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Antioxidant Capacities, Total Phenolic Contents, and Phytochemical Profiles of Canned Dandelion (*Taraxacum officinale* L.) Flowers

Running title: Canned Dandelion Flowers

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SUMMARY

Research background. Dandelion flowers have a very short shelf life. The canning process is known not only to stabilize foods and preserve their nutritional content at a high level but also to significantly extend their shelf life. For this reason, canned dandelion flowers are thought to be beneficial for both consumers and the gastronomy sector.

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Experimental approach. In this study, fresh dandelion (*Taraxacum officinale* L.) flowers were canned using sucrose syrups with varying degrees of Brix (°Bx) (20 and 30) as filling mediums and stored at 25 °C for 30 days. A total of 56 phytochemicals were identified using LC-MS/MS, while in vitro antioxidant activities (DPPH and CUPRAC) and total phenolic content (TPC) were analyzed in both the canned flowers and the filling mediums at different storage intervals (10th, 20th, and 30th days).

Results and conclusions. The antioxidant activities of fresh dandelion flowers were 89.625 % and 0.804 mmol Trolox equivalents per gram (mmol Trolox Eq/g), respectively. The lowest DPPH (41.453 %) and CUPRAC (0.328 mmol Trolox Eq/g) activities were observed on the 20th day in samples stored in the 30 ºBx filling medium. TPC in fresh flowers was measured at 367.409 mg gallic acid equivalents per gram of extract (mg GAE/g extract). The highest TPC levels in canned flowers were recorded in samples taken on the 10th day for both ºBx filling mediums. Using LC-MS/MS analysis, 24 phytochemicals were identified in fresh flowers, including quinic acid, luteolin, siranoside, chlorogenic acid, fumaric acid, caffeic acid, protocatechuic acid, quercetin, cosmosiin, isoquercitrin, and apigenin. A decrease in the polyphenol content of canned flowers was observed during storage. The results indicate that canning dandelion flowers in a 30 ºBx syrup medium and storing them for 20 days was effective in preserving their phenolic components and antioxidant capacity.

Novelty and scientific contribution. In the scientific literature, numerous studies focus on extending the shelf life of fruits and vegetables through the canning method. However, this study fills a gap in the literature by successfully applying the canning technique to edible flowers for the first time. Furthermore, the findings of this study contribute to future research on the potential commercialization of canned dandelion flowers as a consumer food product.

Keywords: dandelion flower; canned; antioxidant activities; phytochemicals; LC-MS/MS

INTRODUCTION

Since ancient times, edible flowers have been traditionally consumed as alternatives to medicines or as part of culinary art. These flowers are highly valued for their ability to enhance foods with aroma and vibrant color and are used in a wide range of beverages, salads, soups, sauces, cakes, purees, omelets, and desserts. In addition to their aesthetic appeal and pleasant aroma, edible flowers possess health-promoting effects and high nutritional value (*1*,*2*). Researchers have identified edible flowers as innovative natural sources of bioactive compounds (*2*,*3*). Consequently, scientific interest in the nutritional value and phytochemical profiles of edible flowers has grown steadily (*3,4*).

Phytochemicals such as phenolics and flavonoids have been reported to significantly reduce the risk of health issues, including cardiovascular diseases, obesity, and cancer (*4*,*5*). Compared to fruits and vegetables, edible flowers have been found to contain higher concentrations of antioxidant compounds, such as vitamin C, carotenoids, anthocyanins, and polyphenols (*6*). In Europe, the pharmaceutical use of the edible plant dandelion (*Taraxacum officinale* L.) has a long history in traditional medicine. Dandelion flowers, in particular, are known for their cough-relieving and immune-boosting properties and are traditionally used to produce a syrup called "honey" in Central and Eastern Europe, particularly in countries like Croatia and Poland (*7*). Luteolin and its 7-O-glycoside, which are abundant in dandelion flowers, inhibit the production of nitric oxide and prostaglandin E2 in macrophages stimulated by bacterial lipopolysaccharides. Furthermore, extracts from dandelion flowers have been shown to inhibit liposome oxidation *in vitro* and protect against DNA damage caused by peroxide ($O2^{\bullet-}$) and hydroxyl ($OH^{\bullet}$) free radicals (*8*). *In vivo* studies have demonstrated that dandelion flower extracts have a higher flavonoid content compared to other plant organs, contributing to stronger antioxidant properties (*9*,*10*). Processed edible flower products offer several advantages over fresh flowers. Processed products are safer to consume, as fresh flowers' high water content can lead to the rapid proliferation of microorganisms (*11*). Preservation techniques, such as processing, can extend the shelf life of edible flowers while maintaining their sensory properties over extended periods. Canning is a preservation method that involves packaging products in hermetically sealed and sterilized containers, effectively maintaining product quality for a long time (*12*). By employing a specific combination of temperature and time, the canning process eliminates food pathogens and inactivates enzymes responsible for quality deterioration during storage. As a result, the final products are shelf-stable at ambient temperature and have a long shelf life (*13*). In the food industry, many fruits and vegetables are preserved in cans or glass jars using suitable sucrose syrups or brines (*14*). Research has shown that canned fruits retain nutritional values comparable to those of fresh fruits (*15*,*16*). However, concerns persist about the potential reduction of bioactive compounds in foods due to the type of processing and extraction conditions (*17*). Ultrasonic technology is increasingly used in food processing, preservation, and extraction. This method provides energy efficiency, effective extraction, and protection for heat-sensitive compounds by utilizing low temperatures (*18*,*19*). Edible flowers have a short shelf life and limited production seasons, necessitating preservation technologies. Despite this, many preservation techniques remain underexplored for edible flowers (*20*). In this study, the canning technique was applied for the first time to fresh dandelion flowers. The flowers were canned using sucrose syrups with different degrees of Brix (20 and 30) as filling mediums and stored at 25 °C for 30 days. The antioxidant activities, TPC,

and 56 phytochemicals identified via LC-MS/MS were analyzed in samples taken on the 10th, 20th, and 30th days of storage. The findings revealed the transfer of bioactive compounds from fresh dandelion flowers to the filling mediums and the quantitative changes in the flowers during storage.

MATERIALS AND METHODS

Plant material

The dandelion (*Taraxacum officinale* L.) samples selected for this study were harvested from the traffic-free area of Yeşilova Village in Aksaray Province/Türkiye (38°24'37.7"N, 33°51'18.7"E) in September 2023. Fresh samples were prepared for analysis on the same day. The plant species identification was conducted by Prof. Dr. Mehmet Fuat Gülhan from the Department of Medicinal and Aromatic Plants at Aksaray University, Türkiye.

