Transformation and agroindustry

Scientific and technological research article

Chemical composition of rose, sunflower and calendula flower petals for human food use

Composición química de pétalos de flores de rosa, girasol y caléndula para su uso en la alimentación humana

Felipe de Lima Franzen,¹* Mari Silvia Rodrigues de Oliveira,² Henrique Fernando Lidório,³ Janine Farias Menegaes,⁴ Leadir Lucy Martins Fries⁵

¹ Master Researcher, Universidade Federal de Santa Maria, Programa de Pós-Graduação em Ciência e Tecnologia de Alimentos [Postgraduate Program in Food Science and Technology]. Santa Maria, Brazil. Email: ff franzen2@gmail.com. Orcid: https://orcid.org/0000-0001-8925-4098
² Professor-Researcher, Universidade Federal de Santa Maria - Centro de Ciências Rurais, Santa Maria, Brazil. Email: marisilviadeoliveira@yahoo.com.br. Orcid: https://orcid.org/0000-0003-4803-5643
³ Academic-Researcher, Universidade Federal de Santa Maria - Centro de Ciências Rurais, Santa Maria, Brazil. Email: henrique.fernando@outlook.com. Orcid: https://orcid.org/0000-0002-4522-0408
⁴ Academic-Researcher, Universidade Federal de Santa Maria - Centro de Ciências Rurais, Santa Maria, Brazil. Email: janine_rs@hotmail.com. Orcid: https://orcid.org/0000-0001-6053-4221
⁵ Professor-Postgraduate Researcher, Universidade Federal de Santa Maria, Programa de Pós-Graduação em Ciência e Tecnologia de Alimentos, Centro de Ciências Rurais. Santa Maria, Brazil. Email: lucymicro@yahoo.com.br. Orcid: https://orcid.org/0000-0002-8849-4812

Subject editor: Edwin Castro Rincón [Corporación Colombiana de Investigación Agropecuaria [AGROSAVIA]]

Reception date: 18/04/2018
Approval date: 29/11/2018


DOI: https://doi.org/10.21930/rcta.vol20_num1_art:1252

This license allows distributing, remixing, retouching, and creating from the work in a non-commercial manner, as long as credit is given and their new creations are licensed under the same conditions.

*Universidade Federal de Santa Maria, Centro de Ciências Rurais, Prédio 42, Sala 3135A. Santa Maria, Brasil.
Abstract

There is a concern for the chemical characterization of foods with economic and nutritional potential, especially those of low caloric value, in their constitution of proteins, lipids, carbohydrates, minerals, and vitamins, important for a healthy diet. Among these foods, edible flowers are distinguished for their beauty and for flavoring dishes; furthermore, they also have nutritional and medicinal properties. In this context, the aim of the study was to characterize chemically the petals of three species, rose (Rosa x grandiflora Hort.), sunflower (Helianthus annuus L.), and calendula (Calendula officinalis L.) for use in human nutrition. The plants were cultivated in a protected environment and in an open field, and after harvest, physicochemical analyses were carried out (ash, carbohydrates, ethereal extract, fiber, moisture, and protein). In the current study, high water content was observed (higher than 80%); sunflower showed a higher ash content (1.2%), calendula presented a higher ethereal extract content (1.2%) and rose had a higher fiber content (3.2%). Rose, sunflower and calendula flower petals had a chemical composition with essential nutrients, being able to be included in the daily human diet because they contain essential nutrients for a healthy diet.

Keywords: Calendula officinalis, food crops, Helianthus annuus, proximate composition, Rosa x grandiflora

Resumen

Existe una preocupación por la caracterización química de los alimentos con potencial económico y nutricional, en especial los de bajo valor calórico, en su constitución de proteínas, lípidos, carbohidratos, minerales y vitaminas, para una alimentación sana. Entre esos alimentos, las flores comestibles se destacan por su belleza y condimentación en los platos; además, poseen propiedades nutricionales y medicinales. En este contexto, el objetivo del trabajo fue caracterizar químicamente los pétalos de las especies de rosa (Rosa x grandiflora Hort.), girasol (Helianthus annuus L.) y caléndula (Calendula officinalis L.), para el uso en la alimentación humana.

