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Application of edible ornamental flowers and their effects in functional dairy products: A review

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Abstract

Ornamental flowers provide a variety of functions including culinary flavorings, preservatives and medicinal compounds. Several ornamental flowers were studied for their medicinal characteristics such as anti-oxidative, anti-hypertensive, anti-inflammatory, anti-diabetic and anti-bacterial properties. Some of the major ornamental flowers addressed in this article are roses, hibiscus, carnations and marigolds. Fortification of dairy meals with attractive flowers may aid in the development of functional dairy products with nutritional and therapeutic value. Ornamental flowers are also utilized to improve the aesthetic and appeal of fortified meals for customers as well as to increase sales of these flowers. The most recent developments in the dairy business involving the addition of several ornamental flowers in various forms (i.e. powder, extract, essential oil) to dairy foods have been examined in this study. The impact of these flowers on the quality of dairy products like yogurt, cheese, fermented milk, ice cream and shrikhand have also been presented.

Keywords: Ornamental flower, functional dairy product, fortification, antioxidant, nutraceutical

1. Introduction

Ornamental Plants are the garden plant that has beauty as its main trait. It is primarily developed for its visual appeal, whether for screening, accent, specimen, color, or aesthetic purposes. Ornamental flowers are grown not just for their aesthetic qualities but also for their nutritional and therapeutic characteristics. Many flower crops including hibiscus, marigolds, roses, night jasmine and dandelions are high in minerals and vitamins and are used as edible flowers. Some flowers such as jasmine, lavender and rose are utilized to extract essential oils. They have soothing and healing properties and are used in aromatherapy (Yashaswini *et al.*, 2011) [67].

Edible flowers are described as innocuous and nontoxic flowers that provide health advantages when consumed as part of a human diet (Alasalvar *et al.*, 2013) [1]. Edible flowers retain vitamins, proteins, essential oils and antioxidants when taken in their natural or minimally processed form (Fernandes *et al.*, 2019) [15]. Following this trend, edible flowers have recently been associated with several biological properties such as ulcerative colitis improvement, anti-hyperglycemic and anti-cholinergic activity, protection against oxidative effects in erythrocytes and even anti-cancer activity (Meurer *et al.*, 2019; Nowicka and Wojdyo, 2019; Yang *et al.*, 2019) [34, 42, 68]. Edible flowers contain a variety of bioactive chemicals including flavonoids, alkaloids, terpenoids, phytosterols, phenolics, tannins, glycosides and saponins. Nowadays, dairy products are a unique carrier that has been effectively exploited to deliver phytochemicals and other nutrients for health benefits in our nutrition food system (El-Sayed *et al.*, 2015) [13]. As a result, the dairy industry should discover innovative methods to improve the functionality of traditional dairy products which might provide significant value and potential effect for customers. The purpose of this paper is to provide an overview of the published data on some of the ornamental edible flowers used for protective, flavor and aromatic purposes in dairy products as well as to discuss the potential modes of action that could be considered suitable for application.

2. Functional roles of edible ornamental flowers

The flavor, color, aroma and enhancing properties of ornamental flowers have been used in food preparation and preservation. An increasing number of studies have examined the role of ornamental flowers as natural preservatives and medicines. Ornamental plants have antimicrobial and antibacterial properties that can be effectively used to prevent spoilage and pathogenic bacteria from growing in dairy products. As shown in table-1

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Table 1: Antimicrobial and antibacterial properties of some edible Ornamental flowers

