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Edible flowers from Southeast Asia: a review

BACHELOR'S THESIS

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Vaňková Klaudie

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Abstract

Edible flowers have been used for centuries in Southeast Asia, both in traditional cuisine and medicinal practices. This study aims to systematically review edible flowers, centring on their botanical classification, culinary aspects, phytochemical profile and biological activity. Data were collected from scientific databases, PROSEA, and relevant literature. A total of 74 edible flower species from 42 plant families were identified, demonstrating high taxonomic diversity.

These flowers are frequently used in teas, desserts, rice dishes, cosmetics, and traditional medicine. Many contain bioactive compounds, such as flavonoids, terpenoids, phenolic acids, and anthocyanins, which are associated with biological effects.

In addition to the research table, four species (*Clitoria ternatea* Linn., *Nelumbo nucifera* Gaertn., *Musa acuminata* Colla, and *Moringa oleifera* Lam.) were selected for in-depth analysis to highlight their nutritional, pharmacological, and potential modern or future applications. The results suggest edible flowers have diverse multifunctional roles, though further research on their nutritional value and safety is necessary.

Keywords: Ethnobotany, Southeast Asia, culinary uses, nutritional value, floriphagia , traditional gastronomy

Abstrakt

Jedlé květy se využívají již po staletí v Jihovýchodní Asii, a to jak v tradiční kuchyni, tak i léčbných postupech. Tato práce přináší systematický přehled vybraných květin se zaměřením na jejich botanickou klasifikaci, tradiční a moderní využití, a biologickou aktivitu. Data byla získána z vědeckých databazí, systému PROSEA a odborné literatury. Celkem bylo indetifikováno 74 jedlých druhů květů ze 42 čeledí, což svědčí o jejich vysoké taxonomické diverzitě.

Jedlé květy nacházejí uplatnění především při přípravě čajů, dezertů, a rýžových pokrmů, ale také v kosmetice a tradiční medicíně. Obsahují řadu bioaktivních látek, jako jsou flavonoidy, terpenoidy, fenolické kyseliny a antokyany, které jsou spojovány s jejich biologickými účinky.

Čtyři vybrané druhy (*Clitoria ternatea* Linn., *Nelumbo nucifera* Gaertn., *Musa acuminata* Colla, and *Moringa oleifera* Lam.) byly podrobně analyzovány z hlediska jejich nutričního složení, biologických vlasností a možných aplikací. Výsledky ukazují, že jedlé květy mají široké využití napříč různými oblastmi. Další výzkum je však stále za potřebí, zejména v oblasti jejich nutričního složení a bezpečnosti konzumace.

Klíčová slova: Etnobotanika, Jihovýchodní Asie, kulinářské využití, konzumace květů ,tradiční gastronomie

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1. Introduction

Edible flowers have been part of the human diet since ancient times, with documentation from Greece, Rome, Europe, the Middle East, and Asia. Globalisation and increased consumer awareness have renewed interest in traditional plant-based foods, including edible flowers. These flowers contain phytochemicals associated with potential biological activity, which have attracted research attention (Pires et al. 2019a)

Historically, flowers have been used in traditional medicine to treat illnesses, and recent scientific studies have confirmed some of these uses. However, not all flowers are edible, and ensuring their safe consumption is essential; certain flowers or associated plant parts may contain toxic substances such as hydrocyanic acid and erucic acid. Despite growing interest, only a limited number of studies have been conducted, showing the need for further research (Pires et al. 2019a).

Southeast Asia, characterised by rich biodiversity, diverse climates, and abundant ecosystems, provides favourable conditions for the growth of many plants, including edible flower species with potential applications in culinary, pharmacological, and cosmetic industries (Mishra et al. 2021).

This work is organised into several chapters, with the core section presenting a research table covering a wide range of edible flowers from multiple families. Additionally, the study focuses on selected flower species, describing them from nutritional, chemical, and pharmacological perspectives.

2. Aims of the Thesis

This thesis provides a comprehensive literature-based overview of approximately seventy-four edible flower species native to or commonly cultivated and used in Southeast Asia, with a focus on their chemical composition and their traditional and contemporary applications in gastronomy. Furthermore, the thesis aims to explore the medicinal or functional uses of these flowers where relevant, based on available scientific and ethnobotanical sources.

The second part of the thesis focuses on four representative species, which are described in terms of their nutritional, pharmacological, chemical and culinary properties.

Selected types of edible flowers, specifically *Clitoria ternatea* Linn., *Moringa oleifera* Lam., banana flowers (*Musa acuminata* Colla.), and lotus (*Nelumbo nucifera* Gaertn.), were chosen as representative examples of edible flowers in Southeast Asia. These plants are among the species traditionally used in local cuisine and folk medicine, and at the same time, they are characterised by a wide range of biological activities.

The selection includes species with various uses, from decorative and beverage applications (*Clitoria ternatea* Linn.), through nutritionally significant and functional foods (*Moringa oleifera* Lam.), to commonly consumed flowers as part of main dishes (*Musa acuminata* Colla.) and a plant that is culturally and symbolically significant (*Nelumbo nucifera* Gaertn).

3. Methodology

This thesis is based on a qualitative literature review. The primary method involved the collection, evaluation, and synthesis of scientific, ethnobotanical, and culinary sources related to edible flowers in Southeast Asia.

Academic journal articles, books, databases such as Web of Science and PubMed, Science Direct and credible online sources were examined to gather information on approximately 74 species of edible flowers, herbs, or trees. The search was conducted using the following keywords: edible flowers, Southeast Asia, nutritional values, edible flower market, processing and handling of flowers, cultivation, phytochemicals, traditional uses, and gastronomy.

The manuscript was written in English, and language quality was reviewed and enhanced using Grammarly (Grammarly Inc., San Francisco, CA) to ensure correct grammar, spelling, and stylistic consistency. AI tools were not used to search for scientific articles or generate scientific content (e.g., discussion or conclusion), but exclusively for language correction and text fluency.

A research table of edible plants was compiled, including not only edible flowers but also trees, shrubs, and aquatic plants. The PROSEA database, which focuses on edible plants from Southeast Asia, was the main source for data collection.

Sources were selected for their relevance, scientific credibility, and geographical focus on SE Asia. Data were organised into structured profiles for each species to provide a clear, comparable overview of their characteristics and uses.

4. Literature Review

4.1. Southeast Asia

Southeast Asia is a geographically and culturally distinct subregion in eastern Asia, east of India and south of China. The region consists of eleven countries grouped into two divisions: mainland Southeast Asia and maritime Southeast Asia. The mainland group includes Vietnam, Laos, Cambodia, Thailand, and Myanmar, all situated on the Asian continent. The maritime group includes Indonesia, the Philippines, Malaysia, Singapore, Brunei, and Timor Leste, which are primarily made up of islands and island chains located in the Pacific and Indian Oceans (Association of Southeast Asian Nations 2025).

The region lies within the tropical zone and is characterised by consistently warm, humid conditions and precipitation. Seasonal monsoons and local topographical features influence rainfall patterns. Coastal and equatorial regions receive heavy rainfall throughout the year, whereas inland areas experience pronounced wet and dry seasons. Southeast Asia experiences two seasons: the summer and winter monsoons. The summer monsoon, occurring from June to September, delivers warm, humid air and often brings storms. Conversely, the winter monsoon, from November to February, introduces cooler, drier air originating from Siberia. In recent years, climate change has affected this subregion, leading to altered precipitation patterns, rising sea levels that threaten low-lying areas like the Mekong Delta, increased salinisation of groundwater, ocean warming, and the formation of tropical cyclones (Mishra et al. 2021).

Southeast Asia is known for its highly diverse ecosystems. The region features tropical forests, mangroves, wetlands, and lowland and mountain forests. However, these are threatened by deforestation and urban development. Deforestation is occurring on a large scale, particularly in Indonesia, Vietnam, the Philippines, Thailand, and Timor-Leste, leading to the disappearance of important tree species like ebony, teak, and sandalwood. Southeast Asia has already lost half of its original forests. Currently, the original forests are being replaced by commercial plantations, for example, for the cultivation of rubber, coconuts, or palm oil (Phillips 2021).

Agriculture in this region is vital, with key crops including rice, tropical fruits, oilseeds, and coconuts. Many plants hold cultural significance; for example, *Nelumbo nucifera* Gaertn. is sacred in several Southeast Asian nations and features in temples, while banana leaves are traditionally used for food and rituals. Traditional knowledge of plant uses continues to be a core aspect of local identity and heritage (Li et al. 2014).

Figure 1. Map of Southeast Asia.

Source: Michael R. Meuser (MapCruzin.com) 2026

4.2. Dietary habits in Southeast Asia

Southeast Asia is among the evolving regions undergoing rapid nutrition transitions, with its population more susceptible to chronic than infectious diseases. This trend affects a growing proportion of the population and is occurring more quickly than in countries like the USA and European countries, where similar transitions have historically been more gradual (Popkin 1998).

