cytotoxicity and cytoprotective activity	Salehi B <i>et al.</i> (2019)
Jasmine	<i>Jasminum</i> L.	Anti-oxidant, anti-inflammatory, anti-cancer, anti-obesity, and neuroprotective effect	Lu <i>et al.</i> (2016)
Coneflower	<i>Echinacea Moench</i>	Antioxidant potential, immunomodulatory effect, therapeutic uses	Burlou-Nagy <i>et al.</i> (2022)
Clover	<i>Trifolium</i> L.	estrogenic and progestogenic activities, antioxidant, anti-cancer and others	Ramos. <i>et al.</i> (2012)
Lavender	<i>Lavandula</i> L.	Anti-inflammatory, antiseptic, antibacterial, antifungal antimicrobial, antidepressant properties	Sharma <i>et al.</i> (2020)
Common poppy	<i>Papaver rhoeas</i> L.	Polyphenols content, antioxidant power and antibacterial effects.	Marsoul <i>et al.</i> (2020)

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2.3 Anti-nutritional compounds in edible flowers

77 Antinutritional factors are substances or compounds found in fruits, flowers, and
78 vegetables that are generally toxic to humans. They reduce the availability of
79 nutrients such as minerals, vitamins, and even proteins found in plants. This affects
80 the nutritional value of these plants. Antinutrients include amino acids, proteins,
81 simple amines, alkaloids, glycosides, and phenolic compounds. When plant foods
82 are consumed as a food source, antinutrients are absorbed, posing health risks to
83 consumers (Ugwu and Oranye, 2006). Antinutritional factors are natural compounds
84 that are present in varying amounts in different foods, depending on the type of
85 food, how it is grown, and the chemicals used to store it. Food storage and
86 preservation (Panhwar, 2005). These antinutritional factors are also called
87 "secondary metabolites" of plants and have been shown to be highly biologically
88 active. These secondary metabolites are secondary compounds that occur as
89 byproducts of processes that lead to the synthesis of primary metabolites.
90 Antinutrients are chemicals that plants produce for self-defense. These anti-

91 nutritional factors are produced by plants to protect themselves from fungi, insects
 92 and predators and represent a plant defense mechanism. These anti-nutritional
 93 factors are known to impair metabolism, thereby negatively impacting growth and
 94 bioavailability of nutrients (Abara, 2003). Many edible flowers are also known to
 95 contain these anti-nutritional components, and most of these edible flowers are
 96 directly consumed by rural people. Although these are not necessarily toxic plant
 97 substances, they reduce the nutritional value of plant foods, often making essential
 98 nutrients unavailable or indigestible to humans and animals. Animal Consumption
 99 (Petroski W, Minich DM, 2020). Some vitamins found in foods can be destroyed by
 100 antinutrients. Below are some of them and the compounds they contain.

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102 **Table 3. List of edible flowers having anti-nutritional compounds**

Name of Flower	Toxic Compound
<i>Allium cepa</i>	Phytates, Oxalates, Alkaloids and Saponin
<i>Carica papaya</i>	Tannins, Phytates, Oxalates and Alkaloids
<i>Cucurbita maxima</i>	Tannins, Oxalates, Alkaloids and Saponin
<i>Moringa oleifera</i>	Alkaloids and Saponin
<i>Musa paradisiaca</i>	Tannins, Phytates, Oxalates,
<i>Musa acuminata</i>	Tannins, Alkaloids and Saponin
<i>Woodfordia fruticosa</i>	Phytates, Alkaloids and Saponin

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Halder and Khaled (2021)



Apple Blossoms (*Malus species*)



Citrus Blossoms



Elderberry Blossoms (*Sambucus spp*)



Banana Blossoms (*Musa paradisiaca*)

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FIG. 1 Common edible flowers of fruit crops



Arugula (*Eruca vesicaria*)



Artichoke (*Cynara scolymus*)



Broccoli Florets
(*Brassica leracea*)



Mustard (*Brassica* species)



Okra (*Abelmoschus esculentus*)



Pea Blossoms (*Pisum* species)



Radish Flowers
(*Raphanus sativus*)



Squash Blossoms
(*Curcubita pepo*)

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FIG.2 Common edible ornamental crops

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4. CONCLUSION

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113 This review has focused light on the numerous health benefits linked with eating
114 edible flowers. Edible flowers provide a unique and attractive addition to the diet,
115 delivering both flavour and health benefits, thanks to their rich nutritional profiles and
116 potential antioxidant and anti-inflammatory capabilities. However, when selecting
117 edible flowers for food, it is critical to use caution and discretion. The disadvantage
118 is the presence of poisonous blooms, which, if consumed inadvertently, can cause
119 severe health difficulties or even death. To discern between safe and dangerous
120 floral kinds, it is critical to be well-informed and rely on expert help.

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134 Authors do not have any competing interests.

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136 **AUTHORS' CONTRIBUTIONS**

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138 'Author A' designed the study andwrote the first draft of the manuscript. 'Author B' and
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140 Author D' managed the literature searches. All authors read and approved the final
141 manuscript."

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