Preparation of canned flowers and storage conditions

The stems of fresh dandelion flowers were cut immediately before transportation to the laboratory. Fresh flowers were rapidly assessed after being set aside as control samples. All materials used in the canning process were sterilized in an autoclave (MELAG, MELAG 75+, İstanbul, Türkiye) at 121°C and 1 Pa for 15 min. The canned dandelion flowers were produced following methods described in the research on fruit preserves by Campbell and Padilla-Zakour (*15*) and Christofi *et al.* (*16*). Sucrose syrups, prepared with sucrose to achieve 20 ºBx and 30 ºBx degrees, were used as filling mediums Fig. S1. Flowers weighing 250 g were placed in glass jars, which were then filled progressively with 1.5 L of the filling medium, ensuring there were no gaps. The jars, sealed with lids, underwent a pasteurization process at 97–98 °C for 20 min. After pasteurization, the jars were rapidly cooled to room temperature under cold running water. The prepared flower preserves were stored in the dark at 25 °C for 30 days. On the 10th, 20th, and 30th days, samples of both flowers and filling mediums (Fig. S1) were collected for analysis of antioxidant activity, TPC, and phenolic component levels. The flower samples taken during storage were first blotted with blotting paper for a few min to absorb any excess filling medium before analysis.

Ultrasound-assisted extraction

The ultrasound-assisted extraction (Hielscher UP400St Ultrasonic Processor, Teltow, Germany) process was carried out under the following conditions: 40 °C (temperature), 40 kHz

(frequency), 0.025 W/cm² (power), 30 min (duration), 5 g/100 mL (raw material to total solvent ratio), and a 64:36 (EtOH:H_2O) solvent ratio, as outlined by Wang *et al.* (*21*).

2,2-diphenyl-1-picrylhydrazil (DPPH) radical scavenging activity

The free radical scavenging capacity of the samples was determined using a modified version of the DPPH assay described by Brand-Williams *et al.* (*22*). In a 96-well microplate (Nunc™ MicroWell™ 96-Well Microplates, Saint-Herblain, France), 20 µL of the diluted sample (0.5 mg/mL) was mixed with 180 µL of a 0.2 mM methanolic DPPH solution (Sigma-Aldrich, St. Louis, USA). The reaction mixture was incubated (INC 125 F digital Incubator, İstanbul, Türkiye) at room temperature (15–20 °C) for 25 min, allowing the reaction to proceed. Absorbance measurements were taken at 517 nm, the wavelength corresponding to DPPH's maximum absorption, using the microplate reader (Thermo Scientific™ Multiskan™ GO Microplate Spectrophotometer, Massachusetts**,** USA). The absorbance values of the sample (A sample) and the blank (A blank, containing no extract) were then recorded for analysis. DPPH inhibition was calculated as:

$$\text{DPPH inhibition} = ((A_{\text{blank}} - A_{\text{sample}}) / A_{\text{blank}}) \cdot 100 \qquad /1/$$

Cupric reducing antioxidant capacity (CUPRAC) assay

In this study, 500 µL of $CuCl_2$ solution (Sigma-Aldrich, St. Louis, USA) and 500 µL of a 1 M glycine solution (Sigma-Aldrich, St. Louis, USA) ($C_2H_7NO_2$, pH 7.0) were transferred into test tubes. Each tube was then supplemented with 500 µL of a neocuproin solution ($C_{14}H_{12}N_2$, 7.5×10^{-3} M) (Sigma-Aldrich, St. Louis, USA). Subsequently, 100 µL of a lyophilized extract solution (1 mg/mL) was added, followed by the addition of 550 µL of distilled water. For blank samples, the extract was replaced with distilled water. The mixtures were incubated for 30 min, both at room temperature and in a water bath maintained at 50 °C. The absorbance at 450 nm was recorded relative to the blank, using ascorbic acid (Sigma-Aldrich, St. Louis, USA) as a standard reference (*23*).

Determination of total phenolic contents

The TPC of the samples was assessed using spectrophotometric (Thermo Scientific™ Multiskan™ GO Microplate Spectrophotometer, Massachusetts**,** USA) methods. For analysis at 760 nm, a mixture was prepared by combining 7.9 mL of distilled water, 0.5 mL of Folin-Ciocalteu reagent (Merck, Darmstadt, Germany), and 1.5 mL of 20 % Na_2CO_3 solution (Merck, Darmstadt, Germany). The resulting solution was incubated at 25 °C for 2 h. Triplicate measurements were performed using

gallic acid (Merck, Darmstadt, Germany) as the reference standard, and the phenolic content was reported as mg GAE/g (*24*).

LC-MS/MS instrumentation and chromatographic conditions

Using tandem mass spectrometry and Shimadzu-Nexera (Kyoto, Japan) model UHPLC, 56 different phytochemicals were measured and Total Ion Chromatograms (TICs) of standard phenolic compounds were shown (Fig. 1). LC-30AD model binary pumps, a DGU-20A3R model degasser, a CTO-10ASvp model column oven, and a SIL-30AC model autosampler made up the reversed-phase UPLC system. For chromatographic separation, a reversed phase Agilent Poroshell 120 EC–C18 model analytical column with 150 mm length, 2.1 mm inner diameter, and 2.7 µm particle size was utilized. The column temperature was fixed at 40 °C. The gradient elution was prepared using Eluent A [(H_2O +5 mM NH_4HCO_2 (Merck, Darmstadt, Germany)+0.1 % HCOOH (Merck, Darmstadt, Germany)] and Eluent B [(MeOH (Sigma-Aldrich, St. Louis, USA) + 5 mM NH_4HCO_2 (Merck, Darmstadt, Germany) + 0.1 % HCOOH (Merck, Darmstadt, Germany)]. The following parameters were used in a gradient elution profile: 20 % B (35–45 min), 100 % B (25–35 min), and 20–100 % B (0–25 min). 5 µL was the injection volume, and 0.5 mL/min was the solvent flow rate. The Shimadzu LCMS-8040 (Kyoto, Japan) tandem mass spectrometer, which included an electrospray ionization (ESI) source that could function in both positive and negative ionization modes, was used for mass spectrometric detection. Shimadzu's LabSolutions software was used to gather and analyze LC-MS/MS data. The multiple reaction monitoring, or MRM, approach was used to quantify the phytochemicals. The MRM approach proved to be the most successful in identifying and quantifying the phytochemical compounds, according to tests of various precursor phytochemical-to-fragment ion transitions. For effective phytochemical fragmentation and maximal transfer of the intended product ions, the collision energies (CE) were tuned. The MS operated with the following parameters: DL temperature of 250 °C, heat block temperature of 400 °C, interface temperature of 350 °C, drying gas (N_2) flow rate of 15 L/min, and nebulizing gas (N_2) flow rate of 3 L/min (*25*).

