

A Review of Traditional and Prospective Vegetable, Medicine, Spice-Yielding Edible Flowers, and Some Toxic Non-Edible Flowers of West Bengal

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ABSTRACT: The EAT-Lancet Commission in 2019 advocated for a change in the global food system to one that is sustainable and nutritious. In West Bengal, poor households spend more on entertainment than on purchasing food materials, so edible flowers are one of the inexpensive dietary sources and provide a sensory contribution to foodstuffs. In West Bengal, vegetable curries prepared from the flowers of banana, pumpkin, agati, drumstick, etc. are very popular for their taste and nutritional supplementation. Edible flowers have many bioactive substances that have anti-cancer, cardioprotective, and anti-inflammatory qualities, as well as being useful in the management of diabetes, obesity, and neurological illnesses. On the other side, a few flowers have toxic substances that, if consumed by people in small quantities, can cause allergies and some dreaded diseases. Some common flowers have ornamental or crop values that are edible in several countries but not in West Bengal, making them prospective for future consumption as a new inexpensive food source.

Keywords: West Bengal, Nutritious flowers, poisonous flowers, future edible flowers, food processing, pharmaceutical, alternate food.

INTRODUCTION

A call for "planetary health diets" in the year 2019 was an important landmark in the research of food choice (Willett *et al.*, 2019). The EAT-Lancet Commission, comprising 37 scientists representing 16 nations from a variety of fields, called to improve human health in order to meet the mandate of the United Nations to reach the Sustainable Development Goals as well as the Paris Agreement by 2050. The achievement of the planetary health diet's concept again depends on the socio-economic structure, political and cultural beliefs, agricultural activities of the surrounding area, perception, familial taste, and overall, the personal palate (Cuevas *et al.*, 2021). The success of planetary health diets in West Bengal is not possible because the food choices in that state are deeply rooted in its history, lifestyle, traditions, and customs. Moreover, a significant population in West Bengal did not get the proper nourishment (Singh and Mukherjee 2015; Das and Bose 2015). Banerjee and Duflo (2007) "a poor person is essentially defined as someone without enough to eat". But the poor households of India, especially in West Bengal, spent more of their income on entertainment during a religious festival, wedding, or funeral than on purchasing food materials. On this aspect wild edible plants are becoming more and more popular on a global scale for their high nutraceutical

value, health benefits, and potential to support healthy eating, diversity in diets, revenue generation, and biodiversity protection (Gaikwad *et al.*, 2023). The sexual reproductive organs of plants are their flowers, and the naturally growing wild edible flowers are one of the major ingredients in vegetable dishes in poor households in West Bengal. In fact, "Ayurveda," an Indian traditional medicine system, determines the dietary consumption of Indian people, and from ancient times, people of West Bengal have used flowers in culinary preparation and a healthy diet.

Flowers and gardens are mentioned in Sanskrit literature from India dating back to 3000 BCE, illustrating the heritage of the country's use of flowers, primarily for ornamentation and decoration. Nevertheless, despite the fact that flowers have long been a part of Indian culture, they have only recently come to be recognised as a commercial industry, boosted by the adoption of western cultures such as Mother's Day, Valentine's Day, etc. The market is expected to grow significantly in the coming years. The aroma from the flowers is utilised by fragrance industry from a long time but people always need variation and searching of new flowers specially the fragrance of orchid has great commercial value. Recently, a study on sensory evaluation of aroma source from an orchid species *Aerides odorata* was identified for future use (Natta *et al.*, 2021). Some authors have noted that

Indian locals also eat flowers in addition to using them as ornaments. For instance, Deb *et al.*, (2019) documented that the different parts of the plants *Amomum dealbatum*, *Bauhinia purpurea*, *Bauhinia variegata*, *Chimonobambusa callosa*, *Curcuma angustifolia*, and *Musa sikkimensis* were consumed by the people of Nagaland. The documentation on the identification, their chemical constituents' analysis of underutilised edible flowers, and the dissemination of the information among the local people provide accessible options for the poor man's nutrition that ultimately contribute to food security. According to a review of edible flowers in India by Pinakin *et al.* (2020), tree blooms have been important to the history of the country and are thought to stand for immortality. Based on this assumption, tribal people in India consume different parts of trees like *Bauhinia variegata*, *Delonix regia*, *Moringa oleifera*, and *Rhododendron arboretum* as food and medicine. Besides their use as vegetables, flowers are now more than just decorative additions to savoury dishes and desserts. They offer a distinctive blend of senses and improve the dietary value of food recipes. Fresh versions of them—like the petals of marigolds in salads—as well as savoury dishes with fish and meat, soups and stews, and beverages (wine, beer), as well as desserts, candy, and jams, as well as spices and colours, are all edible. They can be employed in powder form (Chen & Wei 2017), crystallised form, in their dry state (infusions, dry petals of roses in sweets), or to develop foams (Fernandes *et al.*, 2019a). While the flowers of certain plants are also edible, they are frequently overlooked in favour of their biological and seasoning properties, or the nutritional possibilities of their fruits or leaves, as is the case with *Passiflora edulis*, *Allium schoenoprasum*, and *Cucurbita pepo* (Fernandes *et al.*, 2019b). It is essential to find out the underutilised plants for direct consumption by poor and underprivileged people. A survey conducted by Sharma *et al.*, (2015) near the village areas of Chandigarh selected a few underutilised plants like *Annona squamosa*, *Carrisa carandas*, *Cordia dichotoma*, *Moringa oleifera*, *Schleichera oleosa*, and *Zizyphus mauritiana* for their consumption in various ways.