Las plantas fueron cultivadas en ambiente protegido y cielo abierto, y después de la cosecha se realizaron los análisis físico-químicos (carbohidratos, cenizas, extracto etéreo, humedad, fibra y proteína). En el presente estudio se observó un alto contenido de agua (> 80%); el girasol tuvo mayor contenido de cenizas (1.2%); la caléndula tuvo mayor contenido de extracto etéreo (1.2%), y la rosa tuvo mayor contenido de fibra (3.2%). Los pétalos de las flores de caléndula, girasol y rosa presentaron una composición química con nutrientes esenciales, pudiendo ser incluidos en los menús diarios por contener nutrientes esenciales para una dieta sana.

Palabras clave: Calendula officinalis, composición aproximada, cultivos alimenticios, Helianthus annuus, Rosa x grandiflora
Introduction

Some edible flowers, in addition to possessing the beauty of color and the shape of their petals, also possess nutritional and medicinal properties. The best-known and most commonly used edible flowers are cauliflower (*Brassica oleracea* var. *botrytis* L.), broccoli (*Brassica oleracea* var. *italica* Plenck.) (Brassicaceae), artichoke (*Cynara scolymus* L.) (Asteraceae) and pumpkin flower (*Cucurbita* spp.) (Cucurbitaceae). Similarly, other species are also edible, such as garden nasturtium (*Tropaeolum majus* L.) (Tropaeolaceae), rose (*Rosa x grandiflora* Hort.) (Rosaceae), begonia (*Begonia cucullata* Willd.) (Begoniaceae), calendula (*Calendula officinalis* L.) (Asteraceae), wild pansy (*Viola tricolor* L.) (Violaceae), and lavender (*Lavandula angustifolia* Mill.) (Lamiaceae). Among the less common, carnation or clove pink (*Dianthus caryophyllus* L.) (Caryophyllaceae) and lemon verbena or lemon beebrush (*Aloysia citrodora* Paláu) (Verbenaceae) are also used (Santos, Melo, & Menegaes, 2012).

Eating flowers is a common practice in Europe, and extremely popular in the French and Swiss cuisine, as well as in Asia. In Brazil, supermarkets, stores, and shops specializing in culinary products have been selling edible flowers, which are used in salads, soups, pizzas, canapés, and jellies, both in sweet and savory dishes (Franzen et al., 2016).

Edible flowers have traditionally been used for human consumption in various cultures. They improve the appearance, taste and aesthetic value of food, aspects that consumers appreciate, justifying the growing trend of sales of high-quality fresh flowers around the world. However, consumers also demand foods with beneficial health properties, in addition to the nutrients they contain, in search of functional qualities such as antioxidant and antimicrobial properties (Fernandes, Casal, Pereira, Saraiva, & Ramalhosa, 2017).

Flower cultivation has been an important line in the economy and export since the end of the nineties. The use of flowers has not been merely for decorative purposes since some species are used as food for wild animals, meanwhile, others have phytotherapeutic properties and produce oils and essences, which are used in perfumery and cosmetics, or are used in cooking (Barbieri & Stumpf, 2005).

Currently, there are few studies that prove the edibility of flowers when they are related to compounds of nutritional interest since there is no tradition of using flowers in food, in addition to the lack of research regarding the toxicity of some species (Franzen et al., 2016).

Since ancient times, flowers have been used for edible and medicinal purposes in a very specific way. For example, *Althaea officinalis* L. of the Malvaceae family is known in English as marshmallow, and has been used in salads and, from the mucilage of the roots, sweets were elaborated, besides being served as food, even though the flower had laxative properties (Prata, 2009; Stancato, 2014).

Furthermore, English women in the Victorian era served sophisticated dishes with crystallized rose (*Rosa x grandiflora*) petals. Currently, rose is offered in salads, jellies, and cakes (Stancato, 2014).