Fig. 1

Statistical analysis

Statistical analysis of the acquired data was performed using Minitab version 21.3 software (*26*). The results are presented as means (SEM) derived from three independent experiments ($N \geq 3$). Each sample in the study was replicated at least three times. Variability among the mean results was

assessed using ANOVA, and Turkey's multiple comparison test was employed for variance analysis. Statistical significance was determined at $p \leq 0.05$.

RESULTS AND DISCUSSION

Phytochemical composition

The therapeutic effects of dandelion flowers are attributed to numerous bioactive compounds (terpenes, flavonoids, phenolics, *etc*.) (*27*). The phytochemical composition of herbal preparations is influenced by factors such as the harvest period, environmental conditions, and applied techniques (*28*). The stability of bioactive ingredients, which is critical for the shelf life and bioavailability of the food products to which they are added, is impacted by their sensitivity to environmental conditions (oxygen, light, temperature, and water) (*29*). In this study, for the first time, comprehensive and sensitive analyses of 56 phytochemicals in both fresh and canned dandelion flowers and their filling mediums were conducted using LC-MS/MS (Table 1). The analysis revealed the presence of 24 phytochemicals in varying amounts in fresh flowers, including quercetin, cyranoside (luteolin-7-O-glucoside), cosmosiin (apigenin-7-glucoside)chlorogenic acid, quinic acid, fumaric acid, caffeic acid, luteolin, protocatechuic acid, , isoquercitrin (quercetin-3-O-glucoside), p-coumaric acid, aconitic acid, protocatechuic aldehyde, apigenin, vanillin, salicylic acid, 4-hydroxybenzoic acid, rutin (quercetin-3-O-rutinoside), rosmarinic acid, hesperetin, naringenin, hesperidin (hesperetin 7-rutinoside), acacetin, and chrysin. The polyphenol content in dandelion plants has been reported to be higher in the flowers and leaves ((9.9±0.28) g polyphenols per 100 g dandelion extract) compared to the roots ((0.086±0.003) g polyphenols per 100 g dandelion extract) (*30*). Previous studies have identified various flavonoid glycosides in fresh dandelion flowers, such as luteolin, chlorogenic acid, caffeic acid, luteolin-7-diglucoside, luteolin-7-O-glucoside, and (*31*,*32*), as well as chrysoeriol, monocaffeoyltartaric acid (*33*), ferulic acid, cichoric acid, 3,5-di-O-caffeoylquinic acid, caffeic acid ethyl ester, p-hydroxybenzoic acid, 4,5-di-O-caffeoylquinic acid, 3,5-dihydroxybenzoic acid, gallic acid, p-coumaric acid, 3,4-dihydroxybenzoic acid, and syringic acid (*34*). Furthermore, various flavonoid glycosides, such as quercetin-7-O-glucoside, isorhamnetin-3-O-glucoside, apigenin-7-O-glucoside, and luteolin-7-O-rutinoside, have also been detected (*33*,*35*). When compared with other studies, this study is unique in that it identifies, for the first time, the presence of fumaric acid, quercetin, cosmosiin, isoquercitrin, p-coumaric acid, apigenin, 4-hydroxybenzoic acid, protocatechuic acid, aconitic acid, vanillin, salicylic acid, rutin, naringenin, hesperidin, rosmarinic acid, hesperetin, protocatechuic aldehyde, chrysin, and acacetin in fresh dandelion flowers. Changes in the content of

biologically active components in plants can be influenced by factors including genotype, climate, soil characteristics, vegetative structure, harvest time, and various technical practices (*36*). Recent studies have indicated that thermal processing of fruits and vegetables leads to various chemical changes, which may alter the biological activities of phytochemicals (increase, decrease, or stability). Therefore, it has been observed that heat-processed foods generally exhibit different biological activities compared to their raw counterparts. Phenolic component analysis revealed that 11 of the 56 phenolic compounds were the most dominant in dandelion flowers. These phenolics were ranked in descending order based on their quantities as follows: Quinic acid (52.313 mg analyte/g extract), luteolin (29.50 mg analyte/g extract), cyranoside (luteolin-7-O-glucoside) (28.51 mg analyte/g extract), chlorogenic acid (22.439 mg analyte/g extract), fumaric acid (15.65 mg analyte/g extract), caffeic acid (3.981 mg analyte/g extract), protocatechuic acid (2.594 mg analyte/g extract), quercetin (2.151 mg analyte/g extract), cosmosiin (2.068 mg analyte/g extract), isoquercitrin (2.001 mg analyte/g extract), and apigenin (1.991 mg analyte/g extract) (Table 1). Phenolic compounds exhibited variations in their quantities during the storage process of preserved flowers and filling mediums due to their distinct properties. Phytochemicals such as quinic acid, luteolin, luteolin-7-O-glucoside, chlorogenic acid, protocatechuic acid, and apigenin were better preserved in flowers stored in 20 ºBx and 30 ºBx syrup mediums during the 10th and 20th days compared to the 30th day. These phytochemicals, especially in the 30 ºBx syrup, were found at the highest quantities, particularly on the 20th day. Furthermore, these compounds were also detected in filling mediums, likely due to their high thermal stability and hydrophilic nature. Analysis indicated lower leakage of phenolic compounds into the filling mediums on the 20th day, with this phenomenon being more pronounced in samples preserved in 30 ºBx syrup compared to those in 20 ºBx syrup. Based on the chromatographic results, it can be concluded that phenolic components were best preserved in dandelion flower preserves prepared with 30 ºBx syrup on the 20th day. On the other hand, phytochemicals such as caffeic acid, quercetin, cosmosiin, isoquercitrin, p-coumaric acid, 4-hydroxybenzoic acid, aconitic acid, protocatechuic aldehyde, vanillin, salicylic acid, rutin, hesperidin, rosmarinic acid, hesperetin, naringenin, chrysin, and acacetin despite their hydrophilic properties were found in very low or undetectable levels in preserved flowers and filling mediums, due to their moderate or low thermal stability. Fumaric acid, unlike other phytochemicals, has a hydrophobic nature. This compound consistently decreased during the storage process in canned foods prepared with 20 ºBx and 30 ºBx filling mediums, and it was noteworthy that it did not migrate into the filling mediums at all. Chromatograms of phytochemicals detected in fresh flowers (Fig. 2a), canned dandelion flowers (Fig. 2b), and filling mediums (Fig. 2c) are shown. In line with this study's findings, Şengül-Binat and Kırca-Toklucu (*37*) determined rutin, gallic acid,

chlorogenic acid syringic acid and epicatechin concentrations in canned fig samples and filling mediums during 12 months of storage at 25 °C. They found that the fig juice used in the canning process leaked into the filling medium, leading to a significant increase in phenolic compounds, and measured syringic acid, chlorogenic acid, rutin, epicatechin, and gallic acid concentrations as 122.64, 22.82, 27.28, 43.32, and 9.96 mg/100 g FM, respectively.