In addition, costly spices like *Syzygium aromaticum* (clove) and *Crocus sativus* (saffron) are made from flowers, as is the widely used flower vegetable cauliflower. The Ayurvedic Dhataki (*Woodfordia fruticosa*) flowers are used as a fermenting agent when making therapeutic goods. Honey, which is flower nectar digested by bees, frequently bears the names of the flowers. The different floral parts, like the petals of *Rosa centifolia* (Shatapatra), the whole inflorescence of *Careya arborea* (Kumbhi), and the stigma or style of *Crocus sativus* (saffron), are popularly used for medicinal purposes (Shubhashree *et al.*, 2015). Edible flowers have primarily been used because of their aroma and aesthetic appeal, but recently, the discovery of natural bioactive substances has increased their food value and made them more popular among health-conscious people all over the world (Nowicka & Wojdyo 2019). Additionally, the availability of cutting-

edge analytical tools like HPLC/DAD-MS/MS to identify their chemical components and the expanding knowledge regarding the biological properties of edible flowers make them alluring and may have potential as ingredients for the creation of therapeutic foods that promote health and can be used as a preventative or curative for the treatment of acute and chronic diseases (Gostin & Waisundara 2019). Edible flowers retain their nutritional value, protein content, aromatic oil content, and, most importantly, their antioxidant properties when consumed organically or with little preparation (Fernandes *et al.*, 2019a). Following this pattern, edible flowers have also recently been linked to a number of biological properties, including anti-diabetic and anti-cholinergic activity (Nowicka & Wojdyo 2019), reduction in the symptoms of inflammatory bowel disease (Meurer *et al.*, 2019), protection against oxidative stress in erythrocytes, and even anti-tumour properties. (Nguyen *et al.*, 2019). Fresh or barely processed edible flowers are rich in a range of bioactive compounds, such as phenolic substances, carotenoids, betaines, and alkaloids (Pires *et al.*, 2021). The phytochemicals like phenolic acids, flavonoids, and alkaloids present in the edible flowers provide a number of health benefits because of their antioxidant properties and several bioactivities. These compounds act as cardioprotective, anti-inflammatory, and cancer prevention agents (Kumari and Bhargava 2021; Zheng *et al.*, 2019; Xiong *et al.*, 2014). Polyphenols are also helpful in controlling diabetes, neurodegenerative diseases, and obesity (Petropoulos *et al.*, 2018). Carotenoids are the precursors of vitamin A and protect the eyes against night blindness (Rop *et al.*, 2012). Different edible flowers also provide a good quantity of other vitamins and minerals (Mlcek and Rop 2011). Due to various health benefits, consumption of edible flowers is increasing day by day among health-conscious people (Gostin and Waisundara 2019). The state of West Bengal lies between latitudes 85°50' and 89°52' east and 21°20' and 27°32' north and is situated in eastern India. The state has an area of 88,752 square kilometres, or 2.7% of the country's total land area (Mandal and Chauhan, 2018). Except for the region of the northern Himalayas, a tropical, humid climate prevails throughout the state. On the mainland, the temperature during winter ranges from 7 to 26 °C, and in summer it ranges from 24 to 40 °C (Dey *et al.*, 2017). The average amount of precipitation in the state each year is about 1750 mm, but there is a large variation among the districts. The diverse climatic conditions, from tropical coastal regions to temperate Himalayan regions, favour a wide range of floral diversity in the state and the inhabitants of this state also use a wide range of flowers for different purposes. The poor and marginalised people of West Bengal use different types of edible flowers for making curries, soups, and fried foods because they are freely available in the countryside. The most commonly used edible flowers in this state are agastya (*Sesbania grandiflora*), drumstick (*Moringa oleifera*), lady's finger (*Abelmoschus esculentus*), mustard (*Brassica juncea*), radish (*Raphanus sativus*), sweet gourd (*Cucurbita*

maxima) etc. Neem flowers (*Azadirachta indica*), are used for improving digestive health and have been used in Indian cooking since time immemorial. Neem flowers are roasted, boiled, and fried for use in sauces and rice dishes. The young gular or atti (*Ficus racemosa*), fig (*Ficus cunia*), and banana (*Musa paradisiaca*) flowers are put into practise for various cooking preparations. Recently, the food industry has required healthy supplements in powdered or liquid form, and efforts are being carried out to prepare the powdered form of leaves and flowers of *Sesbania grandiflora* (Agastya) by using blanching and sulfitation treatment to improve its nutritional and phytochemical value. Similarly, the edible flowers of butterfly pea (*Clitoria ternatea* L.) are a rich source of anthocyanins called ternatins, which have free radical scavenging activity. The microwave assisted extraction with aqueous solvent was found to be suitable and showed significantly higher scavenging activity (Netravati *et al.*, 2022). Most of the flowers are not edible because of their bad taste, poisonous in nature and causing allergic reactions. Biodiversity in this state is enormous in terms of climate and living creatures. In this respect, the documentation on edible flowers in West Bengal is very scanty. In this review, a list of common edible flowers

from West Bengal that are used for vegetable, spice, and medicinal purposes has been discussed. The flowers that are toxic or allergic in nature but are used for different edible purposes, directly or indirectly, have also been discussed. A number of flowering plants that are cultivated for ornamental purposes or other uses but whose flowers are edible and scientifically proven to be safe in foreign countries but not in our state are discussed under the section on prospective edible flowers.

Flowers used as Vegetables: The different flowering shoots are consumed in West Bengal, and their selection depends on local availability, tradition, and the socioeconomic structure of the family. The common edible flowers have been listed in Table 1, except for the common cruciferous group, like cauliflower.

Flowers used as Spices. Some edible flowers of certain plants are used as spices for their unique flavour and testing due to the presence of various bioactive compounds. All across the world, chefs utilise them as spices in whole, powdered, or combination form. These flower-type spices are widely used in West Bengal and all parts of India. Details of different edible flowers mainly used as spices in West Bengal are given in Table 2.

Table 1: Common edible flowers used as vegetables in West Bengal.