According to Prata (2009), the Brazilian gastronomic culture has not stimulated the use of flowers in food, finding these “foods” in exotic culinary recipes and at a high cost, unlike European countries in which gastronomy uses commonly the flowers for food products.

The nutritional needs required by the human body in health and disease states has been the object of intense research in recent years, as well as the concern regarding the chemical characterization of foods with economic and nutritional potential, especially those of low caloric value, since obesity and chronic degenerative diseases have led the discussions on public health. Therefore, the study of the chemical composition of food is extremely important (Ohse et al., 2012; Oliveira & Marchini, 2008).
The natural substances of plant origin make the food more attractive to the consumer, besides increasing the useful life by the bacteriostatic and bactericidal capacity, slowing the beginning of the deterioration and the growth of undesirable microorganisms (Pereira et al., 2006). In parallel, industrialized foods that contain high levels of preservatives to reduce the microbial load are undesirable. Demand from consumers is turning towards greater production of fresh foods with natural preservatives and a higher safety guarantee (Forsythe, 2013).

From the perspective of phytochemical research, it is possible to know the chemical constituents of plant species or assess their presence in these. When chemical studies on the species of interest are not available, this type of analysis can identify the relevant secondary metabolite groups (Simões, 2006). Edible flowers, as well as fruits and vegetables, contain various compounds with antioxidant properties, which can be more efficient and less expensive than synthetic supplements to protect the body against diseases (Prata, 2009).

For example, rose is a species native to Asia and is considered one of the most popular flowers in the world (some articles date its emergence to more than 5,000 years ago), besides being the most cultivated flower worldwide. Scientifically, roses belong to the Rosaceae family and to the Rosa genus, with more than 100 species and thousands of varieties, hybrids and cultivars. The plant is classified as woody and has a size of 1 to 2 m in height. The species has simple leaves divided into 5 or 7 lobes, and solitary flowers of the most varied colors (Bellé, 1999; Prata, 2009).

Rose flowers are widely used in Arabic cuisine and can be consumed in creams, mousses or combined with fruit juices, salads, desserts, jams and drinks such as lemonade and orange juice, to give an exotic touch. In addition, the flowers can be served in cake decorations. Normally, an infusion is made first to concentrate the flavor (Franzen et al., 2016; Prata, 2009). Because rose petals are very rich in vitamins, it has a regenerative effect on the skin and can also be used to fight colds and flues, as well as for digestive problems, freeing the body of toxins, as they have analgesic, anti-inflammatory, antipyretic, soothing, healing and diuretic properties (Prata, 2009).

Sunflower (Helianthus annuus L.) (Asteraceae family), as it is popularly known due to its heliotropism, has its origin in culinary over 3,000 years ago, used by indigenous peoples in northern Mexico, where the oil from its seeds was used. The plant is rich in proteins and vitamins of the B complex, and today, in addition to the oil, flower buds can be used served with asparagus and its flowers in salads (Franzen et al., 2016). According to Reis, Queiros and Froes (2004), the main properties of this species are the regulation of cholesterol in the blood, improvement in cardiovascular health, fighting degenerative problems, and helping hormone formation for the proper functioning of the digestive system.

The species popularly known as calendula (Calendula officinalis) belongs to the Asteraceae family and its origin is probably in the Mediterranean region (Bellé, 1999; Lorenzi & Souza, 1999). This plant has been used since ancient times for medicinal purposes and as a textile dye. Recently, it has assumed the function as an edible flower. Its petals have been used in decorations for cakes, sweets and savory coverings. The use of this species in food requires removal of the pollen since it can cause allergic reactions. Calendula flowers are rich in substances such as carotenoids and essential oils and has a spicy palate, which can be used in rice, fish, cheeses, butter, yogurt, and tortillas, often replacing the saffron flavor (Reis et al., 2004).