Table 1

Fig. 2

Antioxidant activities and total phenolic contents

The two tests used to determine antioxidant capacities assess antioxidant activity through different mechanisms. The DPPH test measures the ability of antioxidants in herbal preparations to neutralize free radicals, whereas the CUPRAC test evaluates their ability to reduce Cu^{2+} ions to Cu^{+} ions. In both DPPH and CUPRAC analyses, the highest antioxidant activities were detected in sample A (89.625 % and 0.804 mmol Trolox Eq/g, respectively) (Table 2). The results closest to this value were observed in samples E (86.326 % and 0.731 mmol Trolox Eq/g), F (78.140 % and 0.728 mmol Trolox Eq/g), B (74.938 % and 0.645 mmol Trolox Eq/g), and C (72.902 % and 0.638 mmol Trolox Eq/g), respectively. In the filling mediums, DPPH and CUPRAC activities were significantly lower than in both fresh and preserved flowers ($p<0.05$). The lowest levels of DPPH (56.608 %) and CUPRAC (0.475 mmol Trolox Eq/g) were found in sample I, which consisted of canned flowers in a 20 ºBx syrup medium. DPPH (41.543 %) and CUPRAC (0.328 mmol Trolox Eq/g) showed the lowest antioxidant activity for 30 ºBx syrup ($P<0.05$). A proportional relationship was observed between TPC and antioxidant activity tests. The highest TPC level in sample A was 367.409 mg GAE/g extract ($p<0.05$). During storage, these levels were found to be lower in canned dandelions with both 20 ºBx and 30 ºBx syrups (Table 2). TPC levels in filling mediums were also lower compared to fresh and canned flowers. Notably, the lowest TPC levels were observed in sample I (20 ºBx, 205.387 mg GAE/g extract) and sample L (30 ºBx, 171.827 mg GAE/g extract) ($p<0.05$). Based on these results, it can be concluded that, compared to fresh flowers, the antioxidant activity of canned flowers in 20 ºBx and 30 ºBx sucrose syrups was preserved between the 10th and 20th days, but a decrease in these activities was observed by the 30th day. Furthermore, the results show that phenolic components with hydrophilic characteristics, which leach into the filling mediums, are present in varying amounts. It is noteworthy that less transition from canned flowers prepared with 30 ºBx syrup into the filling medium was observed compared to those prepared with 20 ºBx. In fact, TPC levels were found to be lowest in the 20th day samples from the 30 ºBx filling medium ($p<0.05$). These data indicate that at 30 ºBx,

the phenolic components of canned flowers are better preserved and transfer less into the filling medium. Dedić *et al*. (*38*) produced aqueous-ethanol extracts of dandelion using many extraction methods, such as maceration at ambient and elevated temperatures, ultrasonic extraction, and soxhlet extraction. They then examined the root, leaf, stem, and floral components of the plant. The authors indicated that the phenolic compound concentration was greater in the floral and foliar sections of the plant than in the root, with the maximum antioxidant activity detected in the aqueous-ethanol extract derived from soxhlet extraction. Nowak *et al*. (*39*), extracted fresh and dried dandelion leaves, flowers, and roots using an ultrasonic bath with ethanol concentrations (40, 70 and 96 %) and extraction periods (15, 30, and 60 min). The research noticed that raw material, solvent, and extraction time affected dandelion's antioxidant activity. Dried flower extracts with 70 % ethanol for 30 min had the greatest DPPH activity, whereas dried leaf extracts with 40 % ethanol had the highest FRAP reduction capability. Ivanov (*27*) reported that total phenolics, chicoric acid content, and antioxidant activity (DPPH, FRAP, and CUPRAC) were elevated in 50 % ethanol extracts of dandelion leaves. Milek and Legath (*40*) extracted phenolic components from dandelion flowers and leaves by ultrasonic extraction with solvents (methanol, ethanol, and acetone) at a concentration of 70 %. The maximum production of phenolics from leaves was achieved using acetone, followed by methanol and ethanol. The total phenolic content in the extracts of *Taraxacum officinale* was determined to be (362.14±6.76) μM. The parts of the plant used, the climatic conditions of the region where the plant is collected, the type, duration, and temperature of extraction, the polarity of the solvent, the solubility of polyphenols, and their interactions with other compounds significantly affect antioxidant activity. Additionally, the lipophilic/hydrophilic properties of plant compounds should be considered. Moreover, thermal processing conditions can accelerate oxidation and other degenerative reactions, leading to the loss of natural antioxidants. Considering these factors, the results of the current study may differ from those of other studies. Several studies have investigated the antioxidant effects of fresh dandelion flowers in both in vitro and in vivo mediums. In a study consistent with our findings, it was reported that methanolic dandelion flower extract exhibited a 95 % inhibition rate (*41*). Antioxidant compounds in dandelion flowers have been shown to inhibit DNA and liposome oxidation induced by peroxyl and hydroxyl radicals in vitro (*42*). Another study found that dandelion flowers were more effective than leaves in inhibiting plasma protein and lipid oxidation in vitro (*9*). The authors indicated that the reducing activity of dandelion flowers is equivalent to 40 % of ascorbic acid, and the inhibitory activity of fresh flower extracts against damage induced by reactive oxygen species and nitric oxide may be linked to caffeic acid, chlorogenic acid, luteolin, and luteolin 7-O-glucoside. Dandelion polyphenols have been shown to reduce nitric oxide, prostaglandin E2, TNF-α, and IL-1 production in