Scien-tific name	Local or vernacular name	Order and Family	Flower description	Major nutrients present	Benefits in daily diet
<i>Musa paradisiaca/ M. acuminata / Musa balbisiana</i>	Mochar phool	Zingiberales and Musaceae	Creamish-coloured flower covered with dark purple spathes.	Rich source of fibre, minerals (P, Ca, K, Cu, Mg, Fe), Vitamins (A, C, and E), and antioxidants like phenolic acids, tannins, flavonoids, etc. (Shubham <i>et al.</i> , 2019).	Prevents infection, reduces menstrual problems, controls blood sugar level, improves lactation, is anti-ageing and anti-cancerous, and supports bone and prostate health (Shubham <i>et al.</i> , 2019).
<i>Cucurbita maxima</i>	Kumro phool	Cucurbitales and Cucurbitaceae	Large funnel-shaped, vivid orange or yellow.	Good source of fibre, vitamins (C, B3, B9, A), minerals (Cu, Mg, Fe, P), and antioxidants (anthocyanins, carotenoids, flavonoids, phenols, etc.). (Ghosh & Rana 2021).	Helps bone formation, RBC production, and male infertility; enhances immunity, ensures healthy vision. It also has anti-ageing, anti-cancerous, and cardioprotective properties (Muntean <i>et al.</i> , 2013).
<i>Sesbania grandiflora</i>	Bak phool	Fabales and Fabaceae	Big Pure White	Good source of vitamins A, C, folate, thiamin, niacin, minerals (Ca, Mg, P, K, and Se), and antioxidants (flavonoids, carotenoids, and phenols). (Bhokre <i>et al.</i> , 2022).	Detoxify the body, useful in intermittent fever, diarrhoea, dysentery, running nose, abdominal pain, night blindness, and liver problems (Semwal <i>et al.</i> , 2019).
<i>Moringa oleifera</i>	Sajne phool	Brassicales and Moringaceae	Small white	Good source of fibre, vitamins A and C, minerals Ca and Fe., amino acids, and phenolic compounds like ferulic acid and quercetin (Madane <i>et al.</i> , 2019).	Boost the immune system, maintain healthy vision, strengthen bones, reduce inflammation, increase milk production in nursing mothers, and lower cholesterol (Igwilo, 2020).
<i>Brassica nigra, B. campestris,</i>	Sharse phool	Brassicales and Brassicaceae	Small yellow	Rich in vitamins A, C, E, K, and B6, minerals Cu, Ca, K, Mn, and Zn, fibres, antioxidants (flavonoids, phenolic compounds, tannins, carotenoids (zeaxanthin, lutein, and beta-carotene), and alkaloids (Nawaz <i>et al.</i> , 2018).	Good for the eye, heart, boost immunity, and work as antioxidants (Nawaz <i>et al.</i> , 2018).
<i>Colocasia esculenta</i>	Kachu phool	Alismatales and Araceae	Yellow flower with spathes and long stalks.	Good source of fibres, minerals (Zn, Mg, Fe, Ca, and P), vitamins (A, B, C, and E). Also contains a good amount of alkaloids, flavonoids, phenols, saponins, and tannins (Ogukwe, 2017).	Good for the eye, heart, and skin, it cures insomnia, is used as a mild laxative, boosts immunity, and prevents cancer (Mitharwal <i>et al.</i> , 2022).
<i>Typhonium trilobatum</i>	Ghatkol phool	Alismatales and Araceae	Dark purple or blackish red flower with spathes and long stalks.	Rich in fibre, minerals (Fe, K, Ca.), vitamin C, and antioxidants like polyphenols, flavonoids, and tannin (Manna <i>et al.</i> , 2016).	anti-inflammatory, analgesic, anti-bacterial, and anti-diarrheal properties useful in filariasis and stomach ailments (Manna <i>et al.</i> , 2016)
<i>Allium cepa</i>	Piyanj kali	Asparagales and Amaryllidaceae	Small white flower with a long flower stalk.	Good source of dietary fibre, cysteine amino acid, vitamins A, C, and B6, folate, minerals (Na, K, Mn, Mg, and S), and pigments (lutein and zeaxanthin). (Kumar <i>et al.</i> , 2010)	Useful in wound healing, heart diseases, hyperglycemia, gastric and prostate cancer, and liver function (Griffiths <i>et al.</i> , 2002).
<i>Basella alba</i>	Pui mituli	Caryophyllales	White, pink, or	Rich in fibre, vitamins A, C, and B	It has gastro-protective properties, aids

		and Basellaceae	red flowers grow in clusters.	complex., minerals K, Mn, Mg, Cu, Ca, antioxidants β -carotene, lutein, zeaxanthin, and mucilage (Chaurasiya <i>et al.</i> , 2021).	ulcer healing, has anti-inflammatory activity, is anti-cancer, and has mild laxative properties (Chaurasiya <i>et al.</i> , 2021).
<i>Nymphaea alba</i> , <i>N. nouchali</i>	Shaluk phool	Nymphaeales and Nymphaeaceae	large, showy white or red flower with a long stalk.	Good source of minerals (Na, K, Ca, Mg), antioxidants, phenols, and flavonoids. tannin and saponin, quercetin, isokaempferide, kaempferol, apigenin, etc. (Agnihotri <i>et al.</i> , 2020).	Used as a cardiogenic, natural aphrodisiac, sleep aid, and anxiety reliever. It also has anti-inflammatory, anti-carcinogenic, anti-allergic, hepatoprotective, and anti-bacterial properties (Agnihotri <i>et al.</i> , 2020).
<i>Madhuca longifolia</i>	Mahua phool	Ericales and Sapotaceae	cream-colored flower develops as a bunch.	Good source of fibre, minerals (P, K), fibre, vitamins-A, C, and antioxidants like carotene (Sinha <i>et al.</i> , 2017)	Used as a sweetener, tonic, analgesic, and diuretic. Good for the heart, skin, and eye, helps to cure impotency, piles, and chronic bronchitis, and also has laxative and anti-helminthic properties. (Sinha <i>et al.</i> , 2017).
<i>Marsdenia volubilis</i>	Jukti phool	Gentianales and Apocynaceae	A small green or yellowish green flower grows in a bunch.	Good source of minerals (Ca, Mg, Fe, etc.), steroids, glycosides, alkaloids, flavonoids, tannins, and phenolics (Das <i>et al.</i> , 2019).	Good for the liver and skin; prevents pox, jaundice, and diabetes. Useful to treat piles, inflammation, asthma, leukoderma, and tumours (Das <i>et al.</i> , 2019).

