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Flores comestíveis: beleza, saúde e nutrição

Edible flowers: beauty, health and nutrition

Flores comestibles: belleza, salud y nutrición

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Resumo

O mercado de flores comestíveis está se expandindo mundialmente, devido ao maior interesse da população em alimentos com propriedades terapêuticas e à necessidade de conquistar o mercado com produtos diferentes e inovadores. As flores podem ser usadas na decoração e preparação de alimentos e bebidas, adicionando aroma, sabor e cor. No entanto, a composição química das flores deve ser conhecida antes do consumo humano. O objetivo foi discutir as espécies mais consumidas, seus componentes bioativos e informações sobre a qualidade, preservação e consumo de flores. Foi realizado um levantamento bibliográfico de 1992 a 2018 nas plataformas de pesquisa da ScienceDirect, SciELO e Periódicos Capes, onde foram selecionados 40 artigos para servir como banco de dados. Estudos sobre a percepção do consumidor sobre o consumo de flores comestíveis e sua preparação são limitados. O conteúdo de compostos bioativos é alterado pelo método de preparação. A preferência do consumidor é por formas não processadas ou minimamente processadas (como pétalas de rosa secas). As flores comestíveis são uma oportunidade empreendedora, seja para produção para consumo, preparação de novos produtos ou extração de bioativos.

Palavras-chave: Flores comestíveis e ornamentais; Alimentos e aspectos estéticos; Nutrição humana.

Abstract

The market for edible flowers is expanding worldwide, due to the greater interest of the population in foods with therapeutic properties and the need to conquer the market with different and innovative products. Flowers can be used in decorating and preparing food and drinks, adding aroma, flavor and color. However, the chemical composition of flowers must be known before human consumption. The objective was to discuss the most consumed species, their bioactive components and information on the quality, preservation and consumption of flowers. A bibliographic survey from 1992 to 2018 was carried out on the research platforms of ScienceDirect, SciELO and Periódicos Capes, where 40 articles were selected to serve as a database. Studies on consumer perception of consumption of edible flowers and their preparation are limited. The content of bioactive compounds is changed by the method of preparation. Consumer preference is for unprocessed or minimally processed forms (such as dried rose petals). Edible flowers are an entrepreneurial opportunity, whether for production for consumption, preparation of new products or extraction of bioactives.

Keywords: Edible and ornamental flowers; Foodstuffs and aesthetic aspects; Human nutrition.

Resumen

El mercado de flores comestibles se está expandiendo en todo el mundo, debido al mayor interés de la población en los alimentos con propiedades terapéuticas y la necesidad de conquistar el mercado con productos diferentes e innovadores. Las flores se pueden usar para decorar y preparar alimentos y bebidas, agregando aroma, sabor y color. Sin embargo, la composición química de las flores debe conocerse antes del consumo humano. El objetivo fue discutir las especies más consumidas, sus componentes bioactivos e información sobre la calidad, preservación y consumo de flores. Se realizó una encuesta bibliográfica entre 1992 y 2018 en las plataformas de investigación de ScienceDirect, SciELO y Periódicos Capes, donde se seleccionaron 40 artículos para servir como base de datos. Los estudios sobre la percepción del consumidor sobre el consumo de flores comestibles y su preparación son limitados. El contenido de compuestos bioactivos se modifica por el método de preparación. La preferencia del consumidor es para formas sin procesar o mínimamente procesadas (como los pétalos de rosa secos). Las flores comestibles son una oportunidad empresarial, ya sea para la producción para el consumo, la preparación de nuevos productos o la extracción de bioactivos.

Palabras clave: Flores comestibles y ornamentales; Alimentos y aspectos estéticos; Nutrición humana.