lipopolysaccharide-stimulated RAW264.7 cells. Additionally, luteolin and luteolin-7-O-glucoside from dandelion flower extracts have been shown to reduce the expression of both inducible nitric oxide synthase and cyclooxygenase 2 (*43*). According to studies by Burda and Oleszek (*44*), the hydroxyl radical-suppressing effect of dandelion flower extract may be partly due to the presence of phenolic components such as flavonoids and coumaric acid. Furthermore, the DPPH radical scavenging activity of dandelion flower extract has been associated with the presence of luteolin-7-glucoside. Hassan *et al.* (*45*) observed that long-term use of dandelion flower extract (300 mg/kg body weight per day) in rats played a crucial role in combating oxidative stress. The study concluded that the flavonoids, phenolic acids, and terpenoids found in fresh dandelion flowers, along with other antioxidants, could protect the human body against the pathological effects of free radicals (*31*,*32*). Therefore, it is suggested that the natural compounds found in dandelion exhibit antioxidant, anticoagulant, and anti-clotting activities, making them potentially useful in the prevention and treatment of commonly occurring cardiovascular diseases. Many studies have indicated that canned foods contain similar amounts of certain nutrients compared to fresh or frozen foods. For example, more than 30 % of phenolic compounds in canned peach and apricot varieties diffused into the syrup (*15*). Additionally, it has been reported that canned fruits and syrups exhibited higher phenolic content after 6 months of storage at 20 °C. Researchers have suggested that syrup consumption or secondary use may be important to increase total phenolic intake from canned fruit. In the study by Chaovanalikit and Wrolstad (*46*), approximately 50 % of the phenolic compounds in canned cherries were found to pass into the syrup. Asami *et al.* (*47*) noted that different storage periods might alter the quantity of phenolic compounds. In the study by Şengül-Binat and Kırca-Toklucu (*37*), total phenolic levels in the filling medium of figs during the canning and storage process were examined. They observed an increase in the TPC of canned juice and syrup, while the TPC of canned fig juice decreased after canning. They also reported that 6 and 12 months of storage led to a 25–35 % decrease in the TPC of canned figs. These results suggest that the canning process preserves a substantial portion of the phenolic compounds and antioxidant capacity. However, antioxidant compounds can be oxidized and degraded due to thermal processing. Various factors, such as heating temperature, duration, and type, can influence the stability of these compounds. Phenolic compounds, being water-soluble, may leach into their surroundings, particularly in fruits immersed in syrup or filling medium (*17*). Thermal treatment can significantly impact the absorption of phenolic compounds by the body, resulting in a notable reduction in the chemical composition of foods, particularly phenolic compounds (*48*). This process is often linked to a substantial decrease in antioxidant activities. Additionally, the storage process itself can contribute to a decline in the TPC of food products (*49*). The cooking of plant

products may break down cell wall components, leading to the release of molecules or leaching of water-soluble polyphenols into the surrounding environment. Polyphenols may also degrade at elevated temperatures (*50*). In contrast to our findings, Wang *et al.* (*51*) reported a significant increase in the antioxidant activity of canned lychee pulps following heat application at 121 °C. Similarly, Chen *et al.* (*52*) demonstrated that high-pressure treatment and thermal processing (121 °C, 3 min) elevated bioactive compounds and total antioxidant activity in green asparagus juice. Yahya *et al.* (*53*) determined the TPCs of canned fruits to be 95.16 mg GAE/100 g in pineapple, 47.69 mg GAE/100 g in longan, 51.80 mg GAE/100 g in litchi, and 27.53 mg GAE/100 g in rambutan. Notably, fruits in syrup form exhibited higher TPCs compared to canned fruits. The radical scavenging capacities of canned pineapple (41.79 μmol TE/100 g), rambutan (39.35 μmol TE/100 g), longan (41.67 μmol TE/100 g), and lychee (39.76 μmol TE/100 g) were determined using the DPPH assay. Interestingly, syrup samples exhibited higher radical scavenging activity compared to canned fruit. Durst and Weaver (*54*) reported that canned peaches exhibited 1.5 times greater antioxidant activity compared to fresh peaches, with no significant decline noted after 3 months of storage.

Table 2

CONCLUSIONS

The study highlights an innovative approach to extending the short shelf life of dandelion flowers through canning while preserving their valuable phytochemical content and antioxidant-active compounds. This method offers a practical solution for utilizing dandelion flowers beyond their natural availability period, making their health benefits accessible year-round. Notably, the research establishes the optimal storage period for canned flowers prepared with 30 °Bx sucrose syrup as 20 days, providing critical insights for producers and consumers. The findings emphasize the superior preservation capacity of sucrose syrup, even though a decline in antioxidant activity is observed after 10 days. A key innovation lies in the recommendation to consume the flowers along with the filling medium to maximize nutritional benefits. Furthermore, the study introduces the idea of exploring alternative filling mediums, such as fruit juices, which could open new avenues for enhancing both the nutritional value and consumer appeal of preserved dandelion flowers. This research not only provides practical guidelines for manufacturers but also contributes to the growing body of knowledge on the preservation of phytochemical-rich natural products, underscoring its novelty and importance in the field of food science and nutrition.

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DECLARATION OF COMPETING INTEREST

The author declare no conflict of interest.

SUPPLEMENTARY MATERIALS

Supplementary materials are available at: www.ftb.com.hr.

AUTHORS' CONTRIBUTIONS

Ayca Gülhan and Mehmet Fuat Gülhan contributed to the development of the initial idea and design of the research project, the organization and management of data in a structured and accessible manner, the execution of the investigation (including data collection and necessary experiments), and the design and framework of the research methods; they ensured adherence to appropriate procedures throughout the study, and managed and coordinated the project. Oğuz Çakır and Mustafa Abdullah Yılmaz contributed to formal data analysis, including statistical examination and interpretation of the results, as well as data processing and analysis, and were involved in writing, reviewing, and editing the manuscript. Cihan Düşgün contributed to conducting antioxidant analysis, including statistical examination and interpretation of the results, and participated in the design and development of the methods.

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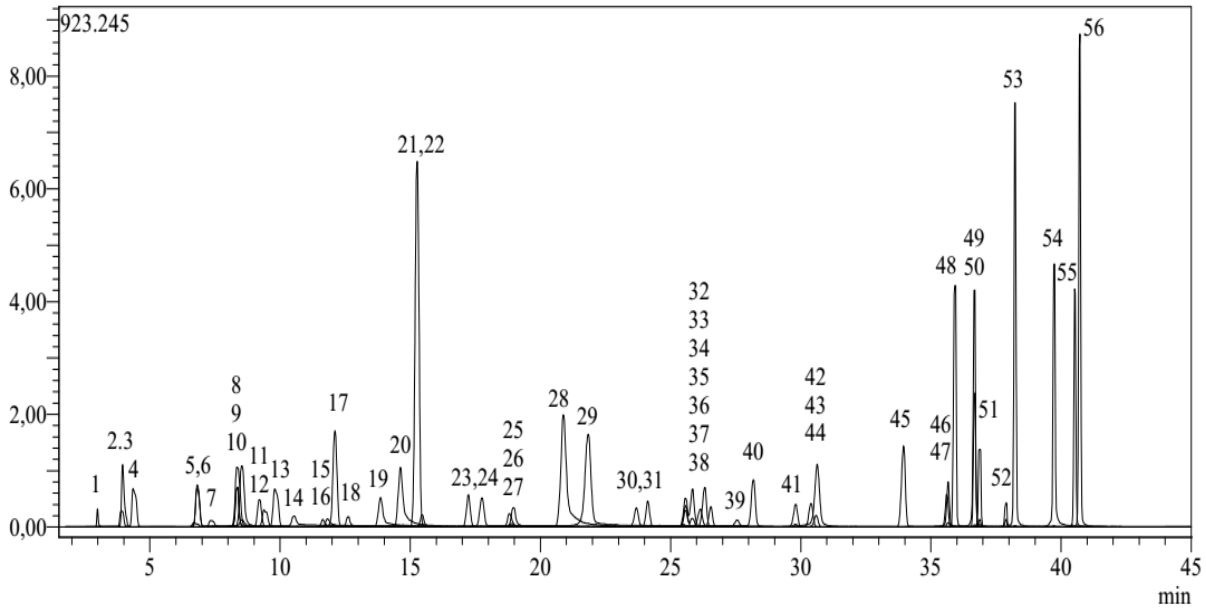