In this context, the alternative use of natural products obtained from plants has attracted attention, mainly because these products have chemical and functional properties, in addition to the fact that edible flowers have a mild flavor, which changes very little the characteristics of the products with which they are combined. Hence, the need to investigate the chemical composition of flower species with potential use in human nutrition. Therefore, the aim of this study was to evaluate the chemical composition of rose, sunflower and calendula flower petals for future application in food.
Materials and methods

The experiment was carried out in the period from March to October 2017 in two stages, the first was the production of flowers and the second was their chemical characterization. The first stage was carried out in the Floriculture Sector of the Department of Plant Breeding of the Universidade Federal de Santa Maria (UFSM), located in Santa Maria, Rio Grande do Sul (Brazil) at 29°43ʹS and 53°43ʹW, and at an altitude of 95 m.a.s.l.

Sunflower (H. annuus) was planted in plastic cups with a capacity of 5 L in commercial substrate H-Decker, with 3 plants/beaker and with 10 experimental units. Each experimental unit comprised three vessels cultivated in a vegetation house. Flowering began 65 days after sowing (DAS) and the harvest occurred between the periods of 69 to 73 DAS, with one flower per plant being harvested.

Calendula (C. officinalis) was planted in open beds with dimensions of 10 m in length and 1 m in width, with 30 plants/m², containing 10 experimental units; each unit had dimensions of 1 m × 1 m. The flowering started 60 DAS and the harvest occurred between the periods of 60 to 85 DAS, with 5 flowers/plant being harvested.

The flowers of the hybrid rose (Rosa x grandiflora) were collected from plants grown in the greenhouse, with two years of cultivation and 16 experimental units; each unit had dimensions of 1 × 1.2 m, containing 3 plants/m², and 8 flowers/plant were harvested. All species were irrigated daily and cultivated without the use of fertilizers or chemical products. The flowers were harvested manually in the morning and placed in thermal packaging; subsequently, they were transported to the physicochemical laboratory of Departamento de Tecnologia e Ciência Alimentar of UFSM, where triple washing was carried out under running water, sanitized with 1 % sodium hypochlorite and manually centrifuged.

The second stage of the experiment was carried out in the physiochemical laboratory in the Department of Technology and Food Science of the UFSM, where the removal of the petals as well as the analyses were carried out, including the following. Humidity was determined gravimetrically, by greenhouse weight loss at 105 °C up to a constant weight; ashes were obtained by incineration of the muffle material at 550-600 °C; ethereal extracts were obtained by continuous extraction in the Soxhlet equipment, using petroleum ether as an organic solvent (Association of Official Analytical Chemists [AOAC] International, 2005; Zenebon, Pascuet, & Tiglea, 2008) (figure 1).

Figure 1. a. Rose flower (R. x grandiflora); b. Sunflower inflorescence (H. annuus); c. Calendula inflorescence (C. officinalis).
The method used for the determination of total nitrogen was Kjedahl, composed of three stages: 1) digestion of the sample, 2) distillation, and 3) titration. Copper sulfate and selenium were used as catalysts, and boric acid as the ammonia receptor solution in the distillation process (AOAC, 2005; Zenebon et al., 2008). Likewise, the determination of crude fiber was carried out employing the filter analysis method in filter bags (AOCS Ba 6a-05) as proposed by AOAC (2005) and Zenebon et al. (2008). Carbohydrates were obtained by subtracting the values of moisture, gray, protein, ether extract, and crude fiber, and the gross caloric value (GCV) of the petals analyzed was obtained using the traditional conversion factors of 4 kcal/g for carbohydrates and proteins, meanwhile for lipids, 9 kcal/g was used (Agência Nacional de Vigilância Sanitária [Anvisa], 2003).

The chemical composition of the flower petals was determined in triplicates following the methods recommended by the AOAC (2005) and the Analytical Standards of the Adolfo Lutz Institute (Zenebon et al., 2008). The data obtained was subjected to a statistical treatment through an analysis of variance (Anova), and means were compared to each other through the Tukey test at the level of 5% significance employing the IBM® SPSS® Statistics System program (version 20). The means of the results and the standard deviation were calculated in Excel®.