The number of people suffering from undernutrition in Southeast Asia is decreasing. The cause of malnutrition is not only low food intake but also deficiencies of minerals and vitamins, as well as so-called hidden malnutrition, where people have access to food, but it is nutritionally inadequate. The causes of this may include dietary habits in which residents consume little fruit and vegetables and eat more fatty foods. Socioeconomic factors, including income, high food prices, or poverty, also play a role. The surrounding environment can influence dietary habits, for example, a lack of education about nutrition, and lastly, health infrastructure; limited access to healthcare and nutritional support can also be a contributing factor (FAOSTAT 2026; WHO 2026).

4.3. Edible flowers: a general overview

In recent years, demand for natural products with potential health benefits has risen rapidly. This trend also reflects a strong interest in plant-based products, including edible flowers. These flowers are considered safe for consumption and have positive health effects (Nicolau 2016; Matyjaszczyk & Śmiechowska 2019).

Approximately 180 species from ninety-seven families are classified as edible flowers (Lu et al. 2016). These flowers originate from Asia and are now widely distributed through tropical and subtropical regions. They are mostly used in desserts, stews, salads, as vegetables, or medicinal herbs (Tai 2000; Da-Costa-Rocha et al. 2014).

Edible flowers can be classified into fruit-bearing flowers, such as the blossoms of bananas or citrus fruits, and then there are non-fruit-bearing flowers, including hibiscus, begonias, calendula and various culinary herbs: alliums, thyme and marjoram (Prabawati et al. 2021). However, some vegetables (artichokes, broccoli, and cauliflower) are botanically classified as inflorescences (Nicolau 2016).

Edible flowers have recently attracted attention due to their nutritional composition and potential health benefits, which are associated with the presence of various bioactive substances and phytochemicals important to human nutrition (Carboni et al. 2025).

EF* consists of 70-90% water, while its dry matter comprises only a few tens of per cent. Despite this, they contain a variety of important nutrients. Sugars, particularly fructose, glucose, and sucrose, are the main contributors to the flavour and nutritional value. In addition, they also contain crude fibre, polysaccharides, and oligosaccharides, including cellulose and lignin. The main micronutrients include calcium, sodium, and potassium, whereas trace elements include iron, manganese, and zinc (Carboni et al. 2025a).

Proteins are present in smaller amounts compared to other major components, and their levels vary depending on the type of flower. Their content can also be influenced by environmental factors such as the growing conditions, pollution, and other influences (Fernandes et al. 2020b; Mlcek et al. 2021).

Although seeds are the main storage of lipids in plants, flowers also contain a small amount in the form of neutral lipids. Because of the flower's high-water content, its fat content is low. For example, *Hibiscus* flowers may contain up to 19-26 g/100 g of dry matter (Fernandes et al. 2018a).

Mlcek & Rop (2011) classified EF based on nutritional value, categorising flowers according to nectar content, petals, pollen, and other parts. Pollen is present in minimal amounts in flowers and contains proteins, flavonoids, carotenoids, and carbohydrates. The flavour of pollen is generally mild. Petals and other floral parts serve as significant sources of vitamins and minerals. The last component is nectar, a sweet liquid composed of sugars, mainly fructose, glucose, and sucrose, as well as other components such as lipids and amino acids. [1]

The scent profile of the flower is determined by a complex mixture of chemical constituents, including aliphatic compounds, benzenoids, phenylpropanoids, and mono- and sesquiterpenes, each contributing to its distinctive aroma (Knudsen et al. 2006).

Post-harvest processing of flowers can alter their colour and taste, underscoring the importance of understanding their sensory profiles. This knowledge eases their application across diverse sectors, including the perfumery and functional foods industries. Sensory characteristics are affected by bioactive and volatile compounds, and optimal flavour intensity is attained when flowers are harvested at dawn during full bloom (Fernandes 2019; Fernandes et al. 2020b).

4.3.1. Morphology of flowers

Unlike other plant parts, like roots and leaves, flowers are complex organs. They are composed of a vegetative part, which includes non-reproductive structures, such as petals, and a reproductive part. Flowers have 4 rings: calyx, corolla, androecium, and gynoecium. The first two are called accessory organs, while the androecium and gynoecium are the reproductive organs of the flower. In some plants, including lilies, the

[1] The text on the composition of edible flowers, including protein, sugar, and lipids, was created by the author of the work. The Grammarly tool was used solely for linguistic and stylistic editing of the text and to ensure consistency. *EF-edible flowers

calyx and corolla are fused and form a single organ called the perianth. Flowers can be either bisexual or unisexual, depending on which rings they have (Endress 2001; Louis & Ronse De Craene 2022).

The calyx, the outermost circle of the flower, is formed by sepals, which are usually green and protect the flower in the bud. **A corolla** is composed of individual petals, which can have diverse colours and shapes, e.g., tubular, funnel-shaped, or star-shaped, depending on the species of the plant. Their main role is to attract pollinators to the flowers. **The androecium** refers to the male reproductive organ, which includes stamens, filaments, and anthers. The stamens can be clustered or bundled. They may also fuse with other floral parts or with each other. Sterile stamens are called staminodes. **The gynoecium** is the female reproductive organ, which consists of several parts: the ovary, style, and stigma, which are involved in ovule development and pollination (Louis & Ronse De Craene 2022).

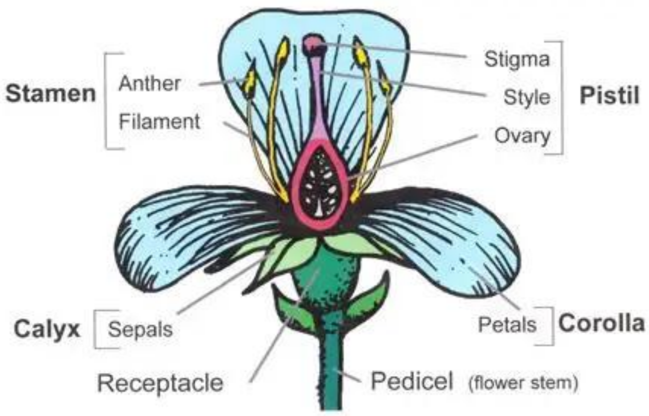

Figure 2. Morphology of a typical flower showing major floral parts.

Source: adapted from worldoffloweringplants.com (2025).

4.3.2. Processing methods of edible flowers

Compared to the fruit or vegetable market, the edible flower market is a small, specialised sector with low production. Edible flowers are often imported to markets or stores fresh; therefore, their storage is important. After harvesting, they usually stay fresh for about 5 days, after which they begin to wilt gradually (Kou et al. 2012).

4.3.2.1. Drying

Drying is a widely used preservation method for flowers. It extends shelf life, inhibits microbial growth, and prevents enzymatic degradation. Various drying methods are employed, including hot-air, solar, freeze-drying, vacuum-microwave, and combination drying. The outcome of the drying process depends on the type of flower selected, as well as the chosen method and processing (Fernandes et al. 2019b; Zhang et al. 2026).

4.3.2.2. Other processing methods of edible flowers

Irradiation is a physical preservation method that reduces microbial contamination without the use of antimicrobial agents. It includes ionising radiation, such as gamma rays, electron beams, and X-rays. Non-ionising radiation includes ultraviolet light (Fernandes et al. 2019b).

Ultraviolet irradiation has been explored as a post-harvest treatment because it inhibits microbial growth and reduces overall deterioration of flower quality. Low or sublethal doses of UV radiation can induce beneficial stress responses in plant tissues, which help preserve colour, antioxidant capacity, and nutritive quality. Research on this method is limited, and its effects are species-specific; therefore, further investigation is needed (Fernandes et al. 2019b). **Ionising irradiation** can be used as a post-harvest treatment to slow down the ripening and ageing of plant-based foods, although its use is strictly regulated by law. The WHO, IAEA, and FAO approve these technologies. Research on edible flowers is still limited, showing that tolerance to irradiation varies by species (Fernandes et al. 2019b).

Villavicencio et al. (2018) investigated electron beams on *Bauhinia variegata* L. var. candida alba Buch.-Ham, finding that this method did not significantly affect the plant's chemical or nutritional activities and could potentially be used for decontamination or as a preservative.

High-hydrostatic-pressure is a non-thermal processing technique in which flowers are exposed to pressures typically ranging from tens to hundreds megapascals. The method has been examined on a limited number of flowers, and it was shown that the response varies significantly depending on cellular structure (Fernandes et al. 2019b).

Fermentation is a biological process in which microorganisms convert organic substrates into added-value products. This method is used in food processing to preserve the sensory properties of foods, such as aroma, taste, and texture, which have a key role in the production of biofuels, chemicals, and pharmaceuticals. The method is exceedingly popular because it does not pollute the environment and reduces energy use (Rocha et al. 2014).

4.3.2.3. Storage and packaging of flowers

The delivery of fresh flowers to stores or markets is influenced by their packaging, which preserves their freshness both after processing and during storage (Jadhav et al. 2023). The most used methods are briefly described below.