Fig. 1. Total ion chromatogram (TIC) of standard phenolic compounds analysed by the LC-MS/MS method: 1=quinic acid, 2=fumaric acid, 3=aconitic acid, 4=gallic acid, 5=epigallocatechin, 6=protocatechuic acid, 7=catechin, 8=gentisic acid; 9=chlorogenic acid, 10=protocatechuic aldehyde, 11=tannic acid, 12=epigallocatechin gallate, 13=1,5-dicaffeoylquinic acid, 14=4-hydroxybenzoic acid, 15=epicatechin, 16=vanilic acid, 17=caffeic acid, 18=syringic acid, 19=vanillin, 20=syringic aldehyde, 21=daidzin, 22=epicatechin gallate; 23=piceid, 24=*p*-coumaric acid, 25=ferulic acid-D3, 26=ferulic acid; 27=sinapic acid, 28=coumarin, 29=salicylic acid, 30=cynaroside, 31=miquelianin, 32=rutin, 33=rutin-D3, 34=isoquercitrin, 35=hesperidin, 36=*o*-coumaric acid, 37=genistin, 38=rosmarinic acid, 39=ellagic acid, 40=cosmosiin, 41=quercitrin, 42=astragalin, 43=nicotiflorin, 44=fisetin, 45=daidzein, 46=quercetin-D3, 47=quercetin, 48=naringenin, 49=hesperetin, 50=luteolin, 51=genistein, 52=kaempferol, 53=apigenin, 54=amentoflavone, 55=chrysin, 56=acacetin

Table 1. Phytochemical composition of fresh dandelion flowers, canned flowers and filling mediums by LC-MS/MS

No	Analytes	RT[a]	M.I. (*m/z*)[b]	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Quinic acid	3.0	190.8	(52.313±1.94)[a]	(38.698±1.44)[a]	(35.439±1.31)[a]	(21.503±0.80)[a]	(46.244±1.72)[a]	(41.722±1.55)[a]	(32.414±1.20)[a]	(19.056±0.70)[b]	(9.274±0.34)[b]	(13.586±0.50)[b]	(5.421±0.20)[b]	(2.230±0.08)[c]	(12.576±0.46)[b]
2	Fumaric acid	3.9	115.2	(15.650±0.14)[b]	(9.713±0.08)[b]	(5.659±0.05)[b]	(4.451±0.04)[c]	(12.067±0.10)[b]	(10.218±0.09)[b]	(7.412±0.06)[b]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3	Aconitic acid	4.0	172.8	(1.609±0.04)[c]	(0.279±0.07)[d]	(0.254±0.06)[d]	(0.104±0.03)[d]	(0.415±0.01)[d]	(0.327±0.08)[d]	(0.195±0.05)[d]	N.D.	N.D.	(0.045±0.01)[d]	N.D.	N.D.	(0.023±0.01)[d]
4	Gallic acid	4.4	168.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
5	Epigallocatechin	6.7	304.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
6	Protocatechuic acid	6.8	152.8	(2.594±0.09)[c]	(2.045±0.07)[c]	(0.988±0.03)[d]	(0.653±0.02)[d]	(2.423±0.08)[c]	(2.369±0.08)[c]	(1.227±0.04)[c]	(0.215±0.08)[d]	(0.134±0.05)[d]	(0.261±0.09)[d]	(0.148±0.05)[d]	(0.171±0.06)[d]	(0.389±0.01)[d]
7	Catechin	7.4	288.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
8	Gentisic acid	8.3	152.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
9	Chlorogenic acid	8.4	353.0	(22.439±0.4)[b]	(16.673±0.35)[b]	(13.587±0.28)[b]	(7.331±0.15)[b]	(19.308±0.41)[b]	(18.711±0.39)[b]	(12.981±0.27)[b]	(0.642±0.01)[d]	(0.222±0.05)[d]	(0.712±0.01)[d]	(0.361±0.08)[d]	(0.198±0.04)[d]	(0.597±0.01)[d]
10	Protocatechuic aldehyde	8.5	137.2	(1.411±0.05)[c]	(0.559±0.02)[d]	(0.509±0.02)[d]	(0.375±0.05)[d]	(0.752±0.03)[d]	(0.451±0.01)[d]	(0.367±0.01)[d]	N.D.	(0.042±0.02)[d]	(0.058±0.02)[d]	N.D.	N.D.	(0.059±0.02)[d]
11	Tannicacid	9.2	182.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
12	Epigallocatechin gallate	9.4	457.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
13	Cynarin	9.8	515.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
14	4-hydroxybenzoic acid	10.5	137,2	(0.409±0.01)[d]	(0.346±0.08)[d]	N.D.	N.D.	(0.431±0.01)[d]	(0.405±0.01)[d]	(0.417±0.01)d	(0.032±0.01)[d]	N.D.	N.D.	N.D.	N.D.	(0.007±0.01)[d]
15	Epicatechin	11.6	289.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
16	Vanilic acid	11.8	166.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
17	Caffeic acid	12.1	179.0	(3.981±0.06)[c]	(1.529±0.02)[c]	(1.341±0.02)[c]	(0.712±0.01)[d]	(2.422±0.03)[c]	(1.898±0.03)[c]	(1.036±0.01)[c]	(0.622±0.09)[d]	(0.057±0.01)[d]	(0.469±0.07)[d]	(0.333±0.05)[d]	(0.275±0.04)[d]	(0.571±0.09)[d]
18	Syringic acid	12.6	196.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
19	Vanillin	13.9	153.1	(0.121±0.01)[d]	(0.078±0.01)[d]	(0.077±0.01)[d]	(0.081±0.01)[d]	(0.102±0.01)[d]	(0.101±0.01)[d]	(0.109±0.01)[d]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
20	Syringic aldehyde	14.6	181.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
21	Daidzin	15.2	417.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
22	Epicatechin gallate	15.5	441.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
23	Piceid	17.2	391.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
24	*p*-Coumaric acid	17.8	163.0	(1.833±0.03)[d]	(0.135±0.03)[d]	(0.096±0.02)[d]	(0.088±0.02)[d]	(0.378±0.07)[d]	(0.103±0.02)[d]	(0.112±0.02)[d]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
25	Ferulic acid-D3	18.8	196.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
26	Ferulic acid	18.8	192.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
27	Sinapic acid	18.9	222.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
28	Coumarin	20.9	146.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
29	Salicylic acid	21.8	137.2	(0.524±0.08)[d]	(0.056±0.01)[d]	(0.059±0.01)[d]	(0.055±0.01)[d]	(0.417±0.07)[d]	(0.272±0.04)[d]	(0.125±0.002)[d]	N.D.	N.D.	N.D.	(0.021±0.01)[d]	(0.034±0.01)[d]	(0.023±0.01)[d]
30	Cyranoside	23.7	447.0	(28.510±1.0)[b]	(21.813±0.79)[b]	(16.852±0.61)[b]	(9.231±0.33)[b]	(23.899±0.87)[b]	(19.461±0.71)[b]	(14.861±0.54)[b]	(4.027±0.14)[c]	(3.065±0.12)[c]	(6.027±0.21)[b]	(2.027±0.07)[c]	(1.022±0.03)[c]	(4.027±0.14)[c]
31	Miquelianin	24.1	477.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
32	Rutin-D3-IS	25.5	612.2	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
33	Rutin	25.6	608.9	(0.413±0.01)[d]	(0.078±0.02)[d]	(0.046±0.01)[d]	(0.151±0.04)[d]	(0.248±0.06)[d]	(0.216±0.05)[d]	(0.199±0.05)[d]	N.D.	N.D.	(0.028±0.01)[d]	N.D.	N.D.	N.D.
34	Isoquercitrin	25.6	463.0	(2.001±0.04)[b]	(0.257±0.06)[d]	(0.247±0.05)[d]	(0.152±0.03)[d]	(0.479±0.01)[d]	(0.297±0.07)[d]	(0.127±0.03)[d]	(0.008±0.01)[d]	(0.014±0.01)[d]	(0.112±0.02)[d]	N.D.	N.D.	(0.034±0.01)[d]
35	Hesperidin	25.8	611.2	(0.212±0.07)[d]	(0.071±0.02)[d]	(0.013±0.01)[d]	(0.080±0.03)[d]	(0.063±0.02)[d]	(0.059±0.02)[d]	(0.054±0.02)[d]	(0.008±0.01)[d]	N.D.	(0.011±0.01)[d]	N.D.	N.D.	N.D.
36	*o*-Coumaric acid	26.1	162.8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
37	Genistin	26.3	431.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
38	Rosmarinic acid	26.6	359.0	(0.168±0.02)[d]	(0.128±0.02)[d]	(0.051±0.01)[d]	(0.024±0.01)[d]	(0.123±0.02)[d]	(0.023±0.01)[d]	(0.019±0.01)[d]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
39	Ellagic acid	27.6	301.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
40	Cosmosiin	28.2	431.0	(2.068±0.01)[c]	(0.088±0.01)[d]	(0.027±0.01)[d]	(0.023±0.01)[d]	(0.101±0.01)[d]	(0.084±0.01)[d]	(0.013±0.01)[d]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
41	Quercitrin	29.8	447.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
42	Astragalin	30.4	447.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
43	Nicotiflorin	30.6	592.9	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
44	Fisetin	30.6	285.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
45	Daidzein	34.0	253.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
46	Quercetin-D3-IS	35.6	304.0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
47	Quercetin	35.7	301.0	(2.151±0.03)[c]	(0.613±0.01)[d]	(0.507±0.09)[d]	(0.331±0.06)[d]	(1.896±0.03)c	(1.852±0.03)[c]	(0.834±0.01)[d]	N.D.	N.D.	(0.059±0.01)[d]	N.D.	N.D.	(0.034±0.01)[d]
48	Naringenin	35.9	270.9	(0.437±0.01)[d]	(0.251±0.01)[d]	(0.244±0.01)[d]	(0.235±0.09)[d]	(0.239±0.09)[d]	(0.213±0.08)[d]	(0.211±0.08)[d]	(0.026±0.01)[d]	(0.004±0.01)[d]	(0.047±0.02)[d]	N.D.	N.D.	(0.004±0.01)[d]
49	Hesperetin	36.7	301.0	(0.119±0.04)[d]	(0.054±0.02)[d]	(0.017±0.01)[d]	(0.032±0.01)[d]	(0.105±0.03)[d]	(0.053±0.02)[d]	(0.047±0.02)[d]	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