Results and discussion

Table 1 shows the moisture, dry matter, ash, ethereal extract, crude protein, crude fiber, carbohydrate and GCV percentage contents (g/100 g) of the flower petals of the species assessed. It is observed that the chemical constituents analyzed showed a significant difference (p < 0.05) between flower species.

Table 1. Average percentage of the centesimal composition and total caloric value of rose (R. x grandiflora), sunflower (H. annuus) and calendula (C. officinalis) petals, values expressed on a wet basis

<table>
<thead>
<tr>
<th>Nutrients** (%)</th>
<th>Rose</th>
<th>Sunflower</th>
<th>Calendula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>84.56 ± 0.122</td>
<td>86.45 ± 0.377</td>
<td>89.34 ± 0.100</td>
</tr>
<tr>
<td>Dry matter</td>
<td>15.44 ± 0.122</td>
<td>13.55 ± 0.377</td>
<td>10.66 ± 0.100</td>
</tr>
<tr>
<td>Ash</td>
<td>0.72 ± 0.008</td>
<td>1.25 ± 0.005</td>
<td>0.93 ± 0.005</td>
</tr>
<tr>
<td>Ethereal extract</td>
<td>0.23 ± 0.005</td>
<td>0.86 ± 0.013</td>
<td>1.32 ± 0.015</td>
</tr>
<tr>
<td>Protein</td>
<td>1.88 ± 0.042</td>
<td>1.75 ± 0.011</td>
<td>1.20 ± 0.014</td>
</tr>
<tr>
<td>Raw fiber</td>
<td>3.20 ± 0.095</td>
<td>2.12 ± 0.045</td>
<td>1.59 ± 0.105</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>9.41</td>
<td>7.57</td>
<td>5.62</td>
</tr>
<tr>
<td>Caloric value***</td>
<td>60.03</td>
<td>53.50</td>
<td>45.52</td>
</tr>
</tbody>
</table>

*Data are means ± standard deviation; * Means within the same line with different letters are significantly different at the 5% level, by the Tukey test (p < 0.05); ** = (g/100 g); *** = (kcal/100 g).
Source: Elaborated by the authors
The humidity percentage of flower petals was 89.34 %, 86.45 % and 84.56 % for calendula (*C. officinalis*), sunflower (*H. annuus*) and rose (*R. x grandiflora*), respectively. This shows a considerable amount of water present in the flower petals, a quality that helps hydration and also improves intestinal functioning. As water is an essential component of all body tissues necessary for all reactions and physiological processes as digestion, absorption and excretion, it can be ingested as part of the food (Mahan & Escott-Stump, 2005).

The ash content (table 1) refers to the total amount of minerals present in the plants, showing a percentage in flower petals that varied statistically (*p < 0.05*) from 1.25 % to 0.72 % on a wet basis between species. Sunflower (*H. annuus*) presented a higher ash content. Silva, Wiest and Carvalho (2016) observed the ash percentage for the Chinese hibiscus or shoeblackplant (*Hibiscus rosa-sinensis* L.) and Rose of Sharon (*Hibiscus syriacus* ‘Tots Albus’) (Malvaceae) of 0.74 % and 0.80 %, respectively, similar to the results found for rose (*R. x grandiflora*) and calendula (*C. officinalis*) in this experiment.

The contents of the ethereal extract in flower petals (table 1) varied from 1.32 % for calendula, to 0.23 % for rose, presenting a low ethereal extract content. Takeiti, Antonio, Motta, Collares-Queiroz and Park (2009), as well as Rocha et al. (2008) in their investigations with Barbados gooseberry, leaf cactus, or ora-pro-nóbis leaves (*Pereskia aculeata* Mill.) obtained lipid contents of 4.1 g% and 3.64 g%, respectively. Within the contents of ethereal extract, there are not only lipids but also other organic substances soluble in ether, such as pigments, fatty acids, waxes, among others.

