

SHORT COMMUNICATION

**BIOACTIVE COMPOUNDS IN FRESH AND DRIED GINGER ROOT
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Liela iela 2, Jelgava, Latvia**Abstract**

Ginger (*Zingiber officinale*) is known as an additive for food and therapeutic purposes. It can help improve memory, helps eliminate toxins from the body, lowering arterial pressure and cholesterol, and is a good source of many bioactive compounds – phenolic s, vitamins and mineral elements. The aim of study was to determine biological active compounds of fresh and dried ginger in aqueous extracts. Spectrophotometric methods were used for determination content of total phenolic (according to the Folin-Ciocalteu method) and flavonoid compounds (aluminium chloride method) as well as antioxidant activity with DPPH radical. Content of vitamin C was determined by titration with with 2,6-dichlorophenolindophenol. The highest content of phenolic compounds (104.7 ± 4.5 mg GAE 100 g^{-1} DW) in water extracts was obtained using fresh ginger root; it is for 30% more than from dried root sample. The flavonoid content was higher in the samples obtained from fresh ginger peel (68.74 ± 3.39 mg quercetin equivalent 100 g^{-1} , DW) and there were not significant differences in the use of fresh or dried ginger root (46.16 ± 2.23 mg quercetin equivalent 100 g^{-1} on average, DW). Content of vitamin C in aqueous extract from fresh ginger root (4.59 ± 0.98 mg 100 g^{-1} , DW) was for 21.7% higher than from fresh ginger peel, but there were not significant differences ($p > 0.05$) regarding dried samples (3.43 ± 0.71 mg 100 g^{-1} , DW). Order of antioxidant activity by free radical scavenging activity in aqueous extracts was as follows: fresh ginger root > dried ginger root > fresh ginger peel > dried ginger peel. The recommendation is that fresh ginger root is more suitable for obtaining a richer extract with the biological active compound, as the drying process affects both the phenol and vitamin C content in the samples and in the extract accordingly.

Keywords: ginger, phenolic, flavonoids, vitamin C

Introduction

Ginger (*Zingiber officinale*) is often used plant, containing many bioactive compounds such as phenolic, flavonoids, vitamins, carotenes and therefore possesses health promoting properties (Ghasemzadex et al., 2010). This herb is used as spice as well as in herbal medicinal for prevention of some diseases (Afzal et al., 2001; Ali et al., 2018; Kundu et al., 2009). Antioxidant activity of ginger has been reported by many authors (Adel, Prakash, 2010; El Ghoab et al., 2010; Gupta et al., 2014; Oboh et al., 2012; Przygodzka et al., 2014) Wilson et al., (2013) mentioned that ginger has many medicinal properties due to such bioactive compounds as gingerols, shogaols, zingerone and others.

Plant phytochemicals are biological active compounds that could impact health improvement and prevention of diseases (Kim et al., 2012). Polyphenols and flavonoids are plants secondary metabolites and their antioxidant activity is connected with redox properties. Atoiu et al., (2005) wrote that these compounds take part in chemical reactions as reducing agents and they have a metal chelation potential.

Content of organic acids in plant materials are important for their application in functional food (Yeh et al., 2014) and one of them - vitamin C is well-known antioxidant, which participate in many reactions in human body.

Herbal teas are known as significant source of different phenolic compounds (Shahidi, 2000). Different solvents may be applied for extraction of biologically active compounds, but for human consumption suitable ginger tea preparation water is the only one possible solvent.

Moreover, it is known that total polyphenols and flavonoids could be found more in water extract than other extracts, because these compounds have better solubility in hot water than in other solvents (Adel, Prakash, 2010). Drying process of plants could promote changes in nutritional and antioxidant properties (Chan et al., 2009).

The aim of this study was to determine bioactive compounds of fresh and dried ginger in aqueous extracts.

Materials and Methods

Ginger samples were analysed out at the Latvia University of Life Sciences and Technologies, Department of Chemistry, in the laboratory of Inorganic and Analytic Chemistry. The ginger root used for analysis was fresh without any physical defects. The country of origin of the purchased ginger root was China. Ginger surface was cleaned, washed, peeled, snip in little pieces (moisture content of ginger and ginger peel $82.94 \pm 1.25\%$ and $86.16 \pm 0.98\%$ respectively) and then dried in traditional convective dryer (Memmert, Modell 100-800) at $60 \pm 1\text{ }^{\circ}\text{C}$ till constant weight (moisture content $9.14 \pm 1.12\%$). 0.5 ± 0.0001 g of finely ground fresh ginger root, fresh ginger peel, dried ginger root and dried ginger peel were extracted in 50 ± 0.5 mL of boiling deionized water and stirred on a magnetic stirrer at room temperature $+20 \pm 2\text{ }^{\circ}\text{C}$ for 15 min. Ginger extract was filtered with paper filter ($10\text{ }\mu\text{m}$, Whatman Inc., Clifton, NJ, USA). Extracts were prepared in triplicate.