Low-temperature storage is mainly used to preserve the postharvest quality of edible flowers; it slows down the physiological activity. Storing at low temperatures reduces the flower's respiration and also slows the growth of microorganisms and the production of ethylene (Jadhav et al. 2023).

Atmosphere-based packaging has been used for a long time on flowers; the gases contained in the packaging protect them from wilting, microbial activity, or ethylene production (Singh et al. 2018; Jadhav et al. 2023).

Controlled Atmospheric Packaging using this method monitors the contents of gases such as carbon dioxide and nitrogen, along with oxygen, with humidity and temperature as the final factors (Jadhav et al. 2023).

4.3.3. Safety aspects and toxicological considerations

The safety of edible flowers remains a topic with limited research, and the limited literature highlights a notable knowledge gap. The available literature indicates that toxicity varies depending on which plant part is consumed. Some plants contain harmful compounds like erucic acid, coumarin, hydrocyanic acid, or thujone. Regulatory bodies, including the European Food Safety Authority and the Joint FAO/WHO Expert Committee on Food Additives, set limits on tolerable and acceptable daily intake to ensure safe consumption levels (Matyjaszczyk & Śmiechowska 2019).

In addition to naturally occurring toxic compounds, safety concerns for edible flowers also involve external contamination. Data from the European Union Rapid Alert System for Food and Feed (RASFF) indicate that *Salmonella* spp. contamination is the primary issue. There are also concerns about residues from chemical sprays, insecticides, or other substances. Microbial contamination mainly affects edible flowers eaten fresh, stemming from cultivation, harvesting, and managing processes. Poor hygiene practices, such as using contaminated irrigation water or mishandling during post-harvest processing, significantly increase the risk of contamination or cross-contamination (Hirneisen et al. 2012; Liu et al. 2018).

Collecting EF in the wild can lead to confusion with similar-looking, but inedible or even poisonous species. These flowers often grow in clusters with other plants and may become contaminated. Therefore, it is very important to correctly identify edible flowers. Contamination can also occur from heavy metals present in soils, like cadmium, which they absorb (Matyjaszczyk & Śmiechowska 2019b).

Chemical contamination of EF mainly results from the use of plant protection products in agriculture. EF from ornamental plants poses a higher risk because they are not primarily grown for consumption, and maximum residue limits are often not set. However, because the consumption of EF is limited, proper cultivation, harvesting, and handling are crucial to ensure their safety for consumers (Liu et al. 2018).

4.3.4. Culinary and traditional applications

This section provides a general overview of culinary and traditional applications of edible flowers, serving as a background. In the following chapter, specific uses are mentioned.

Edible flowers are often eaten in their entirety, although in some species only specific parts are eaten, such as the petals of *Rosa* spp. They can be enjoyed fresh or dried, incorporated into beverages and desserts, or preserved in sugar or spirits. Beyond their nutritional value, these flowers are mainly used to add colour, flavour, and aroma to food and drinks. Their importance in gastronomy is increasing due to their aesthetic appeal and distinctive flavour. Examples like pansies and rose flowers are used to decorate dishes, including salads, cakes, and other desserts, as well as beverages (Thapa et al. 2025).

EFs contain high levels of antioxidants that lower the risk of various diseases, including cardiovascular conditions, and may help prevent chronic illnesses. Their therapeutic properties have made them a part of traditional medicine for centuries, especially in Asian countries. However, in modern pharmacology and clinical practice, EFs are rarely used as approved medications. Most research remains at the preclinical and nutraceutical stages, exploring their roles as functional foods or dietary supplements rather than as officially approved medicines (Janarny et al. 2021; Zhao et al. 2021; Pensamiento-Niño et al. 2024).

4.3.5. Industrial, cosmetic, and nutraceutical applications

Edible flowers can be used in the nutraceutical sector, which includes preparations or functional foods that contain a range of bioactive substances and may protect against certain diseases. Flowers are added to tea, capsules, or various loose powders, where they contribute to flavour and therapeutic effects, but they are not considered medications (Thapa et al. 2025).

Some edible flowers are also used in perfumery because they contain aromatic compounds suitable for use, such as *Cananga odorata* and *Jasminum sambac*. Beyond perfumery, flowers are incorporated into a range of cosmetic products, including anti-ageing creams, serums, and eyeshadows. *Clitoria ternatea* Linn. flowers have been used in eyeshadow production, where their anthocyanin content contributed to vivid colouration while demonstrating sustainability and skin gentleness (Mourya et al. 2017; Kwartiningsih et al. 2024; Thapa et al. 2025). *Hibiscus sabdariffa*, often called the Botox plant, contains anthocyanins and organic acids, particularly AHA (alpha hydroxy acids), which contribute to skin rejuvenation by supporting collagen production and reducing signs of ageing. Some types of flowers contain essential oils with medicinal effects, but in cosmetics, volatility, light and heat instability, and variable composition compared to synthetics pose challenges (Indryani Fauhan et al. 2023; Achagar et al. 2024).

4.3.6. Natural dyes and cultural significance

Many of these blossoms are further utilised as natural dyes, including *Bougainvillea glabra, Clitoria ternatea* Linn*.,* and *Hibiscus* L., or as texturising agents such as *Malva sylvestris* L. *Bougainvillaea glabra* is prized for its vivid pigments, while *Hibiscus* L., rich in anthocyanins, is employed as a red or pink colourant in syrups, jams, and teas (Siti Azima et al. 2017; Contreras-López et al. 2021).

Using edible flowers in food, cosmetics, and nutraceutical industries can enhance sustainability by decreasing reliance on synthetic substances and promoting the valorisation of plant-derived raw materials (Chen et al. 2021).

Beyond practical uses, edible flowers hold cultural and spiritual significance. They are often used in religious ceremonies, offerings, and rituals, symbolising purity, prosperity, and fertility. Floral motifs are common in Southeast Asian architecture, with the lotus serving as a prominent symbol. Certain species, such as *Jasminum sambac* and *Hibiscus* spp., are also utilised to create living fences. Additionally, climbing flowering plants are employed as decorative features for gazebos and pergolas (Thaneshwari et al. 2018).

4.3.7. Market relevance

The edible flower market has expanded s in recent years, due to increasing consumer demand for health and natural foods. These products are typically sold fresh through the growth farms, markets often alongside herb or ornamental plants. Due to their high perishability, edible flowers are usually harvested in the morning and stored at low temperatures to preserve quality, with delivery to consumers required within a few days. Some flower-derived crops, including broccoli and cauliflower, are particularly important in Asian markets, which account for a large share of global production (Jadhav et al. 2023).

According to FAO in 2024, broccoli and cauliflower production was 15469.3 kg/ha (FAOSTAT 2026b). There is also international trade in edible flowers, with specific exports from producing countries to other markets. The market's closing price depends on processing methods, transportation, and seasonal availability (Jadhav et al. 2023). Specific market prices or total exports of EFs are not available because organisations such as the FAO do not track them, as the market for these flowers is still limited.[2]

[2] The text on market relevance and processing of EF was created by the author of the work. The Grammarly tool was used solely for linguistic and stylistic editing of the text and to ensure consistency.

5. Chemical composition of edible flowers

EF are a rich source of chemical constituents, including pigments, alkaloids, nitrogen and sulphur-based compounds, phenolic substances (Lu et al. 2016b). The presence and abundance of these compounds depend largely on the floral tissues. While pollen is mainly associated with carotenoids and flavonoids, nectar is characterised by the occurrence of organic acids, inorganic ions, and various secondary metabolites. In contrast, petals are recognised by their vitamin and mineral content (Pires et al. 2019). The chemical profile of edible flowers is not fixed and may vary depending on multiple factors, such as soil and climatic conditions, variations in flower colour or stage of flowering, and farming methods (Fernandes et al. 2018).

5.1. Primary metabolites

Primary metabolites are essential to plant growth, photosynthesis, and respiration. Primary metabolites include proteins, lipids, nucleic acids, and sugars. This group also includes organic acids and alcohols (Hounsome et al. 2008).

"**Proteins** are polymers of amino acids linked via α -peptide bonds." (Watford & Wu 2018, p. 651). Considering that the protein content varies significantly among plant species and families, specific values cannot be determined; for example, Marigold contains 1.5 g / 100 g in the wet state (Poonia et al. 2025). Proteins are composed of twenty standard amino acids, encoded by the genome. From a nutritional perspective, essential amino acids are important for humans because the body cannot synthesise them and must obtain them from food. Examples include histidine and isoleucine (Nutrition News 2026). In flowers, proteins have a structural role; they are components of cells and tissues. They are also part of enzymes, where they regulate chemical reactions such as growth and photosynthesis.