Villas-Boas, Oliveira, Oliveira, and Lima (1999) determined that lipid values lower than 1 % can be indicated for weight reduction diets since this value is found in most of the fruits, leafy vegetables and edible flowers. Monteiro (2009) verified that the integral consumption of vegetables can increase the consumption of good quality fats, within the limits of recommendation for lipids, collaborating in the prevention of cardiovascular diseases.

In the characterization of raw fiber (table 1), rose petals were the ones that showed the highest amount (3.20 %), followed by sunflower (2.12 %) and calendula (1.59 %). Rose petals can be characterized as a source of fiber, since according to RDC No. 54 (Ministry of Saúde, 2012), for a food to be characterized as a source of fiber it must have a minimum of 3 g of fiber/100 g (solids).

Elleuch, Bedigian, Roiseux, Besbes, and Blecker (2011) emphasize that food fibers, when added to products, increase water retention capacity, fat retention capacity, emulsification, and gel formation. In addition, it prevents syneresis, i.e. the separation of liquid from a gel caused by shrinkage and improves the shelf life of the products.

Kinupp and Barros (2008) emphasize that unconventional vegetables such as anise-scented sage or hummingbird sage (*Salvia guaranitica* A.St.-Hil. ex Benth.) (Lamiaceae), swamp hibiscus (*Hibiscus diversifolius* Jacq.) (Malvaceae), cumari pepper or locoto (*Capsicum baccatum* L. var. *baccatum*) (Solanaceae), the tomatillo, husk tomato, low ground-cherry or hairy groundcherry (*Physalis pubescens* L.) (Solanaceae), among others, sometimes have higher concentrations of fibers, antioxidant compounds and proteins, compared to the sources of conventional vegetables such as lettuce (*Lactuca sativa* L.) (Asteraceae), arugula or rocket (*Eruca sativa* Mill.) (Brassicaceae), and tomato (*Solanum lycopersicum* L.) (Solanaceae), among others, favoring a better nutritional quality diet.

The edible flowers of rose, sunflower and calendula showed 9.41 %, 7.57 % and 5.62 % of total carbohy-
dretes, respectivamente (tabla 1). El valor promedio de contenido de carbohidratos se calculó por las diferencias de los macronutrientes mencionados, clasificando las flores comestibles como grupo A, según la propuesta publicada por Ornellas (1988) para tener un 5% de total de carbohidratos (Franzen et al., 2016). Rodrigues (2016) en su trabajo con muestras de hojas de oru-pro-nóbis (P. aculeata Mill.) (Cactaceae), obtuvo un valor de 8.49 g por 100 g de carbohidratos, valores que se encuentran en este estudio.

El valor promedio de contenido calórico de las flores comestibles mostró valores de 60.03%, 53.50% y 45.52%, respectivamente. Según el valor calórico calculado para los cuatro macronutrientes mencionados (carbohidratos, fibra, proteína y lipidos), los valores indicados para las flores comestibles en base fresca están orientados para ser alimentos bajos en calorías, como lo describen Reis et al. (2004), donde las flores comestibles, en general, tienen 40 calorías por 100 g.

Monteiro (2009) verificó para flores de brócoli (B. oleracea var. italica), 4.83 g de fibra por 100 g de vegetal fresco, mientras que para flor de coliflor (B. oleracea var. botrytis), el valor fue de 1.74 g de proteínas y 2.08 g de fibra por 100 g de vegetal fresco. Estos valores corroboran los resultados de la actual investigación para flores de rosas, girasol y calendula.

Souza, Curado, Vasconcellos y Trigo (2007) evaluaron la composición cencesimal de frambuesa (Rubus idaeus L.) (Rosaceae) y descubrieron que 100 g de fruta contiene 83-87 g de agua, 51-62 kcal, 0.4-0.7 g de proteínas, 0.5 g de lipidos, 11.4 g de carbohidratos, 1-1.5 g de fibra y 0.19-0.25 g de ash, valores que son similares a los encontrados en hojas frescas de flores, mostrando que, nutricionalmente, las flores comestibles son similares a algunos frutos y comparables a otros vegetales convencionales.