Ornamental flower	Microorganism	References
Hibiscus	<i>S. typhimurium</i> and <i>S. aureus</i> .	(Mak <i>et al.</i> , 2013) [39]
Carnation	<i>Bordetella bronchiseptica</i> , <i>Staphylococcus epidermidis</i> , and <i>Klebsiella pneumonia</i> .	(Chandra <i>et al.</i> , 2016) [8]
Rose	<i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>B. subtilis</i> , <i>Staph. aureus</i> , <i>Chromobacterium violaceum</i> , <i>Erwinia carotovora</i> , <i>Xanthomonas axonopodis</i> spp., <i>Staphylococcus epidermidis</i> , <i>S. aureus</i> , <i>M. luteus</i> , <i>Klebsiella pneumonia</i> , <i>Proteus mirabilis</i> .	(Labban and Thallaj, 2020; Nowak <i>et al.</i> , 2014) [32, 43]
Marigold	<i>Alcaligenes faecalis</i> , <i>Bacillus cereus</i> , <i>Campylobacter coli</i> , <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Pseudomonas aeruginosa</i> , <i>Proteus vulgaris</i> , <i>Streptococcus mutans</i> and <i>Streptococcus pyogenes</i> .	(Gopi <i>et al.</i> , 2012) [19]
Pot Marigold	<i>Staphylococcus aureus</i> and <i>Bacillus subtilis</i> , <i>Pseudomonas aeruginosa</i> and <i>Escherichia coli</i> .	(Jan <i>et al.</i> , 2017) [24]
Chamomile	<i>Staphylococcus aureus</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus epidermidis</i> , <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Klebsiella pneumonia</i> .	(Srivastava and Gupta, 2015) [59]
Blue pea	<i>Escherichia coli</i> , <i>cholera</i> , <i>Staphylococcus aureus</i> , <i>Salmonella typhi</i> , <i>Shigella dysenteriae</i> , <i>Klebsiella pneumoniae</i> <i>Pseudomonas aeruginosa</i> .	(Mhaskar <i>et al.</i> , 2010; Shahid <i>et al.</i> , 2009; Neha and Rekha, 2010; Lijon <i>et al.</i> , 2017) [40, 62, 44, 33]

The following are some examples of important Ornamental flowers that have medicinal or functional characteristics in dairy foods:

2.1. Rose (*Rosa species*), Family: Rosaceae

Rose is a woody perennial plant of the Rosaceae family that belongs to the genus *Rosa*. It is well known for its sweet smell and beauty and it is commonly used as an ornamental in both residential and public gardens (Das *et al.*, 2015) [11]. The majority of species are used in cooking and medicine. Some of the vital components of a rose plant include petals, stems, leaves and roots which are also known to possess medicinal properties (Voon *et al.*, 2012) [66]. They contain a variety of secondary metabolites as well as nutrients in the form of vitamins and minerals. The bioactive compounds present in rose include phenolics, polyphenols, flavonoid and anthocyanins (Kumari *et al.*, 2018) [25]. Rose plant extract has antidepressant, antibacterial, antifungal, antiseptic, anti-inflammatory, digestive stimulant, kidney tonic and menstrual regulator properties (Sivaraj *et al.*, 2019) [61]. In food manufacturing industry, roses are used for the development of tea, jam etc. and thus act as a natural source of vitamin C and can be used to cure cold, flu and other related disorder (Maitra *et al.*, 2017) [35]. Rose petal extract has been shown to have antibacterial activity against a variety of pathogenic bacteria as well as antimicrobial activity against *E.coli*, *S.pneumoniae* and *P.aeruginosa* cultures (Hirulkar and Agrawal, 2010) [20]. Rose oil is an essential oil extracted from the petals of *Rosa* species particularly *Rosa damascena* and *Rosa centifolia*. When used in vapour treatment, it helps to reduce allergic responses, headaches and migraines (Labban and Thallaj, 2020) [32].

2.2. Hibiscus (*Hibiscus rosa-sinensis*), Family: Malvaceae

Hibiscus is a perennial shrub that is widely cultivated as an ornamental plant in tropical and subtropical regions including China, Thailand, Sudan, Nigeria and Mexico. It found in several forms with varying colours of flowers (Jadhav *et al.*, 2009) [23]. The majority of hibiscus species are grown for their ornamental value though several are known to have therapeutic benefits. Hibiscus flowers and leaves have a high nutritional value and are used in cooking (Singh *et al.*, 2017) [53]. Photochemicals such as tannin, phlobatannins, cardiac glycosides, flavonoids, terpenoids and saponins are found in the plant's leaves, stem and root (Patel *et al.*, 2012) [46]. Several research studies have shown that the various parts of

the *Hibiscus rosa-sinensis* plant such as its leaves, barks, roots and flowers have anti-oxidant, anti-microbial, anti-diabetic, anti-ulcer, hepatoprotective, anti-fertility, anti-genotoxic and anti-inflammatory properties which help in the treatment of a number of diseases (Khristi and Patel, 2016) [26]. Hibiscus roots and leaves are used to regulate menstruation and promote blood circulation. The leaves were also used as abortifacient and to induce placental expulsion after childbirth (Jadhav *et al.*, 2009) [23]. In the food industry, it is used as a flavoring agent in alcoholic beverages and in the manufacturing of tea (Pieracci *et al.*, 2021) [47].