Table 2: Common edible flowers used as spices in West Bengal.

Scientific name	Local or vernacular name	Order and Family	Flower description	Major ingredients present	Use and benefits.
<i>Syzygium aromaticum</i>	Labanga	Myrtales and Myrtaceae	Dried, unopened, nail-shaped flower buds.	Eugenol, eugenol acetate, gallic acid and β -cariofileno, α -humulene etc and polyphenol compounds, tannin, flavonoids, Vitamin K, and minerals like Mn (Cortés-Rojas, 2014),	Commonly used for flavouring biryanis, various rich and spicy dishes, pickles, salads, and as an ingredient in garam masala (Hemanta <i>et al.</i> , 2021). Use as a food preservative, reduce oxidant activities, kill bacteria and fungus, and have anti-diabetic, anti-inflammatory, and anti-cancerous properties (El-Maati <i>et al.</i> , 2016).
<i>Crocus sativus</i>	Kesar	Asparagales and Iridaceae	Golden-coloured flower with pungent stigmas	Rich in dietary fibre, vitamins (like C and B ₆), various minerals (Na, K, Fe, Mg, P, and Ca) and antioxidants (like crocin, crocetin, safranal, and kaempferol) (Srivastava <i>et al.</i> , 2010).	The world's most expensive spice is added to various food items for colouring, flavouring, and taste because of its colouring power, unique aroma, and bitter taste (Hemanta <i>et al.</i> , 2021). Useful in depression, anxiety, Alzheimer disease, and uterine disorders (Moshiri <i>et al.</i> , 2015).
<i>Pandanus odorifer</i>	Kewra	Pandanales and Pandanaceae	Flowers are fragrant. Male flowers are small, gathered in large clusters, and ebracteate. Female flowers are like pineapples.	Good source of Ca, P, and Fe minerals, vitamin C, thiamin, and antioxidants like beta-carotene, glycosides, tannins, iso-flavones, and essential oils, mainly 2-phenyl ethyl methyl ether and terpinen-4-ol (Adkar and Bhaskar 2014).	Used mainly for flavouring various rice preparations, desserts, and sweets (Hemanta <i>et al.</i> , 2021). Good for the heart and skin. Used for headaches, earaches, antispasmodics, and aphrodisiacs (Adkar and Bhaskar 2014).
<i>Capparis spinosa</i>	Capers	Brassicales and Capparaceae	Big spherical and round angled large white to pinkish white flower.	Contains a high amount of Na and some Cu, vitamin K, and antioxidants like quercetin and rutin (Zhang and Ma 2018).	They have a very pungent taste and are used as condiments in sauces, salads, and pickles (Hemanta <i>et al.</i> , 2021). They are also used in cosmetics and medicines of anti-diabetic, anti-inflammatory, and anti-cancerous properties Zhang and Ma (2018).
<i>Rosa indica</i>	Golap	Rosales and Rosaceae	Large, showy flower with fragrance and many colours.	Source of fibre, vitamins C, B, and K, carotene, calcium, magnesium, and copper. It also contains many essential oils, mainly nerol, citronellol, and geraniol (Pathak <i>et al.</i> , 2019).	Rose water, a diluted form of rose essence, is used to flavour desserts, biryanis, and yoghurt drinks (lassi) (Hemanta <i>et al.</i> , 2021). Also used in the preparation of famous pan masalas like gulkand, punkhuri, and rose petal tea (Kumari and Choudhury 2021). Beneficial for hyperacidity, constipation, abdominal pains, anti-bacterial, anti-fungal, and anti-oxidant properties, and beneficial for skin, pain, menstrual discomfort, and anxiety (Chahar, 2016).

FLOWERS USED FOR MEDICINAL PURPOSES

The literature of research indicates that flowers and other plant parts contain multiple bioactive compounds that have medicinal qualities and act as anti-microbial, anti-oxidant, anti-cancer, anti-diabetic, anti-inflammatory, and hepatoprotective agents. These characteristics have been employed for generations by rural and ethnic cultures to treat common illnesses (Xiao, 2016). Most of the information on medicinal flowers used in ancient India is available in Pushpa

Ayurveda and Flower Power. The use of flowers as medicine to heal various diseases was first mentioned in the 9th-century text Kalyana Karakam. In the Ayurveda and Siddha systems of ancient Indian medicine, flowers are primarily employed for therapeutic purposes in a variety of formulations, including powder, syrup, arka (distilled extract), juice, perfumes, soups, etc. (Venkatesan *et al.*, 2022). Recently, various flower components like whole flowers, inflorescences, petals, stigmas, and style tops have been used in different preparations in modern medicine (Subhashree *et al.*,

2015). In Table 3, we present detailed information on different medicinal flowers used to treat various

diseases in the state of West Bengal and throughout India.

Table 3: Common flowers used as medicine in West Bengal.