Moura, Souza, Oliveira, Lira y Silva (2009) en su estudio sobre la composición química de flores de moringa (Moringa oleifera Lamark) (Moringaceae) como una fuente de alimento en natura, mostró contenido de 83.40% de humedad, 8.55% de carbohidratos, 2.54% de proteínas, 2.50% de ash y 3.00% de lipidos, resultados que superaban a los de hojas frescas en contenidos de proteínas, ash y lipidos.

Franzen et al. (2016) caracterizaron ocho especies ornamentales de flores en términos de composición química y valor calórico de las hojas, y encontraron, para cada 100 g de hojas de rosa fresca, las siguientes proporciones: 72 calorías, 10.9 g de carbohidratos, 1.84 g de proteína (Rosa x grandiflora Hort.), 61.8 calorías, 8.57 g de carbohidratos, 1.74 g de proteína (Helianthus annuus L.) y 49.1 calorías, 6.16 g de carbohidratos, 1.18 g de proteína (Calendula officinalis L.). Estos valores son similares a los encontrados en el estudio actual, confirmando de nuevo el potencial nutricional de estas especies como ingredientes o para consumo en estado fresco, en platos o menús.

Además, Rosa (2017) también evaluó la composición cencesimal de arándanos (Vaccinium spp.) (Ericaceae) mostrando contenidos de humedad de 85.26%, ash de 0.18%, proteinas de 0.63%, lipidos de 0.32% y carbohidratos de 12.93%. Estos resultados son similares a los reportados por Souza et al. (2007) y Souza, Pereira, Silva, Lima y Queiroz (2014), quienes obtuvieron resultados de 87.70% para humedad, 0.08% para ash, 0.48% para proteinas, 0.19% para lipidos y 11.54% para carbohidratos, siendo inferiores a los valores encontrados para proteínas y lipidos.

El valor promedio de contenido calórico de las flores comestibles mostró valores de 60.03%, 53.50% y 45.52%, respectivamente. Según el valor calórico calculado para los cuatro macronutrientes mencionados (carbohidratos, fibra, proteína y lipidos), los valores indicados para las flores comestibles en base fresca están orientados para ser alimentos bajos en calorías, como lo describen Reis et al. (2004), donde las flores comestibles, en general, tienen 40 calorías por 100 g.

**Conclusions**

El valor promedio de contenido calórico de las flores comestibles de las tres especies analizadas, rosa (Rosa x grandiflora Hort.), girasol (Helianthus annuus L.) y calendula (Calendula officinalis L.), mostró en sus composiciones relevantes de humedad, proteína, y fibra. Al mismo tiempo, mostraron bajos contenidos de extracto etéreo y bajos valores calóricos, lo cual es adecuado para el consumo en estado fresco, en platos o menús.
Chemical composition of rose, sunflower and calendula flower petals for human food use

Acknowledgments

The authors want to thank Coordinación de Perfeccionamiento de Personal de Nivel Superior (CAPES) for financing this study [Finances Code 001] and for providing a Master's degree scholarship for the first author. Moreover, many thanks to the professors of the Floriculture Sector of the Department de Phytotechniques of UFSM, doctor Fernanda Alice Antonello Londero Backes and doctor Rogério Antônio Bellé, for their collaboration and help in the production and the procurement of the flowers used in this study. The authors also wish to thank the peer reviewers and the editors of this journal for their comments that helped improve this document.

Disclaimer

All authors made significant contributions to the document and agree with its publication; further, all authors state that there are no conflicts of interest in this study.

References


Ministério da Saúde. (2012). Resolução da Diretoria Colegiada RDC N.º 54. Dispõe sobre o Regulamento Técnico sobre feature for the constitution of special diets. In addition, the petals contain ash contents that indicate the presence of important minerals for nutrition. Thus, the edible flowers of rose, sunflower and calendula are promising raw materials for human consumption as ingredients, or for in natura consumption.
Transformation and agroindustry
Chemical composition of rose, sunflower and calendula flower petals for human food use

January - April / 2019