2.3. Lavender (*Lavandula angustifolia*), Family: Lamiaceae

Lavenders are low-growing, bushy evergreen shrubs native to northern Africa and the Mediterranean Mountains and belong to the lamiaceae family (Prusinowska and Smigielski, 2014) [48]. Lavender flowers, buds and leaves of lavender are edible and used to flavor broths and jellies (Groot *et al.*, 2016) [10]. It contains a variety of phytochemicals such as terpenoid, ketones, phenol, aldehyde, triterpenoids, polyphenol and betulin (Radu *et al.*, 2020) [51]. Lavender essential oil is well-known for its anti-bacterial, anti-depressive and anti-microbial properties (Silva *et al.*, 2015) [57]. It may also be useful in treatment of anxiety, sleeplessness, depression and restlessness (Sharma *et al.*, 2019) [63]. Lavender essential oil is used as a flavoring agent in chewing gum, candies, beverages (tea, coffee, hot chocolate, lemonade and cocktails), various condiments (chutney, salsa), jams, jellies and syrups, confectionery and dry blends, cooking spices, sugars and salts and confectionery and dry blends (Radu *et al.*, 2020) [51].

2.4. Calendula (*Calendula officinalis*), Family: Asteraceae

Calendula (*Calendula officinalis*) is also known as pot marigold, is an annual herb native to southern Europe that belongs to the Asteraceae family. Calendula is utilized for both medicinal and culinary purposes (Ashwlayan *et al.*, 2018) [2]. The plant species has been shown to contain a wide range of phytochemicals including carbohydrates, phenolic compounds, lipids, steroids, tocopherols, terpenoids, quinones and carotenoids (Kishimoto *et al.*, 2005; Re *et al.*, 2009; Shahrabaki *et al.*, 2013) [27, 52, 56]. The pot marigold flower has astringent, menstrual, anticonvulsant, invigorating, antiseptic nourishing, sopoforic, diuretic, blood thinners and vomiting elimination effects (Moghaddasi and Kashani, 2011) [36]. The flower extracts of the plant have anti-viral properties

against HIV. *In vitro*, calendula plant extracts have anti-cancer action against tumour cell lines derived from leukaemias, fibrosarcomas, melanomas, breast, cervix, prostate, pancreas and lung (Jiménez-Medina *et al.*, 2006).

2.5. Blue pea (*Clitoria ternatea*), Family: Fabaceae

Clitoria ternatea also known as blue pea, is a perennial climber native to tropical Asia and is grown as an ornamental. Blue pea belongs to Fabaceae family (Karel *et al.*, 2018) [31]. It is mostly used in the traditional ayurvedic system of Indian medicine to cure a broad range of ailments (Lijon *et al.*, 2017) [33]. In food industry, blue pea has traditionally been used as a vegetable in cooking to color deserts or to make a strikingly vibrant colored tea. In traditional Thai cooking, blue pea blossoms are pressed for their blue extract, which is then combined with coconut milk and other base ingredients to naturally color Thai desserts in blue and purple (Gaytos and Lumagbas, 2019) [17]. Blue pea has been used for centuries as a memory booster, anti-stress, anxiolytic, anti-depressant, anti-convulsant, tranquillizer and sedative agent (Mukherjee *et al.*, 2008) [37]. It has been proven to have anti-carcinogenic, anti-stress, anti-hyperglycemic, antioxidant, anti-microbial, anti-inflammatory and analgesic properties (Lijon *et al.*, 2017) [33].

2.6. Chamomile (*Matricaria chamomilla*), Family: Asteraceae

Chamomile is a perennial composite herb and annual plant belonging to Asteraceae family. It is a medicinal herb native to southern and eastern Europe (Rehmat *et al.*, 2020) [50]. Chamomile is also widely used as a food supplement and considered a health food by many consumers (Formisano *et al.*, 2015) [16]. Aqueous extract of chamomile with a specific concentration is referred to as tea. Chamomile tea is beneficial for relaxation and general health issues (Srivastava and Gupta, 2015) [59]. Chamomile contains several bioactive chemicals, including herniarin and umbelliferone (coumarins), chlorogenic acid and caffeic acid (phenylpropanoids), apigenin, apigenin-7-O-glucoside, luteolin and luteolin-7-O-glucoside (flavones), quercetin and rutin (flavonols) and naringenin (flavanone) (Singh *et al.*, 2011) [60]. Chamomile leaves, flowers and stems are used as antioxidants and are considered to have analgesic, antiviral, anti-inflammatory, antiseptic, anti-diabetic, anti-proliferative, and anti-bacterial properties (Miraj and Alesaeidi, 2016) [41].