Sugars, including monosaccharides and disaccharides (glucose, sucrose, and fructose), are primary metabolites important for plant growth and energy supply (Birch & Shallenberger 1976; Birch & Shamil 1988). Sugar content varies by type, and general values are either unavailable or vary. In flowers, sugars serve as a source of energy and as building blocks for structural carbohydrates, such as cellulose, which form cell walls. Sugars also contribute to taste and aroma and enhance pollinator attraction. Starch is a storage form of carbohydrate in flowers, seeds, and roots, providing energy for growth and reproduction (O'Donoghue 2006).

Lipids are an essential component of plant cells, providing membrane integrity and energy for metabolic processes (Lim et al. 2026). In many edible flowers, lipids are often stored in seeds as triacylglycerols, but they can also be present in flowers, leaves, and fruits. They play structural and functional roles in cells, although their function or role in flower tissues has not been determined (Wang & Chapman 2013).

5.2. Secondary metabolites

Secondary metabolites are compounds that are required for the basic survival of cellular functions like growth and reproduction. They often help plants defend themselves against abiotic and biotic factors. These compounds are small molecules that are typically produced by specific organs, tissues, or cell types. The major groups include **alkaloids, terpenoids, and phenolics** (Pagare et al. 2015).

They exhibit a wide range of pharmacological effects, including antiviral, antibacterial, and antifungal. In addition, some of the secondary metabolites serve as natural UV filters, safeguarding the foliage from radiation damage (A. Hussein & A. El-Anssary 2019) .

Alkaloids originate from amino acid metabolism. They exhibit potent physiological effects in humans and plants, functioning as defence compounds or stimulants. Common examples are caffeine, piperine, and capsaicin, while many of the alkaloids may be toxic to the body (Kabera et al. 2014).

Phenolic compounds are among the largest groups of secondary metabolites. They are widely present in flowers and other plant tissues and are known for their health-promoting effects. These compounds show a wide range of biological activities, including antioxidant, anti-inflammatory, anticarcinogenic, and various other properties, and may help to protect against oxidative stress and related diseases (Kabera et al. 2014).

Flavonoids, a subgroup of polyphenols, play an essential role in plant pigmentation, aroma, and pollinator attraction. They also protect plants from UV radiation, low temperatures, and drought. In human health, flavonoids are valued for their antioxidant, anti-inflammatory, antimutagenic, and antitumour properties and are widely used in pharmaceutical, cosmetic, and nutraceutical applications (Panche et al. 2016).

Terpenoids are synthesised from isoprene units via the mevalonate pathway. This group of substances includes carotenoids, steroids, and gibberellic acid, which promotes plant growth. They exhibit numerous pharmacological effects, including activity against certain diseases. Terpenoids have a wide range of applications, including use as fragrances, spices, and flavours. (Kabera et al. 2014).

Carotenoids are lipophilic pigments produced by photosynthetic organisms, including algae, plants, and cyanobacteria. In flowers, carotenoids are essential for photosynthesis and the reproductive process (Kandylis 2022). In humans, they support eye, brain, and heart health and eventually protect against UV radiation as a precursor to vitamin A (Eggersdorfer & Wyss 2018).

5.3. Biological activity of edible flowers

This section summarises the main biological activities identified in the research table below. The most common activities are briefly described.

Antioxidant activity was the most represented biological activity in the research table. This activity is due to phytochemicals in the flowers, such as anthocyanins, flavonoids, phenolic acids, alkaloids, and glycosides. Additionally, a positive correlation has been observed between total phenolic content, particularly flavonoids, and antioxidant capacity (Navarro-González et al. 2015; Lu et al. 2016c; Zheng et al. 2018). **Oxidative stress** arises when reactive oxygen species exceed the capacity of the cellular defence system to eliminate them (Pizzino et al. 2017).

Antimicrobial activity refers to the capacity of specific substances to inhibit or eliminate microorganisms. These substances are utilised in various industries, such as cosmetics and medicine. While edible flowers can be preserved, they carry a risk of microbial contamination, arising from improper cultivation, harvesting, or handling (Wilczyńska et al. 2021). Fungi are common, undesirable microorganisms that affect edible flowers. They produce volatile substances that alter the total sensory properties of the flowers, including aroma, taste, and texture. They may also contribute to the damage and withering in packages where they are stored (Carboni et al. 2025a). Moulds are also present in flowers, producing mycotoxins; they target human organs such as the liver or kidneys (Tournas 2005; Wilczyńska et al. 2021). In addition to antioxidant activity, several flowers, including *Hibiscus rosa-sinensis* and *Nelumbo nucifera* Gaertn., have **antimicrobial activity** (Missoum 2018; Radoor et al. 2024).

Inflammation is a protective response of the body to tissue injury caused by physical trauma, toxins, chemicals, or microbial infections. Depending on their duration and characteristics, inflammation is typically classified into two main types: acute and chronic. In acute inflammation, leukocytes migrate to the site of injury, where they repair tissue and defend the wound against infection (Kumar et al. 2013). **Anti-inflammatory activity** was also reported in several species, including *Cassia fistula, Curcuma longa*, and *Moringa oleifera* Lam. (Danish et al. 2011; Leone et al. 2015a).

Finally, **antidiabetic activity** was observed; however, most studies are at the preclinical or preliminary stages. An example is *Nelumbo nucifera* Gaertn., which has been investigated in limited *in vivo* studies (Ye et al. 2022).

Diabetes mellitus is a common metabolic disorder that affects carbohydrate metabolism. There are two main types: type I, caused by the destruction of insulin-producing pancreatic β-cells, and type II, resulting from decreased tissue sensitivity to insulin (Arora et al. 2009).

Overall, antioxidant, antimicrobial, anti-inflammatory, and antidiabetic activities represent the main biological effects reported for edible flowers; many studies remain at the preclinical or preliminary stage, underscoring the need for further research.[3]

[3] The text on biological activities was created by the author of the work. The Grammarly tool was used solely for linguistic and stylistic editing of the text and to ensure consistency.

6. Edible Flowers of Southeast Asia

The research table summarises 74 edible flower species, including herbs, trees, vines, shrubs, and aquatic plants. These flowers belong to 42 plant families, with Fabaceae accounting for 13.5%, Zingiberaceae for 9.5%, and Malvaceae and Asteraceae 4.1%, being the most prevalent. Most listed species are used primarily in culinary applications, especially in soups, salads, teas, desserts, curries, and beverages. Several plants are described as multipurpose, combining medicinal and ornamental uses.

Regarding biological activities, antioxidant, anti-inflammatory, antimicrobial, and antidiabetic effects are most often reported. These activities are commonly associated with flavonoids, alkaloids, phenolic compounds, essential oils, and anthocyanins.

The most represented chemical substances included flavonoids, saponins, and alkaloids. Essential oils, phenolic compounds, and glycosides occurred with the smallest representation.

Flowers are the primary edible part; however, in many species, other plant parts (leaves, rhizomes, or seeds) are also consumed. Overall, the table highlights the diverse array of edible flowers in Southeast Asia and their nutritional and pharmacological importance.