1. Introduction

The first reports of flower consumption as a medicinal product and in human food are from Ancient Rome (Gardner and McGuffin, 2013, González Bario *et al*., 2018). In Europe and Asia its use was reported 2000 years ago (Loizzo *et al*., 2016) and in China at 3000 years (Gardner and McGuffin, 2013). Today, the edible flowers, are traditionally consumed in Europe, Asia, East India and Middle East (Mlcek and Rop, 2011, Kaisoon, Konczak and Siriamornpun, 2012, Guarrera and Savo, 2013).

The use of edible flowers in salads, soups, starters, desserts, beverages, sauces, jellies, syrups, liqueurs, vinegars, honey, oils and decoration (Barash 1998; González-Barrio *et al*., 2018) adds aroma, flavor, improves appearance and adds value to the final product (Pires *et al*., 2017, Chen and Wei, 2017). The most common use is for the salads and desserts decoration, flavoring of vinegar and olive oil, preparation of tea or in ice cubes (Fernandes *et al*., 2016). As is the case with some flowers that have already been widely used in the cooking

of several countries like cauliflower, broccoli and artichoke. The variety of shapes, color and flavor of edible flowers addresses different market niches (Kelley *et al*., 2001).

The flower consumption increase is related to the change in the population food habit that are more aware of the food quality (Rop *et al*., 2012).

The culinary use of flowers is also an opportunity to provide the consumer with dishes with innovative characteristics and compounds that help in the prevention of various diseases (Pires *et al*., 2017; Navarro-González *et al*., 2015, Koike *et al*., 2015). Edible flowers contain amino acids, vitamins, minerals and proteins (Chen and Wei, 2017), phenolic acids, flavonols, flavones, anthocyanins, and other phenolic compounds that act as antioxidant, anti-inflammatory, anticancer, anti-obesity and neuroprotective effects (Lu *et al*., 2016, Chena *et al*., 2018).

The use of flowers with high levels of anthocyanin, an antioxidant component, to produce natural dyes instead of synthetic dyes, aiming at obtaining healthier products is a market trend (Pop *et al*., 2010; Chena *et al*., 2018).

The components present in flowers knowledge is essential before consumption because some plants contain compounds that are harmful to health (Fernandes *et al*., 2007).

The objective was to analyze and discuss the most consumed flower species, their bioactive components and information on the quality, preservation and consumption of flowers.

2. Theoretical Foundation

2.1. Consumption of edible flowers

The nine factors influencing food choice are health, mood, convenience, sensory appeal, natural content, price, weight, familiarity, and ethical concerns (Steptoe *et al*., 1995). Therefore, the acceptance of a new food is related in making it acceptable the cultural perceptions and patterns of consumption (Rodrigues *et al*., 2017).

Edible flowers consumption is greater by well-informed people about the food chemical composition (Chen and Wei, 2017). Aroma is a primary attribute when buying flowers. The scent of flowers attracts attention, curiosity and desire (Yeh and Huang, 2009).

The aroma, curiosity and medicinal properties are the main factors for flower consumption (Bradford and Desrochers, 2009; Moore, 2014, Chen and Wei, 2017). The

edible flowers have bioactive components, which makes the flower market attractive to the functional food industry.

Studies related to the factors that lead to food consumption are important for marketing. These professionals can integrate curiosity, aroma and health to attract consumers. Labeling with product composition and information on health benefits may be a good marketing strategy (Hwang *et al*., 2016).

The petals are the most consumed parts of the flowers, and the stem, sepals, pistils and stamens are discarded (Fernandes *et al*., 2016). The concentration of proteins, lipids, carbohydrates and flavonoids is higher in pollen, however, it can cause allergy in some consumers (Mlcek and Rop, 2011). Nectar is rich in sugars, amino acids, proteins, lipids, minerals, organic acids, alkaloids, terpenoids and flavonoids (Mceek and Rop, 2011). The size, shape, color, flavor and aroma of the flowers are the main quality requirements.

Some flowers are tender and crunchy while others are fragile and silky, with spicy, herbaceous, floral and fragrant flavor (Fernandes *et al*., 2016). More vividly colored flowers such as yellow, orange and blue are preferred by consumers (Kelley *et al*., 2001). Each species is more appropriate to a particular type of dish and drink due to its flavor and aroma (Fernandes *et al*., 2016).