Reagents used for investigation were of the analytical grade from Sigma Aldrich, Germany. Accurate, UV-visible spectrophotometer Jenway 6705 (JENWAY, UK) was used for the absorbance measurements.

Content of total flavonoids was determined using AlCl₃ (aluminium chloride) method with modifications (Augšpole et al., 2018). To 500 µL of extract 2.0 mL distilled H₂O was added, then added 150.0 µL of 5% NaNO₂ (sodium nitrite). 5 minutes later 150.0 µL of 10% AlCl₃ (aluminium chloride) solution was added. The solution was to stand for 5 minutes. Then 1 mL of the 1 M NaOH (sodium hydroxide) was added. The prepared solution was mixed and incubated at room temperature +20±2 °C in dark place for 15 minutes. The absorbance of extracts were measured at 415 nm using UV/VIS spectrophotometer Jenway 6705. The obtained results were expressed as mg QE 100 g⁻¹ DW (milligrams of quercetin equivalents per 100 g).

The total phenolic were analysed spectrometrically (using UV-visible spectrophotometer Jenway 6705) according to the Folin-Ciocalteu (Dewanto et al., 2002; Augšpole et al., 2018). 2.50 mL Folin Ciocalteu reagent (diluted 10 times with deionized water) was appended to 0.50 mL of extract. The obtained mixture was incubated for 3 min, after added 2.0 mL of Na₂CO₃ (sodium carbonate, 7.50 g 100 g⁻¹) and mixed. After reaction for 30 min at room temperature +20±2 °C in dark place for colour development absorbance of obtained extracts were measured at 760 nm. Investigation results were indicate as mg GAE (gallic acid equivalents) 100 g⁻¹ dry-weight (DW) of ginger (Augšpole et al., 2018).

The antiradical activity of ginger extracts was determined spectrometrically (UV-visible spectrophotometer Jenway 6705) in accordance with (Afify, 2012) with modifications. This method is based on the radical scavenging ability in reacting with stable DPPH (2,2-diphenil-1-picrylhydrazyl) free radical. 3.50 mL of 2,2-diphenil-1-picrylhydrazyl solution (4.0 mg of 2,2-diphenil-1-picrylhydrazyl reagent dissolved in 100.0 mL pure ethanol) was added to 0.5 mL of ginger extract. Obtained solution was mixed and stand in dark place at room temperature (+20±2) °C for 30 min. Absorbance was measured at 517 nm. The antioxidant activity was definite as TROLOX (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) equivalent antiradical activity (mmol TE 100 g⁻¹ DW) (Augšpole et al., 2018).

Vitamin C content was determined and calculated after volumetric analysis with 2,6-dichlorphenolindophenol (Duma et al., 2015) according to the equation (1):

$$\text{Vitamin C (mg 100 g}^{-1}\text{)} = \frac{V_{\text{itr}} \cdot 0.044 \cdot V_{\text{total}} \cdot 100}{V_{\text{a}} \cdot \text{weight}}, \quad (1)$$

where: V_{itr} – volume of 2,6-dichlorphenolindophenol, mL;

V_{total} – total volume of infusion, mL;

V_a – volume of infusion for titration, mL.

Results of the study are means of four parallel measurements and were analysed by Microsoft Excel 2016. Differences were considered as significant at p<0.05.

Results and Discussion

Flavonoids are phenolic compounds that are common in different plants. These compounds have a wide range of biological functions – they protect plants from biotic and abiotic stresses, and they actively participate in the interaction between the plants and environment (Amalesh et al., 2011). Data in Figure 1 present the content of total flavonoids in the analysed ginger sample extracts.

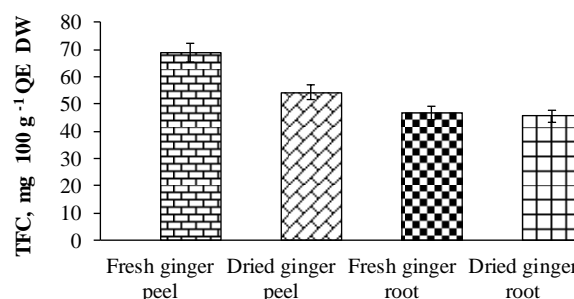


Figure 1. Content of total flavonoids

The results showed that the highest level of total flavonoids is in the aqueous extracts of fresh and dried ginger peel : 68.74±2.58 and 54.27±1.14 mg QE 100 g⁻¹ DW, respectively, while the lowest was determined in the aqueous extracts of fresh and dried ginger root 46.73±2.05 and 45.59±1.75 mg QE 100 g⁻¹, DW. The content of total flavonoids found in this study were lower than the ones reported by other researchers. Researchers Yasser et al. (2016) reported that total flavonoids in ginger was 78.8 mg g⁻¹ QE DW that were significantly higher than this study values.