2.7. Marigold (*Tagetes sps.*), Family: Asteraceae

Tagetes erecta is an annual herb native to Mexico in the genus *Tagetes*. It belongs to Asteraceae family. The plant *Tagetes erecta* is popularly known as genda phool (Khulbe, 2015) [30]. Marigold (*T. erecta*) flowers contain a number of phytochemicals such as tannins, phenolic compounds, Flavonoids, sterols, triterpenoids, saponins and alkaloids (Kadam *et al.*, 2013) [28]. The flower is used to treat epileptic seizures, as well as astringent, carminative, stomachic, scabies, and liver issues (Ampai *et al.*, 2013) [4]. Externally, it is used to treat ulcers, eczema, painful eyes and rheumatism. Marigold is considered to cleanse the blood and flower juice is used as a cure for bleeding piles and bronchitis (Karwani and Sisodia, 2015) [29]. Also, it shows diverse pharmacological activities such as anti-bacterial, antinociceptive and anti-inflammatory, hepatoprotective, anti-cancer, anti-oxidant, antiepileptic, anti-diabetic, anti-

depressant, anti-fungal and wound healing (Singh *et al.*, 2020) [64].

2.8. Carnation (*Dianthus caryophyllus*), Family: Caryophyllaceae

Carnation is annual or perennial herb that belongs to Caryophyllaceae family. It is native to the Mediterranean region and Central Asia (Hashemabadi *et al.*, 2015) [21]. Carnation flowers are an attractive stimulating plant that has historically been used to cure fevers in tonic cordials. It is traditionally used to treat cardiac and neurological problems in European herbal medicine. Phytochemical analysis of *Dianthus caryophyllus* revealed that it contains triterpenes, alkaloids, coumarins, cyanogenic glycoside, cyanid glycosides, pelargonidin, the yellow isosalipurposide, essential oil and volatile oil. (Al-Snafi, 2017) [5]. The flowers were believed to possess alexiteric, antispasmodic, cardiotoxic, diaphoretic, and nerve effects. Carnation also has anti-cancer, anti-bacterial, antiviral, antifungal, insecticide properties (Chandra *et al.*, 2016) [8].

3. Application of edible ornamental flower in dairy products

Several ornamental flowers in various forms such as powder, essential oils, etc. have been effectively applied in a few dairy products. Each dairy product that has been combined with an edible ornamental flower has been described in detail here.

3.1. Yoghurt

Yoghurt's health advantages are well-known, and many yoghurt-based products are enjoyed by people all over the world (El-Shibiny *et al.*, 2018) [14]. Arslaner *et al.*, (2021) [3] evaluated that incorporation of hibiscus in yoghurt enhanced its antioxidant activity, total phenolic content and mineral content while having no effect on the physical, chemical, microbiological, or sensory aspects of the yoghurt samples. Similarly, Ozturk *et al.* (2017) [45] reported that supplementing lavender powder increased lactic acid production during fermentation as well as the viability of *S. thermophilus* and *L. bulgaricus* during cold storage. Addition of lavender powder increased the antioxidant activity of yoghurt. Also, Qiu *et al.*, (2021) [49] found that adding Rose Plant extract (RPE) to fortified yoghurt enhanced numerous physicochemical parameters as well as lowering syneresis during storage. Furthermore, RPE increased the antioxidant capacity, inhibited α -Amylase and α -Glucosidase activity and increased the proteolytic activity of the yoghurt, indicating that RPE-enriched yoghurt had health-promoting qualities. Addition of RPE also had a substantial impact on the aroma and flavor profiles as well as the sensory scores of the yoghurt. Moreover, Marhamatizadeh *et al.*, (2012) [38] developed chamomile incorporated yoghurt and reported that yoghurt having 0.6% chamomile concentration had the best flavor, color and insolubility and it also significantly increased the thickness of the yoghurt as well as the fermentation process and bacterial multiplication. Escher *et al.* (2019) [7] studied that addition of lyophilized marigold extract (LME) in various concentrations to organic yoghurt increased its total phenolic content and antioxidant activity. The organic yoghurt containing 0.25 g LME/100 g had a higher acceptability index, indicating that the use of LME may be a technological and functionally driven strategy for increasing the content of bioactive compounds in

yoghurts.