2.2. Edible species

Among the flowers already identified as edible we have: chrysanthemum (*Chrysanthemum* sp.), hemerocallis (*Hemerocallis* sp.), lilac (*Syringa vulgaris*), mint (*Mentha* sp.), capuchin (*Tropaeolum majus*), pansy (*Viola tricolor*), tulipa (*Tulipa gesneriana*), turmeric (*Lilium* sp.), lotus (*Nelumbo nucifera*), lily (*Malay sylvestris*), dandelion (*Taraxacum officinale*), borage (*Borago officinalis*), marshmallow (*Althea officinalis*), Neem flower (*Azadirachia indica*), (Cantabria), the flower of *Sesbania grandiflora*, cassia flower (*Cassia siamea*), marigolds (*Tagetes erecta*), jasmine (*Ixora chinensis*), dahlia (*Dahlia mignonI*), *R. damascena* 'Alexandria', *R. gallica* 'Francesa', *R. canina*, and other species of the genus Cynodidae, Cynodidae, Cynodidae, Cynodidae, Cynodidae, Cynomysidae, Cynodidae (Otakar and Rop, 2011, Chen and Wei, 2017, Fernandes *et al*., 2017).

2.3. Quality of flowers for consumption

Flowers are highly perishable due to high respiratory activity and few reserve substances (Fernandes *et al*., 2017). The use of post-harvest techniques is essential in maintaining quality and prolonging the marketing period. Dehydration, crystallization, preservation in vinegar, alcohol, oil and refrigeration can preserve the flowers quality. Dehydration is done by keeping the petals in a shady place, taking about 1 week and allowing preservation for prolonged periods (Nicolau and Gostin, 2016). Crystallization consists of coating the flowers with egg white diluted with water (2:1) and then sprinkled with sugar and conditioned in a warm, dry environment until crisp (Nicolau and Gostin, 2016). The flowers of roses, violas, geraniums, borage and pea are easily crystallized (Nicolau and Gostin, 2016).

The floral vinegars are a way of preservation, being common the use of white wine vinegar, therefore, it promotes coloration and enhancement in the flavor (Nicolau and Gostin, 2016). An alternative to vinegar is the use of alcohol, oil, butter and syrups. Syrups are made with flowers, water and sugar, where the petals will add color and texture (Nicolau and Gostin, 2016).

Storage in plastic containers under refrigerated environments is an alternative to increase the post-harvest shelf life of flowers (Kelley *et al*., 2003; Newman and O'Conner, 2009, Fernandes *et al*., 2017). However, it represents an additional cost in the commercial chain and some species may present injury due to cold, and it is necessary to study the ideal storage temperature.

Flower consumption should follow hygiene and food safety rules during production, storage, distribution and sale (Fernandes *et al*., 2016). Ornamental flowers are not recommended for consumption, as these plants can accumulate residues of chemical compounds. Feeding flowers should be grown without herbicides and insecticides), which makes pest control difficult (Koike *et al*., 2015). The presence of pests is indicative of loss of quality, as insects compromise appearance, nutrition and bioactive compounds (Villavicencio *et al*., 2018).

Irradiation is recommended for the decontamination of the products and is already used in flowers (Villavicencio *et al*., 2018), aimed at reducing the use of chemical substances against pests and insects (Ihsanullah and Rashid, 2017). Radiation is also used for the extended marketing period and has been used in several countries (Farkas, 2006; Komolprasert, 2007).