Edible flowers from SE Asia

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Anacardiaceae *Bouea macrophylla*	Marian plum	jam, salads, wine	saponins, tannins, terpenoids	antimicrobial, anticancer	ornamental tree, nutritional, culinary	(Fu'adah et al. 2022)
Annonaceae *Cananga odorata*	ylang-ylang	vegetable, beverages	essential oils, alkaloids, terpenes	antidiabetic, antioxidant	fragrant flowers, ornamental	(Tanaka & Nguyen 2007)
Apocynaceae *Stephanotis volubilis*	milk plant	vegetable	phenolics, flavonoids	anti-inflammatory, antitumour, antileishmanial	fragrant flowers, climbing vine	(Myat et al. 2025; Royal Botanic Garden 2026a)
Apocynaceae *Telosma cordata*	Chinese violet	vegetable, desserts	phenolic acids, flavonoids, polyphenols	antioxidant, anti-inflammatory	edible flowers, culinary use, fragrant	(Fernandes et al. 2020a; Royal Botanic Garden 2026b)
Aponogetonaceae Aponogeton lakhonensis	unknown	vegetable, raw	amino acids, saponins, sterols	antioxidant, antidiabetic, antitumour	aquatic plant, ornamental	(Chougule et al. 2022; Royal Botanic Garden 2026c)
Araliaceae *Trevesia palmata*	snowflake tree	soups, salads, curries	triterpenoids, saponins, flavonoids	anticancer, antibacterial, anti-fungal	ornamental tree with EF* and fruits	(Chen et al. 2025)
Arecaceae *Arenga pinnata*	sugar palm	sweetener, juices	polyphenols, flavonoids, tannins	antioxidant, antidiabetic	EF and fruit, starch source, traditional beverages	(Haagen et al. 2011)
Arecaceae *Borassus flabellifer*	palmyra palm	desserts, juices, wine, sugar	flavonoids, minerals, vitamins	anticancer, antioxidant, anti-inflammatory	EF and fruits, multipurpose tree, a sweetener source	(Jerry 2018; Krishnaveni et al. 2020)
Arecaceae *Colocasia esculenta*	taro	vegetable	minerals, carbohydrates, oxalates	antimicrobial, antioxidant, anti-inflammatory	edible leaves and flowers, staple food	(Prajapati et al. 2011; Temesgen & Retta 2015)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Asteraceae *Blumea balsamifera*	sambong	raw, soups	tannins, terpenoids, essential oils	antitumour, antifungal, antiobesity	EF used in traditional diets	(Pang et al. 2014; Royal Botanic Garden 2026d)
Asteraceae *Spilanthes acmella*	jambu	vegetable, spice	flavonoids, phenolic compounds	antifungal, antimicrobial, antioxidant	EF with medicinal and culinary uses	(Shetty et al. 2015)
Asteraceae *Tagetes erecta*	marigold	condiment, salads	thiophenes, flavonoids, carotenoids	anti-inflammatory, antioxidant, antibacterial	EF used as a natural colourant and decoration	(Dubey et al. 2013)
Bignoniaceae *Oroxylum indicum*	Indian trumpet tree	soups, curries	alkaloids, triterpenoids, proteins	antineuritic, antioxidant, antibacterial	EF with cultural and traditional significance	(Singh & Chaudhary 2021)
Blechnaceae *Stenochlaena palustris*	climbing fern	vegetable, herbal drinks	tannins, saponins, polysaccharides	antioxidant, antidiabetic	EF used in traditional ethnobotanical practices	(Chambers 2013; Pandiangan et al. 2022)
Brassicaceae *Nasturtium officinale*	water cress	soups, salads, raw	glycosides, flavonoids, terpenoids	anti-inflammatory, antiarthritis, antioxidant	EFvalued in traditional diets	(Al-Snafi 2020)
Burseraceae *Dacryodes rostrata*	kembayau	raw	phenolics, alkaloids, terpenes	antioxidant, anti-inflammatory	multipurpose plant with EF	(Tee et al. 2014)
Calophyllaceae *Mesua ferrea*	Ceylon ironwood	raw, tea	flavonoids, tannins	anti-inflammatory, antioxidant, anticancer	hardwood tree with fragrant flowers	(Asif et al. 2017)
Caprifoliaceae *Lonicera confusa*	honeysuckle	soups	flavonoids, saponins	antimicrobial, antifungal	multipurpose plant with EF	(Li et al. 2020)
Combretaceae *Combretum indicum*	rangoon creeper	vegetable	steroids, triterpenoids, saponins	antipyretic, antimicrobial	vine associated with traditional medicinal knowledge	(Gentallan et al. 2021; Royal Botanic Garden 2026f)
Commelinaceae *Commelina diffusa*	climbing dayflower	vegetable, garnish	tannins, cardiac glycosides, terpenoids	antimicrobial, antioxidant	ornamental plant with EF	(Rahman et al. 2021)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Convolvulaceae *Ipomoea aquatica*	water spinach	vegetable, soups, pickled	diterpenes, triterpenoids, flavonoids	anti-inflammatory, anticancer, antioxidant	water plant	(Austin 2007; Malakar 2015)
Costaceae *Cheilocostus speciosus*	white ginger lily	salads, soups, vegetable	phytosterols, triterpenes	antipyretic, antidiuretic	medicinal, ornamental	(Mazumder & Hussain 2021)
Cucurbitaceae *Cucurbita maxima*	pumpkin	vegetable	vitamins, carotenoids, fatty acids	antiobesity, anticancer	edible flowers and fruits	(Salehi et al. 2019)
Cucurbitaceae *Coccinia grandis*	ivy gourd	vegetable	proteins, unsaturated fatty acids, saponins	antimalarial, anti-inflammatory,anti-helminthic	tropical vine with EF	(Siam & Snigdha 2025)
Fabaceae *Bauhinia variegata*	orchid tree	salads, curries	flavonoids, phenolic compounds, saponins	antioxidant, anticancer	ornamental tree	(Singh et al. 2019)
Fabaceae *Butea monosperma*	flame of the forest	curries, soups	saponins, glycosides, alkaloids	antimicrobial, antidiabetic	utility tree species with EF	(Sindhia VR & Bairwa R 2010)
Fabaceae *Caesalpinia mimosoides*	mimosa thorn/pansi	side dish, raw	flavonoids, diterpenoids, oils	antimicrobial, antidiabetic	tropical vine, vibrant yellow flowers	(Patil & Deshmukh 2023)
Fabaceae *Canavalia gladiata*	sword bean	vegetable	flavonoids, steroids, AA**	antioxidant, anti-inflammatory	tropical vine, protein source	(Qian et al. 2025)
Fabaceae *Cassia fistula*	golden shower tree	oil	anthraquinone glycosides, AA	antioxidant, antimicrobial, antipyretic	ornamental tree with EF	(Danish et al. 2011)
Fabaceae *Cassia siamea*	Siamese cassia	curries	flavonoids, triterpenoid	antimalarial, antidiabetic, antitumour	tree species with EF	(Kamagaté et al. 2014)
Fabaceae *Clitoria ternatea*	butterfly pea	soups, tea, condiment	flavonoids, essential oils, phenolic compounds	memory-enhancing, anti-inflammatory	ornamental	(Kazuma et al. 2003; Mukherjee et al. 2008a)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Fabaceae *Psophocarpus tetragonolobus*	winged bean	drinks, dessert, tofu	saponins, tannins, phenolics	antimutagenic, anti-allergic	versatile vegetable	(Bepary et al. 2023)
Fabaceae *Sesbania javanica*	sesbania	sauces, soups, curries	tannins, saponins, proteins	antimicrobial, antidiabetic, antioxidant	nutrient-rich edible flower	(Akram et al. 2021)
Fabaceae *Tamarindus indica*	tamarind tree	curries, sauces, vegetable	AA, fatty acids, minerals	antibacterial, antiviral	tropical tree, culinary, medicinal	(De Caluwe et al. 2010)
Liliaceae *Hemerocallis fulva*	daylily	raw	flavonoids, anthraquinones	antipyretic, antiemetic, antioxidant	flower with cultural uses	(Li et al. 2022)
Lythraceae *Woodfordia fruticosa*	fire flame bush	herbal tea, soups, liquor	flavonoids, tannins, alkaloids	anti-inflammatory, antioxidant	deciduous shrub, traditional uses	(Das et al. 2007; Thakur et al. 2021)
Malvaceae *Grewia asiatica*	phalsa / falsa	jam, desserts, juices	triterpenoids, sterols, flavonoids	antidiabetic, anti-inflammatory	edible flowers, fruit	(Zia-Ul-Haq et al. 2013)
Malvaceae *Hibiscus rosa-sinensis*	Chinese hibiscus	tea, jam, salads	glycosides, saponins, flavonoids	antipyretic, antiasthmatic	exotic shrub, ornamental	(Missoum 2018)
Malvaceae *Hibiscus sabdariffa*	roselle	jam, salads, tea	glycosides, saponins, flavonoids	antioxidant, anti-inflammatory, diuretic	exotic shrub, natural colourant	(Riaz & Chopra 2018)
Malvaceae *Malvaviscus arboreus*	wax mallow	salads, light curries	anthocyanins, phenolic acids, sterols	antifungal, antimicrobial, antioxidant	nectar-rich flowers, nutritious fruit	(Bhat & Bhat 2025)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Meliaceae *Aglaia odorata*	unknown	tea	alkaloids, diterpenoid, steroids	antimicrobial, anti-inflammatory	tree species with EF	(Widodo 2003; Harneti & Supratman 2021)
Meliaceae *Azadirachta indica*	neem	tea, curries	tannins, alkaloids, saponins	antimicrobial, anticancer	natural pesticide, sustainable source	(Islas et al. 2020)
Mimosaceae *Neptunia oleracea*	water mimosa	stir-fries, soups, salads	phenolic compounds, saponins, vitamins	antiulcer, antioxidant, anticancer	aquatic vegetable, culinary	(Wahab et al. 2014)
Moringaceae *Moringa oleifera*	drumstick tree	snacks, raw, desserts	flavonoids, phenolic compounds, vitamins	antidiabetic, anti-inflammatory	edible leaves, flowers, seeds, multipurpose	(Leone et al. 2015a; Karmakar et al. 2024)
Musaceae *Musa × paradisiaca*	plantain	raw, soups, flour	alkaloids, flavonoids, tannins	antimicrobial, antioxidant	edible fruit, leaves for cooking, ornamental	(Galani 2019)
Musaceae *Musa acuminata* Colla	banana	raw, soup, flour, cake	alkaloids, flavonoids, tannins	antimicrobial, antioxidant, anti-inflammatory	edible fruit, leaves for cooking, staple food	(Mathew & Negi 2017b)
Nelumbonaceae *Nelumbo nucifera*	sacred lotus	soups, sweet dishes	alkaloids, flavonoids	antioxidant, antipyretic, anti-inflammatory	ornamental plant with EF	(Chen et al. 2019; Sahu et al. 2024)
Nymphaeaceae *Nymphaea nouchali*	water lily	tea, sweet dishes	tannins, phenolic compounds, polysaccharides	antimicrobial, antioxidant	ornamental, medicinal, aquatic	(Singh & Jain 2017; Sarma et al. 2024)
Oleaceae *Jasminum sambac*	Arabian jasmine	tea	essential oils, flavonoids, peptides	antipyretic, anti-inflammatory	medicinal, aquatic	(Mourya et al. 2017; Jian et al. 2023)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Oleaceae *Nyctanthes arbor-tristis*	night-flowering jasmine	juices	flavonoids, carotenoids, polyphenols	antiviral, antidiabetic, and antiallergy	nocturnally blooming, fragrant flowers	(Singh et al. 2021)
Oleaceae *Osmanthus fragrans*	sweet osmanthus	cake, tea, jam	flavonoids, phenolic compounds, saponins	anti-ageing, anticancer, anti-inflammatory	fragrant edible flowers, culinary uses	(Wang et al. 2022; Yang et al. 2024b)
Opiliaceae *Melientha suavis Pierre*	unknown	salads, soups	essential oils, carotenoids, glycosides	anti-inflammatory, antidiabetic, antioxidant	edible leaves and flowers, culinary, nutritional	(Nguyen Tien Hiep 1993)
Pandanaceae *Pandanus amaryllifolius*	pandan	spice	alkaloids, terpenoids, flavonoids	antidiabetic, antioxidant, anti-inflammatory	aromatic edible leaves, culinary, flavouring	(Bhuyan & Sonowal 2021)
Phyllanthaceae *Antidesma bunius*	bignay	wine, jam	vitamins, flavonoids, saponins	antiplatelet, anticoagulant, antidysenteric	fruit tree, nutritional, medicinal	(Shariful Islam et al. 2018)
Phyllanthaceae *Sauropus androgynus*	star gooseberry	salads, vegetable	volatile oils, phenolic acids	anti-inflammatory, antioxidant	shrubby vegetable with edible flowers	(Zhang et al. 2020)
Poaceae *Cymbopogon citratus*	lemon grass	culinary flavor	phytosterols, anthocyanin, AA	anti-obesity, antibacterial, antifungal	aromatic leaves, culinary	(Majewska et al. 2019; Oladeji et al. 2019)
Polygonaceae *Antigonon leptopus*	coral vine	salads, soups, tea	flavonoids, anthocyanins, saponins	hepatoprotective, analgesic, anti-inflammatory	vine with edible heart-shaped flowers	(Prashith Kekuda & Raghavendra 2018)
Pontederiaceae *Monochoria hasata*	monochoria	vegetable, soups	fatty acids, phenolic compounds	antifungal, anti-inflammatory	aquatic vegetable, culinary	(Boonkerd et al. 2026)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Rubiaceae *Gardenia jasminoides*	cape jasmine/gardenia	raw, pickled	tannins, alkaloids, saponins	antiangiogenic, antithrombotic, antimicrobial	evergreen shrub with edible flowers, leaves	(Phatak 2015)
Rubiaceae *Ixora chinensis*	Chinese ixora	salads, condiment, soups	steroids, terpenoids	antimicrobial, anti-inflammatory, antioxidant	shrub with EF, medicinal	(Chen et al. 2016)
Rubiaceae *Ixora coccinea*	jungle geranium	salads, condiment, soups	steroids, terpenoids	antimicrobial, anti-inflammatory, antioxidant	ornamental plant with EF, attractive to pollinators	(Chen et al. 2016)
Rubiaceae *Ixora javanica*	Java ixora	salads, condiment, soups	steroids, terpenoids	antimicrobial, anti-inflammatory, antioxidant	shrub with EF, medicinal	(Chen et al. 2016)
Sapotaceae *Madhuca longifolia*	mahua	juices, jam, candy	alkaloids, terpenoids, saponins	antibacterial, antiulcer	tropical tree	(Sinha et al. 2017)
Scrophulariaceae *Limnophila aromatica*	rice paddy herb	salads, soups, spring rolls	flavonoids, fatty acids, glycosides	antioxidant, anti-microbial	edible leaves and flowers, culinary, aromatic	(Gorai et al. 2014)
Theaceae *Camellia sinensis*	tea	beverages	polyphenols, AA, alkaloids	anti-ageing, anticancer	ancient, EF	(Mukesh et al. 2012)
Typhaceae *Typha orientalis*	broadleaf cattail	vegetable	flavonoids, terpenoids, saponins	antimicrobial, anti-inflammatory	edible shoots and flowers, aquatic vegetables	(Royal Botanic Garden 2026e)
Zingiberaceae *Alpinia galanga*	galangal	spice, tea	terpenoids, alkaloids	antioxidant, antihypertensive,	edible rhizome and flowers, medicinal	(Khairullah et al. 2020)
Zingiberaceae *Alpinia officinarum*	lesser galangal	spice, tea, curries	essential oils, alkaloids	antitumour, anti-inflammatory	edible rhizome, flowers, medicinal	(Bitari et al. 2023; Lei et al. 2024)