Scientific name	Local or vernacular name	Order/ Family	Flower description	Medicinal ingredients	Names of the diseases used to treat
<i>Abutilon indicum</i>	Potari /Jhumko	Malvales/ Malvaceae	small, yellow, and solitary.	Luteolin, chrysoeriol, apigenin, quercetin, and lactones (Sharma <i>et al.</i> , 2013)	piles, ulcers, cough, skin diseases, leucorrhoea, jaundice, nervous disorders, etc. (Rajeshwari and Sevarkodyone, 2019)
<i>Adhatoda vasica</i>	Basak	Lamiales /Acanthaceae	Large in size, white in colour, with a red or yellow spot.	Vascinine, luteolin, quercetin, kaempferol, alpha-amyrin, and alpha-sitosterol (Hossain and Hoq, 2016).	Mainly used to treat cough, cold, and asthma, fever, bronchodilator activity, wound healing, ulcer treatment, and, moreover, cholagogue, antibacterial activity (Gangwar and Ghosh, 2014).
<i>Cassia alata</i> .	Daad mordon	Fabales/ Fabaceae	Large and yellow.	Tannin, anthraquinones, glycosides, and volatile oil (Adedayo <i>et al.</i> , 2001)	Used for treating various kinds of skin problems, including bronchitis. Flower extracts are also used as purgatives and laxatives (Shubhashree <i>et al.</i> , 2015).
<i>Crocus sativus</i>	Kesar	Asparagales/ Iridaceae	Golden-coloured with pungent stigmas and yellow anthers.	Crocine, crocetin, safranul, isophorene, glucoside, picrocrocine, carotene, lycopene, and zeaxanthin (Khazdair <i>et al.</i> , 2015).	Anti-depressant, treating sexual dysfunction, antioxidant, anticarcinogenic, antispasmodic, and digestive tonic, effect on cholesterol levels, effect on blood glucose, and insulin resistance; in the cosmetic industry as an anti-UV agent, to treat redness of dark spots, skin diseases, anti-ageing effect, perfumery, etc. (Mzabri <i>et al.</i> , 2019).
<i>Datura metel</i>	Dhutro	Solanales / Solanaceae	Large, purplish outside and white inside, funnel shaped.	Yangjinhualine A and five known megastigmane sesquiterpenes (Kuang <i>et al.</i> , 2008), hyoscyamine, scopolamine, atropine, meteoiodine, norhyoscyamine, and hyoscyamine (Alam <i>et al.</i> , 2021).	stimulation of the central nervous system, decongestion, treatment for dental and skin infections, anti-inflammatory properties, respiratory problems, alopecia, analgesics, anti-asthmatics, etc. (Das <i>et al.</i> , 2012)
<i>Hibiscus rosa-sinensis</i>	Jaba	Malvales/ Malvaceae	Large flower with red, yellow or white in colour.	Phenols, alkaloids, terpenoids, tannins, quinines, flavonoids, anthraquinones, cardiac glycosides, saponins, mucilage, different essential oils, and steroids (Al-Snafi, 2018).	Antimicrobial, antiparasitic, antioxidant, antipyretic, analgesic, antidiabetic, fibrinolytic, antidepressant, treatment against reproductive problems, immuno-modulatory, hypolipidemic, anticonvulsant, memory enhancement, anti-inflammatory, cytotoxic, dermatological, anti-hemolytic, against urinary problems, neuroprotective hepatoprotective, antitussive, and other effects (Al-Snafi, 2018)
<i>Madhuca longifolia</i>	Mahua	Ericales/ Sapotaceae	Flowers are pale yellow in colour and fleshy, appearing in dense clusters	Alkaloids, tannins, flavonoids, volatile oils, and high amounts of reducing sugar (Yoshikawa <i>et al.</i> , 2000).	Used to treat skin diseases, cough and cold, fever, gout, polyurea, sexual debility, headache, diarrhoea, and eye diseases (Shubhashree <i>et al.</i> , 2015).
<i>Nelumbo nucifera</i>	Padma	Proteales/ Nelumbonaceae	Large solitary flower with white or pink colour.	Seven glycosides, including kaempferol and isorhamnetin glycosides, and some non-flavonoid compounds, including adenine, myo-inositol, arbutin, and -sitosterol glucopyranoside, have also been identified in stamen extract. (Mukherjee <i>et al.</i> , 2009).	Flowers: to treat cholera, diarrhea, fever, hepatopathy, hyperdipsia, and many bleeding disorders. treatment of premature ejaculation, abdominal cramps, and bloody discharges, and as a cardiac tonic. Flower stalks: one of the ingredients of 'Madhucaava', treatment of excessive menstruation bleeding, post-partum hemorrhage, and gastric ulcers (Mukherjee <i>et al.</i> , 2009)
<i>Saraca asoca</i>	Asoke	Fabales/ Fabaceae	Very fragrant, orange or orange-yellow small flowers appear in dense clustures.	Pelargonidin-3, D-glucoside, 5-digluconide, apigenin-7-o-p, cyanidin-3, 5-digluconide, linolenic, leucocyanidin, palmitic, stearic, and gallic acid (Bhalerao <i>et al.</i> , 2014)	Antimicrobial, antidiabetic, anthelmintic, anti-menorrhagia, CNS depressant, analgesic, uterine tonic, anti-ulcer, anti-cancer, anti-inflammatory, anti-oxytocin, larvicidal, activity (Bhalerao <i>et al.</i> , 2014).
<i>Rosa centifolia</i>	Golap	Rosales/ Rosaceae	Usually pink with many imbricate petals.	Tannin, Vitamins A, B, and C, pigments (like lycopene, rubixanthin, zeaxanthin, xanthophylls, quercitrin, taraxanthin, quercetin, myricetin, polyphenols, gallic acid, rutin, and kaempferol essential oil), flavonoids, and pectin (Kumar <i>et al.</i> , 2008).	Used to treat leucorrhoea, cough, bronchitis, asthma, fever, inflammations, ulcers, wounds, flatulence, dyspepsia, bloody stools, constipation, piles, skin diseases, cardiac disability, and weakness. Also used as a diuretic for pregnant ladies, flower oil is used to treat skin problems, ear pain, etc. (Jitendra <i>et al.</i> , 2012).
<i>Jasminum sambac</i>	Beli	Lamiales/ Oleaceae	Fragrant medium sized white lowers.	Phenolic terpenes, terpenes, ascorbic acid, coumarins, glycosides, flavonoids, saponins, proteins, resin, steroids, essential oils, and triterpenes, sesquiterpenes, indole, cis-3-hexenyl benzoate, cis-caryophyllene, methyl anthranilate, salicylic acid linalool. (Khan <i>et al.</i> , 2021)	Used to treat uterine disorders, infective diseases, suppress puerperal lactation, and prevent and treat breast cancer (Mourya <i>et al.</i> , 2017). Also used to treat nervous system diseases, eye diseases, skin diseases, poisoning, wounds, and vomiting in hypertension. (Khan <i>et al.</i> , 2021)
<i>Tamarin-dus indica</i>	Tentul	Fabales/ Fabaceae	Small in size, yellowish in colour	Riboflavin, thiamine, niacin, and ascorbic acid; hordenine; alpha-	Used as antiseptics, vermifuges, and treatments for conjunctivitis, dysentery,