2.4. Chemical composition of edible flowers

The flowers have high water content, low fat content and different levels of carbohydrates, proteins and minerals (Mlcek e Rop, 2011; Lara-Cortés *et al*., 2013; Navarro-González *et al*., 2015; Pires *et al*., 2017). Fructose is the main simple sugar and polyunsaturated fatty acids predominate over saturated fatty acids, mainly due to the contribution of linoleic acid (Pires *et al*., 2017). The antioxidant effects of anthocyanins, phenolic compounds, peptides, amino acids, amines, carotenoids and terpenoids are the main source of vitamin A, C, riboflavin and niacin (Arya *et al*., 2014; Pires *et al*., 2017) linoleic acid (Pires *et al*., 2017). The antioxidants are present throughout the plant, but the highest concentration is present in the flowers (Vukics *et al*., 2008; Kaisoon *et al*., 2012). The phenolic compounds are a diverse group of aromatic compounds (Harborne and Williams, 2000) present in the free, soluble form bound to other compounds and insoluble (Sosulski *et al*., 1982).

Flavonoids are phenolic compounds abundantly present in flowers, such as flavones, flavonols, isoflavones, flavonones and chalcones that inhibit lipid oxidation by the elimination of free radicals or other mechanisms, such as extinguishing singlet oxygen, metal chelation and lipoxygenase inhibition (Yanishlieva Maslarova, 2001). A study of 12 varieties of edible flowers identified that yellow flowers have a higher flavonoid content (Kaisoon *et al*., 2011). A test with 51 edible flowers, concluded that the main component with oxidant capacity of flowers are phenolic compounds (Li *et al*., 2014). Among them, cyanidin-3-glucoside acid, protocatechic acid, catechin, gallic acid and epicatechin (Li *et al*., 2014) can be cited. The flowers of *R. hybrida*, *L. sinuatum*, *P. hortorum*, *J. integerrima* and *O. fragrans* were the flowers that had higher phenological contents (Li *et al*., 2014). Among the 23 flowers tested by Chen *et al*., 2015, *O. fragrans* (Thunb.) Lour, Paeonia lactiflora Pall and Rosa rugosa Thunb (purple) were the ones with the highest antioxidant activity. Anthocyanins are compounds responsible for the red, purple or blue coloration of leaves, stems, roots, flowers and fruits (Stintzing and Carle, 2004) and is related to the attraction of pollinators. One of its uses is to obtain natural dyes (Pop *et al*., 2010; Roriz *et al*., 2018).

2.5. Use of edible flowers in disease prevention

Reactive oxygen species (ROS) are associated with degenerative and chronic diseases (Young and Woodside, 2001) such as: aging, cancer, atherosclerosis, diabetes, asthma and

rhinitis (Eberhardt *et al*., 2000; Finkel and Holbrook, 2000; Barnham *et al*., 2004). During chronic inflammation, there is production of radicals (Temple, 2000), which can react with lipids, proteins, carbohydrates and DNA (Willett, 2002). Lack of repair in the DNA, the mutated cell will begin to divide becoming cancerous. The flowers increase the contents of phenolic compounds and other antioxidants (Xiong *et al*., 2014) inhibiting this process.

Interest in these compounds has increased in recent years due to the evidence in neutralizing oxidative stress related to various diseases (Li *et al*., 2012). The edible flowers were also effective as anti-tumor (Ukiya *et al*., 2002; Greenlee *et al*., 2012; Sagdic *et al*., 2013), anti-inflammatory agents (Choi and Hwang, 2003), antithrombin (Wongwattanasathien *et al*., 2010), anti-hypertensive (Xie and Zhang, 2012), antibiotic (Ammar *et al*., 2015) and anti-diabetic agents (Mahmood *et al*., 1996).

Phenolic compounds were related to the prevention of diabetes, cognitive decline and cardiovascular disease, as well as, different types of cancer through the inhibition of its initiation and progression, modulating genes involved in the main regulation processes (Barreira *et al*., 2008; Anantharaju *et al*., 2016; Gutiérrez-Grijalva *et al*., 2016).