Scientific name	Common name	Culinary applications	Active ingredients	Biological activities	Featured attribute	Reference
Zingiberaceae *Curcuma longa*	turmeric	spice, soups, sauces	flavonoids, essential oils	antimicrobial, antiulcer, anti-inflammatory	edible rhizome, medicinal, culinary	(Khalandar et al. 2018; Vigyan Kendra et al. 2018)
Zingiberaceae *Etlingera elatior*	torch ginger	condiment, vegetable, pickles	tannins, saponins, alkaloids	antioxidant, anticancer, antiproliferative	culinary, ornamental	(Chan et al. 2013; Asiah Ismail & Ridzuan 2023)
Zingiberaceae *Etlingera hemisphaerica*	black tulip	condiment, vegetable, pickles	tannins, saponins, alkaloids	antioxidant, anticancer, antiproliferative	culinary, ornamental	(Chan et al. 2013; Riyanti et al. 2022)
Zingiberaceae *Hedychium coronarium*	butterfly ginger	vegetable	essential oils, phenolics, flavonoids	antibacterial, immunostimulant	an aromatic flower used in traditional food and culture	(Hartati et al. 2014; Chan & Wong 2015)

**AA- amino acids, *EF- edible flowers

6.1. Selected representative species

This chapter highlights a selection of notable edible flower species from SE Asia. These examples highlight the region's botanical variety, traditional culinary applications, and cultural importance of edible flowers. The goal is not to exhaustively detail each species but to provide illustrative examples that support the overall overview and the table summarising key points from earlier sections.

6.1.1. *Clitoria ternatea* Linn.

Clitoria ternatea Linn. is a climbing, vining plant belonging to the Fabaceae family, commonly known as blue pea, mussel-shell climber, or butterfly pea (Natural Resources Conservation Service 2026). Native to the Indonesian island of Ternate, it is now widely cultivated in tropical and subtropical regions, including India, Australia, and the Americas. It is grown as an ornamental, fodder, or medicinal plant (Jain et al. 2003).

Clitoria ternatea Linn. is a climbing, twisting plant reaching up to 3 meters in height. Its pinnate leaves consist of 5 to 7 oval or oblong leaflets. The fruits are flat pods containing seeds, whose colouration ranges from brown to black (Gupta et al. 2010).

The flowers typically appear singly or in pairs in various colours, from white to blue. The individual flowers are small, with rounded or oval pedicels. The calyces are bell-shaped and can reach up to 2.2 cm, and the lobes are triangular, measuring up to 1 cm. The flowers are mostly funnel-shaped but can also be rounded. The flower's morphology not only aids reproduction but also contributes to its wide use in gastronomy, or as ornamental decoration (Multisona et al. 2023; Maia et al. 2025).

Butterfly pea is a highly adaptable legume that grows well in a wide range of soil and climatic conditions (Tropical Forages 2026). The species may be grown as a standalone crop or intercropped with cover crops, most commonly grasses (McDonald 2002; Conway 2005). Intercropping with grasses has been reported to enhance biomass production plus overall yield. A key agronomic characteristic of C. *ternatea* Linn. is its symbiotic relationship with *Rhizobium* bacteria. As a result, this plant is frequently incorporated into crop rotation systems and used as green manure, supporting eco-friendly farming methods (Conway 2005).

However, research on the specific nutritional values of flowers is still limited. Analyses of other above-ground parts (including flowers) indicated that the plant is rich in proteins, beta-carotene, minerals like iron, calcium, and phosphorus (Kauadmin & Shamnad 2019).

The flowers contain various secondary metabolites: alkaloids, flavonoids, steroids, and saponins. Among the significant substances are anthocyanins, which give *Clitoria ternatea* Linn. its characteristic blue colour. Due to this property, the flowers are used as a natural dye in many sectors (Chakraborthy et al. 2018; Multisona et al. 2023).