Absorption results of phenolic compounds obtained spectrophotometrically are shown in Figure 2.

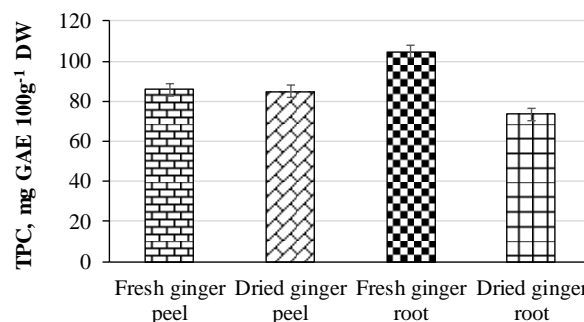


Figure 2. Content of total phenols

The total phenols content in the investigated ginger samples ranged from 104.66±3.73 (fresh ginger root) till

73.6±1.41 mg GAE 100 g⁻¹, DW (dried ginger root). Scientists Kumari and Gupta (2016) from India reported higher values of total phenols in ginger root powder, respectively 776.2 mg GAE 100 g⁻¹, DW. In turn Ghasemzadeh et al. (2010) from University Putra Malaysia reported lower values - total phenols of ginger material was 39.1±9.2 mg GAE 100 g⁻¹, DW. The total phenols content depends on the extracting solvent. Turkmen et al. (2006) reported that it is higher in ethanol extract than aqueous extract, but Shirin and Jamuna (2010) found the highest total polyphenols content in water extracts.

To determine the antioxidant activity of ginger samples, the development of their scavenging effect of free radicals on the 2,2-diphenyl-1-picrylhydrazyl (DPPH) was investigated. Comparison of the mean values of antioxidant activities showed that fresh and dried root ginger aqueous extracts had the highest antioxidant activity, higher by 6.5% compared to fresh and dried ginger peel samples (Figure 3).

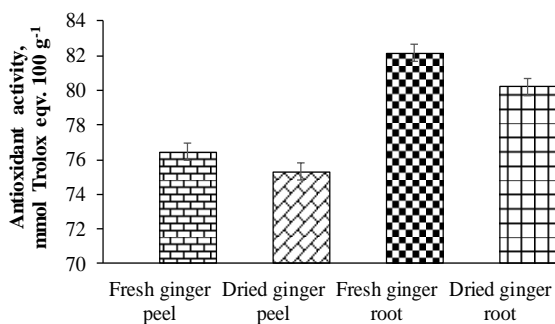


Figure 3. Antioxidant activity of ginger samples

Comparatively, Ali et al. (2008) reported that antioxidant activities of fresh ginger root was 97.47±0.93% to 99.06±1.00% DPPH[•].

Natural antioxidant vitamin C (ascorbic acid) in biological systems participates in various enzymatic processes as well as in hydroxylation oxidation – reduction reactions (Singh et al., 2012). The highest content of vitamin C was found in the aqueous extract of fresh ginger root -5.59 mg 100 g⁻¹ DW (Figure 4

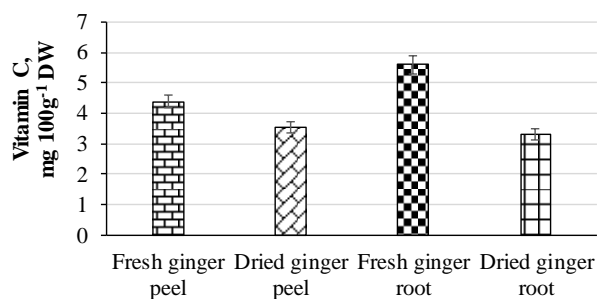


Figure 4. Content of vitamin C

The results obtained in the current study are lower than those reported by Kumari and Gupta (2016), who found

that vitamin C content in ginger root powder was 9.2 mg 100 g⁻¹ DW or results reported by Shirin and Jamuna (2010) – 9.33–10.97 mg 100 g⁻¹ DW.

Conclusions

The results of this study showed that fresh and dried ginger has high antioxidant activity from 75.31 to 82.16 mmol Trolox equivalents 100 g⁻¹ DW. The obtained results indicated that the content of total flavonoids, content of total phenols and vitamin C as well as antioxidant activity depends on the part used in the ginger plant study – whether it is peel or root. The recommendation is that fresh ginger root is more suitable for obtaining a richer aqueous extract with the biological active compounds, as the drying process affects both the phenol and vitamin C content in the samples.

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