Anthocyanins exhibit antioxidant activity (Stintzing and Carle, 2004), anti-inflammatory, anticancer and anti-diabetic properties (Rodriguez-Amaya, 2016). The antioxidants present in camellia flowers (*V. japonicus*) viola (*V. tricolor*), monkfish (*T. majus*), paracreme (*Spilanthes oleracea*) and marigold (*Tagetes erecta*) are used in drugs (Mcek and Rop, 2011; Kaisoon *et al*., 2011; Lara-Cortés *et al*., 2013, Miguel *et al*., 2016). The caryophyllene present in clove is the main anti-inflammatory (Lyra *et al*., 2008).

Lilac has isoprenoids such as linalool, farnesene, pinene, myrcene, terpinene, cimene and/or limonene as anti-inflammatories (Oh *et al*., 2008). Triterpenes arnidiol, faradiol and heliantriol present in chrysanthemum flowers present antimicrobial and anti-inflammatory effects (Shafaghat *et al*., 2009). Benzyl isothiocyanate in marigold has an anti-inflammatory effect (Schreiner *et al*., 2009). Chrysanthemums are consumed in Japan and are known as anti-inflammatory and potential chemoprotective (Ukiya *et al*., 2002). *Camellia japonica* flowers have anti-inflammatory and antioxidant effects (Piao *et al*., 2011) and are used in cosmetics and skin care products in Korea (Trinh *et al*., 2018). Seeds and branches of *S. viciifolia* act as anti-inflammatory, anti-anaphylaxis, immune function and antioxidant activity (Wen and Mao, 2006). Flowers of *Paeonia rockii* and *Cidonia oblonga* were recently identified with antioxidant action (Bao *et al*., 2018; Chandrasekara *et al*., 2018).

Curcuma sessilis, Punica granatum and *Antigonon leptopus* exhibit high antimutagenic levels (Wongwattanasathien *et al*., 2010) and antioxidant activities (Kaisoon *et al*., 2011*).*

The b-ionone cyclic terpenoid found in violets has an inhibitory effect on the growth of malignant cells (Gomes-Carneiro et al., 2006).

Extracts of edible Chinese flowers such as *Gardenia jasminoides* and *Magnolia officinalis* have improved lipid metabolism in hyperlipidemic rats (Wang *et al*., 2016).

Marigold consumption, especially in the form of tea, has been associated with a reduction in the risk of contracting chronic diseases such as cancer, age-related eye diseases (Siriamornpun *et al*., 2012; Matić *et al*., 2013).

Artichokes have demonstrated their hepatoprotective, anticarcinogenic, hypocholesterolemic effects (Llorach *et al*., 2002; Ferracane *et al*., 2008), hypolipidemic and hypoglycemic (Colantuono *et al*., 2018), antimicrobial and anti-HIV (Lattanzio *et al*., 2009), anti-inflammatory, and anti-genotoxic effects (Zuorro *et al*., 2016, Kollia *et al*., 2017, Colantuono *et al*., 2018).

The functional properties of artichokes are related to their high levels of polyphenolic compounds and inulin (Lattanzio *et al*., 2009; Colantuono *et al*., 2018).

Methanolic extracts of rose present anti-inflammatory, analgesic and anticancer effects (Choi and Hwang, 2003; Hu *et al*., 2013).

Roselle extracts demonstrated anti-inflammatory, anticancer and anti-obesity effects (Chang *et al*., 2005; Kim *et al*., 2007; Lee *et al*., 2009; Beltran-Debon *et al*., 2010).

3. Conclusion

Studies of the nutritional composition of edible flowers are necessary, such as: presence of antinutritional or toxic compounds, and content of different molecules with beneficial effects.

In addition to studies regarding the consumer perception of the consumption of edible flowers, therefore, they are very limited and studies related to the preparation form. The content of bioactive compounds is changed by the method of preparation. Due to the concern with natural foods, preference is for unprocessed or minimally processed forms (such as dried rose petals or saffron powder). Edible flowers are a new business opportunity, whether for production for consumption, production of new products or extraction of bioactive. And its production may be coupled with organic production allowing it to serve a market more

concerned with the quality of food. Future works that explore food preparation using edible flowers are recommended.

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