In Southeast Asia, *Clitoria ternatea* Linn. has a long culinary tradition, especially in Malaysian, Thai, and Indonesian cuisines. The main use of its flowers is to make tea. Tea can be made from fresh flowers, as well as from dried or ground forms. Telang tea offers several health benefits; because of the compounds in this flower, it may reduce the risk of cardiovascular disease and improve neurological function. Additionally, it is common to add other herbs or flowers, such as lemongrass and ginger, to improve its aroma and flavour (Zira Azifa Ayska et al. 2024).

A traditional example of its use in flowers is Nasi kerabu, a Malaysian dish of steamed rice served with a variety of herbs and vegetables. The dish typically consists of vividly coloured rice and a fresh vegetable salad and may include additional garnishes according to regional or personal preferences. The rice attains its striking blue colour through the infusion of dried or fresh butterfly pea flowers (Abu Khairi 2004).

According to the Gollen et al. (2018), butterfly pea has been traditionally used for the treatment of asthma, skin diseases, leprosy, or other illnesses.

In addition to their use in traditional gastronomy and medicine, these flowers are also used in industry. Flowers have also been used in natural cosmetics, especially to produce eyeshadows. The study showed that increasing consumers' interest in sustainable and natural-derived products (Kwartiningsih et al. 2024). Butterfly pea can be used as a natural pesticide, as it is lethal to larvae that attack cotton plants. Oil-based products were reported to be effective (Mensah et al. 2015).

Available evidence on *Clitoria ternatea* Linn. shows promising safety. However, toxicological assessments have been performed at varying doses, indicating the need for further systematic investigations to evaluate the safety profile comprehensively (Mukherjee et al. 2008).

Figure 3. *Clitoria ternatea* L.-flower

Source: Royal Botanic Garden, Kew 2026

6.1.2. *Nelumbo nucifera* Gaertn.

Nelumbo nucifera Gaertn. is an aquatic plant in the Nelumbonaceae family and is commonly referred to as the Indian or sacred lotus (Guo 2009). The Nelumbonaceae family comprises two species: *Nelumbo nucifera* Gaertn., which is cultivated, and *Nelumbo lutea* Perr., a wild species. These two species are often referred to as the Asian and American lotuses, reflecting their geographic origins (Lin et al. 2019). Originally native to Southeast Asia, N. *nucifera* is cultivated in many tropical and subtropical regions worldwide, including parts of Europe, Africa, and the USA (Plants of the World Online 2025).

The lotus plant can grow up to 2.5 meters tall, from the roots to the above-ground parts. The plant produces large, circular leaves that can either be aerial or floating. The lotus seed head produces hard, brown seeds, often containing up to 30 seeds (Mehta et al. 2013).

The flowers are easily visible, measuring 10 to 25 centimetres, and appear in pink, yellow, or white with fragrant peduncles. They grow individually from rhizome nodes on strong stems, which can be smooth or slightly rough due to small thorns (Pal & Dey 2013).

The species typically grows in lakes, ponds, and slow-moving rivers, where it is anchored in mineral-rich soils. Lotus can reproduce either vegetatively through rhizomes or sexually by seeds. Optimal growth occurs in soils with a slightly acidic pH, although the plant shows some adaptability to various environmental conditions (Goel et al. 2001; Masuda 2006; McGrath & Colleen Johanna 2012).

Although the lotus is a well-studied plant, its detailed nutritional profile for flowers remains underexplored, indicating potential for further research.

Phytochemical analyses of flowers identified flavonoids as a major phytochemical compound, particularly kaempferol and its glycosides (Sahu et al. 2024). Current research focuses on polysaccharides obtained from lotus flowers, which exhibit significant biological activity. These substances are primarily associated with antioxidant and immunomodulatory effects in vitro, while no cytotoxic effects have been demonstrated (Zhang et al. 2023).

The lotus rhizome and seed represent the primary edible parts; the flowers are also utilised. Petals can be used in teas or as a decorative addition. Their aesthetic appearance and fragrance make them valuable in modern gastronomy (Jiang et al. 2011; Yu et al. 2013; Chen et al. 2019).

Beyond its culinary uses, the lotus has a long tradition in medicine. Lotus flowers have been researched for their potential to treat cancer, liver diseases, and sexual disorders. Flower extracts demonstrate a wide range of biological activities, including antimicrobial, antioxidant, and antidiabetic properties (Sheikh 2014).

The lotus holds significant cultural importance, particularly in Vietnam, where it is considered a national symbol. The lotus is also frequently depicted in temples or serves as a water decoration in ponds (Yang et al. 2024a). Lotus flowers, along with other extracts, were tested to develop a biocomposite film for monitoring the freshness of seafood, specifically shrimp. The ethanol extract from the flowers influenced the film's mechanical properties, and its colour changed with pH. It also showed biological activities, including antibacterial and antioxidant effects. This research demonstrated potential applications in food packaging (Radoor et al. 2024).

Several studies that examined the toxicity of various parts of *Nelumbo nucifera* Gaertn. have shown that this flower is not toxic (Kunanusorn et al. 2011; Rajput et al. 2020; Nuchniyom et al. 2023).

Figure 4. ***Nelumbo nucifera*** **Gaertn.-flowers**

Source: Royal Botanic Garden, Kew 2026

6.1.3. *Musa acuminata* Colla.

Musa acuminata Colla., commonly known as the banana, is a perennial herb belonging to the Musaceae family, classified within the section Emusa as a wild seed-producing banana species. Native to tropical Southeast Asia, particularly Malaysia, it gradually spread to India and Burma, and now it is cultivated globally, including the Canary Islands, Turkey, Fiji, and Ecuador (Häkkinen & Väre 2008; Royal Botanic Gardens 2026b).

The banana is a perennial plant that can reach several meters in height, typically around 6 meters. It develops a rhizomatous or tuberous root system that grows horizontally or vertically underground. The large leaves of the banana plant form a pseudostem; throughout its life cycle, the leaves grow larger and then fall off (Mathew & Negi 2017a).

The inflorescences are variably oriented; they can be erect or slightly pendulous, with their morphology differing according to the specific forms. The flowers are sexually differentiated, with female flowers located in the lower part of the inflorescence and male flowers in the upper part. The overall structure of the inflorescence exhibits considerable morphological variability, including differences in pubescence, shape of the bracts, and coloration (Mathew & Negi 2017a).

Banana cultivation is characteristic of warm and humid environments. At lower temperatures, the growth slows significantly. Soils suitable for banana cultivation are well-drained, rich in organic matter and range from loamy sand to clay loam textures. Since most cultivated bananas are triploid and do not produce seeds, they are propagated mainly vegetatively. Common planting methods include corms, large and different forms of suckers. Seeds are exclusively employed in breeding propagation (Arvanitoyannis & Mavromatis 2009).

According to Fingolo et al. (2012), dried inflorescences contained 14.5% protein and 49.83% dietary fibre, which indicates significant functional potential. It also contains a high proportion of potassium (5008 mg/100g), which may contribute to dietary intake. However, the nutritional composition of flowers varies across cultivars, geographical origins, and processing methods.

The flowers contain a wide range of secondary metabolites, including terpenoids, steroids, and flavonoids. Among the most represented substances in the banana plant are, for example, apigenin-7-glucoside or kaempferol-3-O-rutinoside; these substances contribute to the biological activities of flowers (Leena Bhanushali et al. 2024).

Flowers are widely utilised in gastronomy, for example, in beverages like tea or coffee, and in processed products like chocolate, where they are dried, and ground flowers are incorporated into cocoa mixtures (Shekhara Naik R et al. 2023). In Thai cuisine, banana blossoms are commonly used in a variety of dishes, including stir-fried meals, soups, and sweet-and-sour recipes. Before consumption, the outer peel must first be removed to reveal the edible inner core. In addition to fresh culinary uses, the inflorescences are used to make packaged teas to which additional ingredients (such as ginger) can be added, or they are ground into powder, which is then sold at traditional markets in Thailand and other countries (Panyayong & Srikaeo 2022).

Musa acuminata Colla. flower extracts show a wide range of biological activities, including anticancer, antimicrobial, antiulcer, and other activities (Anupama Yadav 2021). These studies are primarily based on *in vitro* and animal studies. Clinical studies are still a limiting factor.

Beyond medicinal and nutritional uses of flowers, other parts can be used in various sectors. Banana waste provides ecological benefits: fibres from the pseudo-stem can be turned into strong, insulating nonwoven textiles (Sengupta et al. 2020). Banana peels can serve as a renewable source for biofuel production and eco-friendly catalysts (Daimary et al. 2022). Peel extracts have potential as natural preservatives for meat (Afifah et al. 2023).

Regarding the toxicity of *Musa acuminata* Colla, available sources indicate it is not hazardous (Mathew & Negi 2017a).

Figure 5. *Musa acuminata* Colla.-flower bud, fruit

Source: Royal Botanic Garden, Kew 2026

6.1.4. *Moringa oleifera* Lam.