50	Luteolin	36.7	284.8	(29.50±0.92)^{b}	(21.544±0.67)^{b}	(19.882±0.66)^{b}	(12.945±0.40)^{b}	(24.291±0.76)^{b}	(22.407±0.70)^{b}	(16.564±0.51)^{b}	(1.163±0.03)^{c}	(0.513±0.06)^{d}	(1.984±0.06)^{c}	(1.014±0.03)^{c}	(0.759±0.02)^{d}	(1.335±0.04)^{c}
51	Genistein	36.9	269.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
52	Kaempferol	37.9	285.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
53	Apigenin	38.2	268.8	(1.991±0.03)^{c}	(1.851±0.03)^{c}	(1.471±0.02)^{c}	(1.545±0.02)^{c}	(1.636±0.02)^{c}	(1.436±0.02)^{c}	(1.261±0.02)^{c}	(0.187±0.03)^{d}	(0.005±0.01)^{d}	(0.221±0.04)^{d}	(0.069±0.01)^{d}	(0.039±0.01)^{d}	(0.074±0.01)^{d}
54	Amentoflavone	39.7	537.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
55	Chrysin	40.5	252.8	(0.102±0.03)^{b}	(0.092±0.03)^{d}	(0.078±0.03)^{d}	(0.095±0.03)^{d}	(0.067±0.02)^{d}	(0.006±0.01)^{d}	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
56	Acacetin	40.7	283.0	(0.075±0.03)^{d}	(0.106±0.04)^{d}	(0.096±0.03)^{d}	(0.041±0.01)^{d}	(0.024±0.01)^{d}	(0.013±0.01)^{d}	(0.006±0.01)^{d}	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

N.D.=not detected, N.A.=not applicable. Samples: A=fresh dandelion flower, B=dandelion flower in 20 ºBx on 10th day, C=dandelion flower in 20 ºBx on 20th day, D=dandelion flower in 20 ºBx on 30th day, E=dandelion flower in 30 ºBx on 10th day, F=dandelion flower in 30 ºBx on 20th day, G=dandelion flower in 30 ºBx on 30th day, H=filling medium in 20 ºBx on 10th day, I=filling medium in 20 ºBx on 20th day, J=filling medium in 20 ºBx on 30th day, K=filling medium in 30 ºBx on 10th day, L=filling medium in 30 ºBx on 20th day and M=filling medium in 30 ºBx on 30th day. Results are expressed as mg analyte/g extract. Values expressed are means±S.D. of three parallel measurements and values were calculated according to negative control. Values with different letters in the same column were significantly different ($p < 0.05$). The superscript letters (a, b, c, and d) used in the rows represent the significant differences ($p < 0.05$) among the data