Addition of Blue Pea flower extract (BPFE) also increased the antioxidant activity of yoghurt, as per the report of Sutakwa *et al.* (2021) [58]. Similarly, Assem *et al.* (2019) [6] found that eugenol in carnation essential oil possesses antibacterial, antioxidant and antimicrobial characteristics against pathogenic strains such as *E. coli* and *S. aureus*. The addition of eugenol has been shown to extend the shelf life of yogurt with an acceptable taste, flavor and good appearance without any microbial spoilage and suggested that carnation essential oil with eugenol can be used traditionally as a natural preservative agent and antimicrobial material in dairy products.

3.2. Fermented milk

Su *et al.*, (2018) [55] reported that Hibiscus (*Roselle*) extract may increase Titrable acidity (TA), pH, bacteria counts, syneresis value, water holding capacity (WHC) and sensory acceptability of fermented milk along with promoting hypoglycemic and hypolipidemic activities of fermented milk. Furthermore, the positive sensory assessment of *Roselle* extract fermented milk (RFM) showed the viability of producing the fermented milk created in this work on a commercial scale.

3.3. Ice Cream

Ice cream is one of the most popular dairy products in the world, yet it lacks natural polyphenol, antioxidants and colors. As a result, it is intriguing to investigate the prospect of boosting the nutritional content of ice cream by using health-promoting elements such as edible flowers.

Homayouni *et al.* (2022) [21] observed an increase in antioxidant content and antimicrobial activity of ice cream after supplementing it with extract of *Hibiscus (H.sabdariffa)* and Tea (*C. synensis*) and it was further concluded that fortification of dairy products with low to moderate concentrations of the extracts could aid in the promotion of health status in consumers.

Singoe and Beswa (2019) [54] studied that the ice cream sample with 5% hibiscus (*roselle*) extract has potential as functional ice cream as it exhibited high overrun, low meltdown, desirable viscosity, high total solids and light color intensity. Urkek (2021) [65] reported that rosehip has been effectively employed to increase the ash, overrun, melting ratios and consistency features of ice cream as well as to enrich its antioxidant activity, minerals (Calcium, Magnesium, Sulfur, potassium, Manganese, Iron and Zinc) and vitamin C. It can also be utilized as a helpful dietary supplement and can be a natural source of antioxidants and colorants.

3.4. Shrikhand

Shrikhand, a semi-soft, sweetish-sour whole milk product made from lactic fermented curd, may readily incorporate flower extracts without affecting its sensory quality much. Deshmukh *et al.*, (2019) [12] concluded that the sensory parameters of Shrikhand namely color and appearance, flavor, taste, consistency and overall acceptability decreased with the addition of rose petal powder.

3.5 Cheeses

Gautam *et al.*, (2022) [18] showed that marigold petal extract (MPE) has antimicrobial properties and can extend the shelf

life of Indian cottage cheese by 15 days at temperatures ranging from 4-7 ° C. MPE had a significant antimicrobial effect against lactose fermenting bacteria, yeast, and *E. coli*. Based on overall product performance, both sensory and microbial parameters, sample B (2%) was found to be suitable as a preservative in Indian cottage cheese/paneer at 4-7 ° C storage temperature for more than 15 days with no effect on sensory attributes. It inhibited microbial growth without affecting the color or flavor which was a setback for sample C (3%).

Caleja *et al.* (2015) [9] evaluated that adding chamomile flower extract to cottage cheese did not significantly change its nutritional properties, but it did improve its antioxidant property. Only the control samples prepared without the addition of extract showed signs of degradation after 14 days of storage, showing chamomile's preservation potential.

4. Conclusion

Ornamental flowers have long been utilized not just as a food flavoring, but also for their medicinal properties. Flowers may be able to improve human health and medical condition due to their antioxidant, anti-bacterial and anti-cancer properties. Dairy products have long been used by food scientists to assess consumer's preferences for innovation in goods. A combination of ornamental flowers in dairy products with gifted health advantages should adhere to the standards to avoid any negative impacts on quality testing, safety, efficiency, pricing and marketing approval procedures. However, various technical difficulties must be overcome to manufacture dairy products filled with attractive flowers, such as the use of nano-form to boost availability and efficiency. Furthermore, additional study is required to improve the present technology and develop new procedures for optimum extraction and refining separation methods of active components from decorative flowers.

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