			with pink streaks, inflorescence, short racemes,	carotene, and the presence of polyphenols such as β -sitosterol, n-Octacosyl (E)-ferulate; hexacosane; eicosanoic acid, pinitol, and phenolic antioxidants for proanthocyanidins, 21-oxobehenic acid (Menezes <i>et al.</i> , 2016)	erysipelas, jaundice, hemorrhoids, and other ailments. Also used to treat hyperacidity, pain, leucorrhoea, edema, conjunctivitis, ulcers, anemia, and bleeding piles (Shubhashree <i>et al.</i> , 2015).
<i>Mesua nagassar-iium</i>	Nagkeshar/ Nageswar	Malpighiales/Calo phyllaceae	Fragrant white with numerous golden yellow stamens.	Mesulol, mesuone, stearo diolein, palmito-diolein, linoleodiolein, palmitosrearo-olein, dipalmito-olein, and triolein (Shubhashree <i>et al.</i> , 2015).	Treatment for bleeding disorders like menorrhagia, piles, metrorrhagia, epistaxis, snakebite, and scorpion sting. Flower is also used as an anti-inflammatory, stomachic, expectorant, and astringent agent (Thakur <i>et al.</i> , 2021).
<i>Nymphaea alba</i>	Sapla	Nymphaeales/ Nymphaeaceae	Large solitary white or pink.	Rhamnoside, rhamnopyranoside, galactopyranoside, and xylopyranoside, in blue flowered <i>Nymphaea caerulea</i> species, glucopyranoside attached with quercetin was reported from the flowers (Fossen and Andersen 1997).	Antidiabetic, hepatoprotective, antioxidant, antiulcerogenic, and uterotonic activity (Selvakumari <i>et al.</i> , 2016)
<i>Hibiscus mutabilis</i>	Sthal padma	Malvales/ Malvaceae	Large white or pink.	Quercetin, quercemertirine, isoquercetin, meratrim, kaempferol, hyperin, and anthocyanins (Salem <i>et al.</i> , 2014).	Used to treat respiratory disorders, poisoning, leucorrhoea, menorrhagia, dysuria, urinary calculi, nasopharyngeal carcinoma, abdominal problems, polyurea, sterility, and sexual problems (Salem <i>et al.</i> , 2014).

TOXICITY OF EDIBLE FLOWERS

In the previous section of this review, the important ingredients that are helpful to human health in common edible flowers were discussed, but very few reports documented the toxicological and allergic responses of those flowers. This is very important to identify the toxic constituents and allergens before recommending their consumption. People who are suffering from diseases like asthma, hay fever, and allergies should be cautious before consuming it because it may also cause death. The use of flowers for garnish or for direct ingestion that are picked up from nurseries, flower shops, or fields is generally discouraged by food technologists since there is a potential that they may contain pesticide, herbicide, or fungicide residues, which are hazardous to humans (Kumar *et al.*, 2018). The flowers like calendula, begonia, daylilies, honeysuckle, and hibiscus have ornamental value and are used to garnish the plates for attraction, flavour, and sweet aroma; and the flowers of banana, mustard, drum stick, and sweet gourd, which are collected from agricultural fields and used in fry or curry preparation; both types of edible flowers may have bacterial and fungal contamination or agrochemical poisoning. Moreover, a few edible flowers like *Connavalaria majalis*, *Anemone ranunculoides*, etc. have some poisonous chemical constituents that may cause allergic reactions (Ebert, 2013). The toxic constituents, produced by the different flowers to protect themselves from insect damage, may cause serious health impairment to humans if they are consumed (Matyjaszczyka and Smiechowski 2019; Kristanc and Kreft, 2016; Pinela *et al.*, 2017; Egebjerg *et al.*, 2018), though the quantity of the toxic component and frequency of consumption affect health hazards. The flowers of *Colchicum autumnale*, *Datura stramonium*, and *Nerium oleander* contain phytotoxic compounds that can be very poisonous and may cause serious health problems even if consumed in very small quantities (Klitschar *et al.*, 1999; Korkmaz *et al.*, 2019; Farkhondeh *et al.*, 2020). The flower nectar contains

mainly sugar and a very small amount of amino acids, minerals, lipids, antioxidants, and, in some cases, a few toxic constituents that are harmful for bees and even human beings. The floral nectar of *Andromeda*, *Azalea*, *Agauria*, *Euphorbia*, *Kalmia*, *Paullina*, and *Rhododendron* are a few common genera of plants that contain phytotoxic constituents that make them inedible for bees and human beings (Adler, 2001).