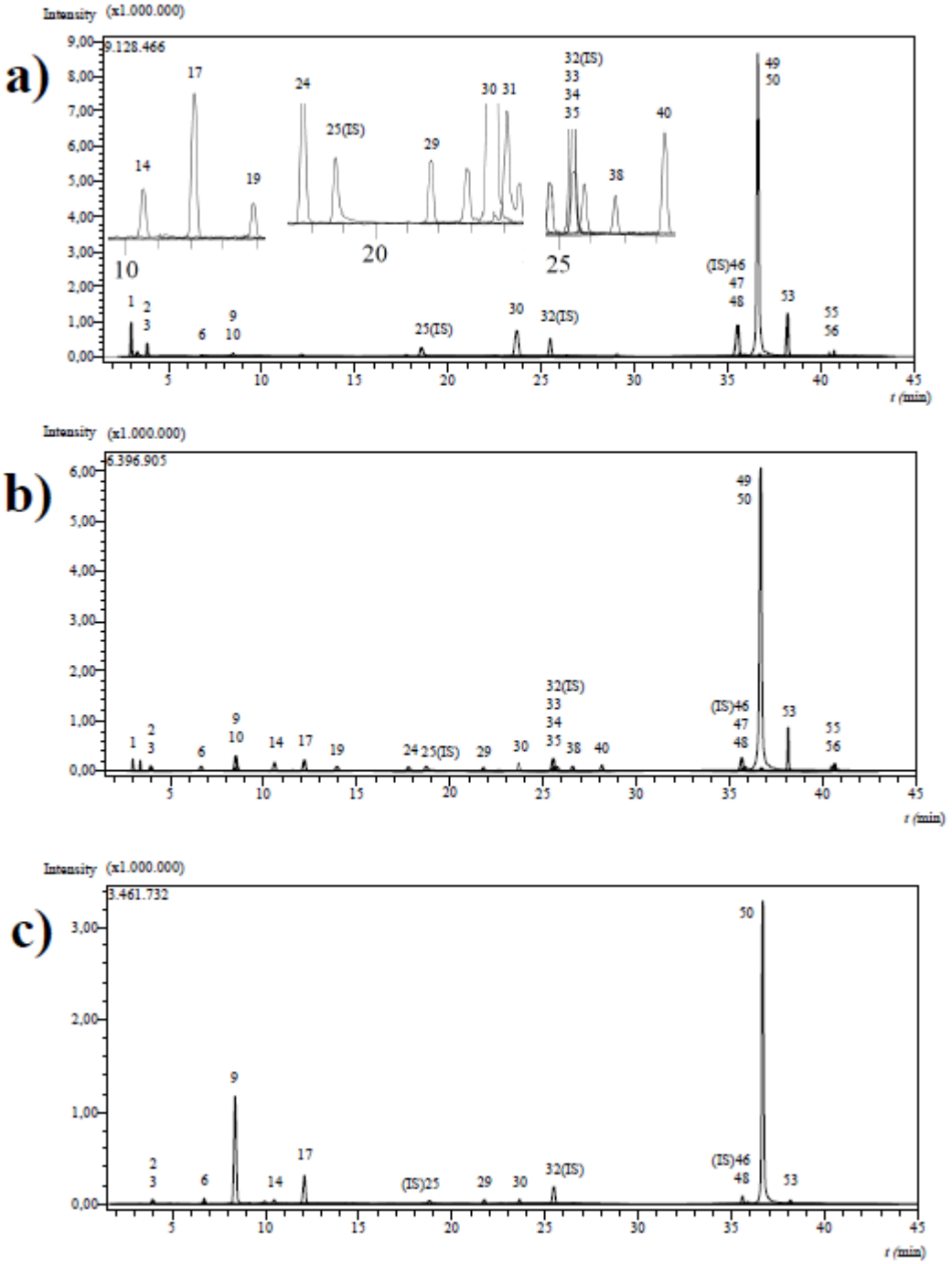

Fig. 2. LC-MS/MS chromatograms of: a) fresh dandelion flower, b) dandelion flower in 30 ºBx on 10th day and c) filling medium in 30 ºBx on 20th day

Table 2. Evaluation of DPPH, CUPRAC, and TPC of fresh, canned dandelion flowers and filling mediums

Sample	DPPH inhibition/%	CUPRAC/(mmol TE/g)	TPC/(mg GAE/g)
A	(89.625±0.56)^{a}	(0.804±0.21)^{a}	(367.409±0.84)^{a}
B	(74.938±0.49)^{b}	(0.645±0.15)^{c}	(321.555±0.69)^{b}
C	(72.902±0.46)^{b}	(0.638±0.12)^{c}	(289.094±0.55)^{c}
D	(63.543±0.37)^{c}	(0.573±0.09)^{c}	(248.112±0.47)^{d}
E	(86.326±0.51)^{a}	(0.731±0.18)^{b}	(353.618±0.78)^{a}
F	(78.140±0.47)^{b}	(0.728±0.17)^{b}	(320.892±0.64)^{b}
G	(69.341±0.39)^{c}	(0.650±0.14)^{c}	(301.958±0.58)^{c}
H	(64.057±0.35)^{c}	(0.603±0.11)^{d}	(281.754±0.51)^{c}
I	(56.608±0.27)^{d}	(0.475±0.08)^{e}	(205.387±0.36)^{d}
J	(60.145±0.29)^{d}	(0.601±0.10)^{d}	(215.567±0.39)^{d}
K	(48.235±0.19)^{e}	(0.454±0.12)^{e}	(194.800±0.29)^{e}
L	(41.543±0.15)^{f}	(0.328±0.10)^{f}	(171.827±0.20)^{f}
M	(58.730±0.28)^{d}	(0.559±0.07)^{c}	(232.342±0.40)^{d}

Different superscripts within the same column demonstrate significant differences ($p<0.05$) (N=3±SD). Samples: A=fresh dandelion flower, B=dandelion flower in 20 ºBx on 10th day, C=dandelion flower in 20 ºBx on 20th day, D=dandelion flower in 20 ºBx on 30th day, E=dandelion flower in 30 ºBx on 10th day, F=dandelion flower in 30 ºBx on 20th day, G=dandelion flower in 30 ºBx on 30th day, H=filling medium in 20 ºBx on 10th day, I=filling medium in 20 ºBx on 20th day, J=filling medium in 20 ºBx on 30th day, K=filling medium in 30 ºBx on 10th day, L=filling medium in 30 ºBx on 20th day and M=filling medium in 30 ºBx on 30th day

SUPPLEMENTARY MATERIAL

a)

b)

c)

Fig. S1. The photographs of: a) fresh dandelion flowers, b) 20 °Bx canned flowers and c) 30 °Bx canned flowers