Moringa oleifera Lam. is a fast-growing tropical tree that belongs to the family Moringaceae (Royal Botanic Gardens 2026b). It is commonly known as the drumstick or the horseradish tree (Anwar et al. 2005). Although this species originates from the sub-Himalayan regions of north-west India, it is currently widely cultivated in tropical and subtropical regions, including Southeast Asia, Africa, South America, and the Caribbean (Somali 1984; Morton 1991; Mughal 1999).

Moringa oleifera Lam. is a medium-sized tree or shrub with small, branching, and typical tripinnate leaves. It can usually reach a height of 5 to 10 meters. The bark is smooth, ranging from grey to brown in colour, and exudes gum-like substances when injured (Abubakar 2021).

The flowers of *Moringa oleifera* Lam. are hermaphroditic, fragrant, and have a yellowish-white colour. They are arranged in racemose inflorescences and exhibit a zygomorphic structure. The plant blooms in two periods, in autumn and in spring (Kalappurayil & Joseph 2017).

Drumstick thrives in tropical and subtropical regions and can tolerate extreme heat, but only for a limited time. It grows well in sandy and loamy soils. Drumstick is usually propagated by cuttings or by sowing. These methods vary by country; for example, in Indonesia, vegetative propagation is common (Yadava et al. 1996b; Leone et al. 2015b; Velázquez-Zavala et al. 2016b).

The flowers exhibit significant nutritional properties, with the dry matter primarily containing carbohydrates (approximately 36%), fiber (32%), and proteins (around 18%). Furthermore, they are a rich source of amino acids, with a balanced ratio of essential to non-essential amino acids. The vitamin C content is significantly higher compared to other parts of the plant (Kalappurayil & Joseph 2017).

The flowers exhibit a rich presence of secondary metabolites, primarily phenolic compounds, flavonoids, and terpenoids. Among the most significant identified compounds are quercetin, kaempferol, and quinic acid, which are associated with antioxidant and anti-inflammatory activity (Kalappurayil & Joseph 2017b).

Flowers are usually added to soups and salads, or the nectar is also utilised for honey production (Gopalakrishnan et al. 2016). The flowers can also be eaten fresh, pickled in vinegar, added to curry, or used to make tea (Prabha & Madhumitha K. 2020).

Moringa oleifera Lam. is considered a highly valuable plant for its medicinal properties; in several studies, its plant parts have been used in combination with other plant species to treat various diseases (Supaporn Pamok 2012). In traditional medicine, it is used to treat malaria, typhoid, diabetes, parasitic diseases, and other conditions (Leone et al. 2015b).

In addition to culinary and medicinal uses, flowers can be used to treat contaminated water. A study by Moura et al. (2011) showed that the flowers exhibit antibacterial activity against both gram-positive and gram-negative bacteria in free water, suggesting potential use in turbid or contaminated waters. *Moringa oleifera* Lam. is also suitable for agroforestry systems. It can improve the resilience of agricultural systems, mixed cropping systems with this tree shown to be more profitable than monocultures, although awareness of its diverse uses remains limited (Devkota & Bhusal 2020).

Moringa oleifera Lam. is generally regarded as non-toxic, although only a limited number of studies have been conducted (Adedapo et al. 2009; Awodele et al. 2012).

Figure 6. ***Moringa oleifera*** **Lam.-flower**

Source: Royal Botanic Garden, Kew 2026

7. Discussion

This work aimed to summarise a research table on EFs from Southeast Asia or commonly used species, then select four representative species and describe them from nutritional, pharmacological, chemical, and culinary perspectives. The following discussion interprets the results and potential limitations of this review.

The nutritional content of edible flowers has been examined for common examples, but data for some species remain lacking. Due to the diversity of species, we cannot precisely determine levels of primary or secondary metabolites in edible flowers. However, they are generally characterised by high carbohydrate levels and the presence of bioactive compounds with antioxidant properties. These substances are associated with their biological activity. Although many studies have documented biological activity, most of the data derive from *in vitro* or experimental models that may not reflect effects in humans.

Generally, edible flowers are not part of the daily diet; this may be because people are unfamiliar with them, not accustomed to eating them, or afraid of their potential toxicity. However, they are commonly used as decorations.

From a nutritional viewpoint, edible flowers can benefit those on a plant-based diet. They add variety to meals and, thanks to their antioxidant properties, can positively impact health. However, the consumption of edible flowers depends on tolerable daily intake or acceptable levels, which are determined by certain organisations mentioned in the chapter on the toxicity of these flowers.

Although some types of flowers are rich in proteins, they cannot fully replace animal proteins or the vitamins and minerals present in meat. This includes essential amino acids or B12, which is found in dairy or meat products, in some cases also in plant food, including algae. Therefore, edible flowers should be used as supplements rather than as substitutes for animal products (Watanabe 2007).

The way these flowers are processed is also crucial to their nutritional value; methods such as cooking, drying, or fermentation can reduce enzymatic activity and even their antioxidant potential.

Regarding how edible flowers are processed, they are mostly dried, typically with cold or warm air. They are also often dried directly in the sun outdoors. High hydrostatic pressures or several types of irradiations have not been studied as thoroughly, as research has been conducted on only a limited number of plants. Ionising irradiation is strictly regulated by law. In contrast, fermentation or pickling is commonly used for edible flowers

EFs are commonly used as natural colourants; many species, such as *Clitoria ternatea* Linn.*, Hibiscus* spp., *and Tagetes erecta,* contain secondary metabolites, notably anthocyanins and carotenoids. Using various extraction methods, like solvent extraction, these dyes are obtained and can then be utilised as food colourings or for textile dyeing (Shantamma et al. 2021).

The primary limitation in this field is the toxicity of edible flowers; some plants are very similar, leading to potential confusion with their related toxic species. Toxicity data are only available for certain species; thus, further research is required (Matyjaszczyk & Śmiechowska 2019b).

In the tropical regions of Southeast Asia, there is a high diversity of flowers. Examples of morphologically similar plants include *Nelumbo nucifera* Gaertn. and *Nymphaea caerulea*; however, *Nymphaea caerulea* contains aporphine alkaloids with psychoactive and sedative effects, which may lead to adverse reactions if consumed in excessive amounts or in inappropriate forms. This highlights the importance of correct identification when using edible flowers (Schimpf et al. 2023)

The edible flower market has expanded in recent years; however, its market or export values for Southeast Asia remain unavailable. This may also be due to the specialised, small-scale nature of the edible flower market, and the fact that organisations such as FAOSTAT have not yet recorded these values.

Production and export are affected by the region's seasonality; Southeast Asia is known for its monsoon season, which brings periods of drought and rain, influencing processing and preservation methods. When comparing the market, for example, with fruit or vegetables, it is more economically advantageous than the EF market, because demand for this item mainly comes from culinary fields.

An important consideration is that flowers typically last only a few days before beginning to decay, losing their nutritional and sensory qualities. They are mainly composted or disposed of by other means. In the future, floral waste could potentially be used for biogas production. Compared to other plant parts, such as peels or leaves, they can be utilised further; for example, banana peels can be employed to produce biocatalysts, while leaves can be used for textile manufacturing (Sengupta et al. 2020; Daimary et al. 2022).

Regarding sustainability, they have both benefits and drawbacks: they are easily accessible and require no initial processing before consumption, which leads to a short shelf life, but they can also lose their properties through further processing, such as drying or high hydrostatic pressure.

Further research should focus on standardised analytical techniques and a comprehensive evaluation of bioactive compounds, safe dosages, and the effects of post-harvest processing. It is also crucial to acknowledge that cultivation factors, such as soil, climate, and other quality determinants that impact bioactive compound variability, contribute to the differences observed across studies. Such research would establish a more solid scientific basis for integrating EF into modern diets, pharmaceuticals, and functional foods.

8. Conclusion

Edible flowers have held a notable cultural and historical significance for centuries. They have been examined through different perspectives, including traditional medicine, culinary applications, and their function as health-promoting foods.

The reviewed literature and assembled research emphasise that edible flowers are abundant in primary and secondary metabolites, which contribute to various biological activities, including antioxidant, antimicrobial, anti-inflammatory, and antidiabetic effects. The research also highlights a broad taxonomic diversity of edible flowers in Southeast Asia, with applications extending beyond food, encompassing cosmetics, traditional medicine, and nutraceuticals.

The analysis of selected species (*Clitoria ternatea* Linn. , *Nelumbo nucifera* Gaertn., *Musa acuminata* Colla, and *Moringa oleifera* Lam.) confirms their versatile uses in nutrition, medicine, ornamentation, and industry. *Clitoria ternatea* L. is commonly used as a natural colourant; *Nelumbo nucifera* Gaertn. holds cultural and medicinal significance; *Musa acuminata* Colla is valued for its nutritional content; and *Moringa oleifera* Lam. is notable for its high fibre, carbohydrate, and calcium and medicinal properties.

Although interest in edible flowers is growing and many *in vitro* and *in vivo* studies have been conducted, there remains a lack of sufficient clinical evidence to thoroughly assess their safety for human consumption. Future research should emphasise more standardised clinical trials to support the inclusion of plant-based foods in the modern diet.

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