The safety issues of edible flowers were recognised and registered by the European Union Rapid Alert System for Food and Feed (RASFF), and they pointed out that the presence of Salmonella bacteria and chemicals such as diethyl-meta-toluamide (an insect repellent), dimethoate (an insecticide), and sulfites are the main problems for consumption of edible flowers like *Connavalaria majalis* and *Anemone ranunculoides* (Matyjaszczyka and Smiechowski 2019). The toxicity study based on cell and mouse models was beautifully reviewed by Zheng *et al.* (2021), and they showed the safe dose of extracts in both models was at $\mu\text{g/mL}$. By using MTT cell viability assays, the cytotoxic activity of the essential oil of *Calendula officinalis* in rats revealed its safety for tropical use (Mishra *et al.*, 2018); in another report, the extract from flowers of *Lagerstroemia speciosa* did not disturb cell line multiplication or survivability; and the flower extract of *Osmanthus fragrans*, rich in phenylethanoid glycosides, did not show any significant clinical, biochemical, haematological, or histopathological variation after 90 days of administration in mice (Lu *et al.*, 2016). Wongwattanasathien *et al.* (2010) conducted a study to assess the toxicity of popular edible flowers in Thailand based on the Ames mutagenicity test and animal toxicity tests (acute, subacute, chronic, and sub-chronic) and inferred that they can be safely used for consumption and production of food products. But other studies showed that roselle flower was hazardous for consumption (Akindahunsi and Olaleye 2003) because the prolonged exposure of their extract on Wistar rats caused liver and hepatic system damage. The treated mouse showed chronic hepatitis like

symptoms, and even these triggered muscular dystrophy (Fakeye, 2009). Testicular toxicity, i.e., impairment of reproductive organ development, was also recorded in male rats when their pregnant and lactating mothers were exposed to the extract of roselle flowers. Additionally, it has been claimed that roselle extract can interfere with crucial medications like hydrochlorothiazide (Ndu *et al.*, 2011) and acetaminophen (Kolawole and Maduenyi 2004).

PROSPECTIVE EDIBLE FLOWERS IN WEST BENGAL

In order to guarantee the accessibility and availability of nourishing food to West Bengal's poor population, particularly in the area's underdeveloped areas, it is crucial to diversify current dietary sources by including plant-based nutrients. It has already been discussed that edible flowers are good options for an inexpensive alternative dietary nutrient source and sensory contribution to foodstuffs. The edible flowers also possess several bioactive compounds with therapeutic potential and add functional foods and nutritional supplements. These compounds prevent a good number of chronic, harmful diseases, ailments, and lifestyle-related chronic non-communicable diseases. Chitrakar *et al.*, (2019) reported that edible flowers are found in 100 genera and 180 species in 97 angiospermic families. In West Bengal, some of the flowers are grown for their ornamental values, the production of seeds, or fibre production, but their flowers are not used for edible purposes. In this section, a few edible flowers that are popular in different countries and can safely be consumed to diversify contemporary dietary sources have been discussed.

1. *Calendula officinalis*: Calendula is an easy growing annual plant in West Bengal. Though slightly bitter in taste, the flower petals are mainly used for their vibrant colour. They are popularly used in salads and preparations of butter, cake, soups, rice, stews, chicken, and tea. The important components of calendula flower are carotenoids, mainly beta-carotene, and a variety of phenolic acids, including quercetin, rutin, caffeic and ferulic acids, p-coumaric which are important flavonoids (Escher *et al.*, 2020). In conventional treatment, the petals are treated against eczema, psoriasis, greasy skin, colitis, stomach troubles, fevers, and infections. It is also used to regulate the menstruation cycle, stimulate the immune system, and prevent inflammation of any organ (Jauron and Naeve 2013).

2. *Hibiscus rosa-sinensis*: This is commonly known as 'Jaba' in West Bengal and is cultivated in every household for offering to the deities. The flowers or leaves of this plant are mainly used as tea or salad throughout the Pacific Islands. A lot of research revealed the various chemical constituents of Hibiscus flowers, which are rich sources of vitamins like riboflavin, niacin, thiamine, ascorbic acid, different flavonoids, and cyanidin diglucoside. The various antioxidants and anticancerous compounds, like quercetin, glycosides, malvalic, gentisic-, lauric-, and margaric acids, are present in their floral extract

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(Makita *et al.*,1996; Block *et al.*, 1992; Weisburger, 1991; Hennekens *et al.*,1984). In a research study, Yashaswini *et al.* (2011) found that on a dry weight basis, 100 gram (g) of Hibiscus flowers contain 353 calories, 3.9 gm of protein, 3.9 gm of fat, 86.3 gm of carbohydrate, 15.7 gm of fibre, minerals like 39 mg of calcium, 265 mg of phosphorus, 1.7 mg iron, and different vitamins such as 5.9 mg of niacin, 3.9 mg ascorbic acid, 0.49 mg riboflavin (B2), 0.29 mg thiamine (B1) and 5.9 mg ash. In India, the flowers and leaves of this plant are used for emmenagogues, antifertility, contraceptives, menorrhagia, diuretics, bronchitis, cough, and menorrhagia (Jadhav *et al.*, 2009).

3. *Tropaeolum majus*: This plant is commonly known as Nasturtium, watercress, or yellowcress. Though it originated in South America, it can be easily grown throughout the world because of its high adaptability to any climatic condition. In India, the consumable part of this plant is mainly the flowers, which are yellowish, orangish, or reddish in colour and have a little bit of a spicy flavour. They are used in the preparation of juices, omelets, sautéed vegetables, purees, salads, and garnishing dishes (Matyjaszczyk & Śmiechowska, 2019). The major bioactive compounds of this flower are lutein, chlorogenic acid, vitamin C, pelargonidin, and different macro- and micronutrients, mainly magnesium, potassium, iron, copper, and zinc (Fernandes *et al.*, 2017). The carotenoid substance lutein, found in marigold, calendula and nasturtium etc. reduces progressive macular degeneration with age (Yang *et al.*, 2020). The market for carotenoids is expanding quickly, and by 2027, it is anticipated to reach

\$1.84 billion.
(<https://www.fortunebusinessinsights.com/industry-reports/carotenoids-market-100180>). Lutein is primarily produced from marigold (*Tagetes* sp.) flowers for commercial purposes; however, *Tropaeolum majus* may also be a viable source of this carotenoid.

4. *Cosmos sulphurous*: In west Bengal, cosmos is one of the best summer flowers and has a yellow or orange-coloured flower with a spicy flavour. The flowers are mainly used in gourmet food for garnishing and as decorative ingredients in salads. de Morais *et al.*, (2020) reported recently that the cosmos flower has a variety of phenols with a significant concentration of rutin, kaempferol, procyanidin B2, hesperidin, and trans-resveratrol. These compounds have long been used for their antigenotoxic, anti-inflammatory, and antioxidant properties (Jaberi *et al.*, 2018).

5. *Clitoria ternatea*: Clitoria is commonly known in Bengali as Aparajita, which means 'one who cannot be destroyed or defeated,' and was originally used as a medicinal plant to treat depression, anxiety, and convulsions. Both antipyretic and anti-inflammatory effects are found in the flowers. The vibrant blue colour of flowers contributes the natural dye from blue to lilac and mixes in foods that are used by water, such as tea, drinks, rice, pasta, eggs, etc. Additionally, grilled fish and poultry are served with the flowers (Muhammad Ezzudin & Rabeta 2018). Important phenolic compounds like myricetin, naringenin, cis-resveratrol,

catechin, petunidin, and malvidin are the major components of clitoria flowers (de Morais *et al.*, 2020).

6. *Tagetes patula*: Marigold is popularly known as 'genda' in West Bengal. The florets are spread on flavoured foods and refreshing drinks, several phenolic acids, terpenoids, alkaloids, flavonoids, and carotenoids are abundant in them (Chitrakar *et al.*, 2019). In conventional rural treatment, the floral parts are used as laxatives, antimicrobials, analgesics, antispasmodics, anti-inflammatory agents, and antioxidants (Chitrakar *et al.*, 2019).

7. *Helianthus annuus*: 'Surjomukhi' is the common name of the sunflower in Bengal. Sunflowers are cultivated throughout Bengal for their seeds, which are again used for the extraction of non-volatile sunflower oil for use as a frying oil during food preparation and in different types of cosmetic formulations as an emollient. In many countries, the flower buds and ray florets are eaten as salad because they are very rich in proteins, vitamins (Matyjaszczyk & Śmiechowska 2019) and other phytochemical compounds such as saponins, flavonoids, alkaloids, phytosterols, and tannins (El Marsni *et al.*, 2015), which have proven to be biologically active. The improvement of the cardiovascular system, the metabolism of cholesterol, the regulation of hormones, and the improvement of the digestive system are the important health improvement keys operated through the consumption of sunflowers (de Lima Franzen *et al.*, 2019).

8. *Hibiscus sabdariffa*: The Bengali name of roselle is 'mestapat or chukar,' and they are mainly cultivated in drought-prone regions of West Bengal for their stem-extracted bast fibre as substitutes for jute. The edible nature of the flower is not popular in West Bengal, but the fleshy red calyces of roselle are used in many dishes and refined foods throughout Asia and Africa. In some of the villages of West Bengal, it is reported that the calyces of roselle are consumed after the preparation of 'chutney'. In the advanced countries of the USA and Europe, jam, wine, healthy juice, syrup, ice cream, pudding, cakes, pickles, and herbal tea prepared from the fleshy red calyces of roselle are very popular. These red calyces of roselle contain different phenolics, flavonoids, and anthocyanins (Peredo Pozos *et al.*, 2020; Riaz and Chopra 2018) that have anti-hyperglycemic and antioxidant properties. In addition, roselle contains different vitamins like vitamin C, riboflavin, niacin, carotene, and minerals like iron, calcium. The diuretic, antiseptic, and antimutagenic properties of roselle flowers and calyces have been reported by several authors (Carvajal-Zarrabal *et al.*, 2012). The flower of roselle contains different antioxidant compounds that have been used as anti-diabetic, antihypertensive, anti-inflammatory, and antimicrobial properties as reported by Izquierdo-Vega *et al.* (2020); while the prolonged exposure of roselle extract caused hepatic system damage in wistar rats (Akindahunsi and Olaleye 2003). Therefore, further research is needed to conclude the medicinal properties of this plant.

CONCLUSIONS

In nature, flowers are wonderful creatures for their beauty and are a major organ for sexual reproduction. Flowers are an integral part of many people's livelihoods, particularly those involved in commercial floriculture and nursery businesses. Since ancient times, many flowers have been grown for their edible qualities and used as vegetables to provide nutrients such as carbohydrate, fat, protein, minerals, and vitamins. Some of the edible flowers are consumed as spices for their beautiful flavour and taste and used in medicines for their active constituents, which protect humans from several dreaded diseases. The flowers are now used to prepare different health drinks and garnish food plates to attract people's palates. Now a days, people are searching for alternate foods and some of the edible flowers that are grown in our surroundings but are not known for their edible nature in West Bengal, whereas they have been famous for consumption purposes in different countries for a long time, so they may be comfortably and securely adopted for consumption purposes without any hazardous side effects. On the other hand, there are some flowers that are consumed in different forms in our country, but people are unaware of the presence of toxic and allergic components in them. Therefore, scientific awareness is required before choosing any flower for consumption purposes.

FUTURE SCOPE

The edible flowers in any form have some good potential in the food processing, pharmaceutical, and cosmetic industries in West Bengal.

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