CHEMIJA
2024. Vol. 35. No. 2. P. 45–53

ISSN 0235-7216 eISSN 2424-4538
DOI: https://doi.org/10.6001/chemija.2024.35.2.3

Analysis of Wormwood (*Artemisia absinthium* L.) teas

Vida Vičkačkaitė*,

Julija Pronckutė,

Vilius Poškus

Department of Analytical and Environmental Chemistry, Vilnius University, 24 Naugarduko Street, 03225 Vilnius, Lithuania

Artemisia absinthium L., commonly known as wormwood, is a medicinal herb with deep roots in traditional medicine. Wormwood possesses numerous healing properties, including positive effects on the liver, bladder, stomach and intestines. It improves digestion, has the antidiabetic effect and exhibits antioxidant, anti-inflammatory and anticancer properties. Although wormwood can be used in various forms, the simplest and most accessible method is wormwood tea, prepared from dried raw material.

In this study, the antioxidant properties and total phenol content of wormwood teas prepared using different methods and raw materials from different manufacturers were investigated. The DPPH radical scavenging activity, expressed in Trolox equivalent antioxidant capacity, ranged from 457 to 623 mg/l, while the total phenol content, expressed in gallic acid equivalents, ranged from 112 to 224 mg/l. The findings suggest that the antioxidant properties of wormwood tea are largely influenced by phenolic compounds. It was found that teas made from wormwood leaves exhibit higher antioxidant activity and phenolic content compared to those made from wormwood stems. The main volatile components of wormwood teas were identified as β-thujone and trans-sabinyl acetate, with β-thujone content in wormwood teas ranging from 36 to 79 mg/l. Additionally, the thujone content decreases when the tea is brewed.

Keywords: wormwood tea, antioxidant activity, total phenol content, volatile compounds

INTRODUCTION

Medicinal plants have been prime sources of natural drug molecules utilised by humans since ancient times [1]. One such plant is the aromatic and bitter wormwood (*Artemisia absinthium* L.). Its documented medicinal use dates back to the Ebers Papyrus, an ancient Egyptian medical document from around 1552 B. C. [2]. The importance of wormwood in the history of medicine is well-described in an excellent review article [3].

Wormwood has deep roots in folk medicine and is increasingly gaining attention in modern medicinal practice. Numerous studies are being conducted to prove its effectiveness on certain conditions and diseases, and to explore further potential applications.

The use of wormwood to relieve or treat various ailments is extensive. It is primarily used for loss of appetite, gastrointestinal disorders, bile secretion disorders, and has liver-protecting and anti-diabetic effects [4, 5]. The bitter compounds in wormwood enhance digestion. Historically, its decoctions and teas were used to treat diseases of the gallbladder and bladder and inflammation of the eyes. Bitter decoctions were used to make eye poultices, believed to be anti-inflammatory and to improve vision. Wormwood has been proven to exert nematicidal and antifungal activity and is used in folk medicine as a remedy against intestinal parasitic worms [6–8]. Additionally, due to the antibacterial and anti-infiamatory properties

* Corresponding author. Email: vida.vickackaite@chf.vu.lt

wormwood helps to treat wounds [1, 9]. Traditionally, fresh wormwood or its powder have been used for wound healing. However, a novel delivery technique – a wormwood microneedle patch – has recently been suggested [10]. This technique offers enhanced therapeutic penetration through the skin and may significantly reduce excessive adhesion between the skin and the patch, resulting in fewer mechanical injuries when the patch is removed.

Wormwood is also renowned for its antioxidant and antimicrobial properties [11–14], primarily due to its phenolic compounds. While numerous studies have identified these compounds in wormwood essential oils and various organic extracts, there is a notable lack of research on wormwood teas, despite their widespread availability.

Several studies have shown that wormwood has anti-cancer properties, inducing apoptosis and inhibiting the proliferation of cancer cells [15]. Wormwood has also been evaluated for its anti-inflammatory and analgesic effects [16]. Research into its effects on various neurological, mental and psychological disorders has shown that wormwood can relieve and treat depression, epilepsy and convulsions related to nervous system damage [17]. It demonstrates neuroprotective and cognition-enhancing activities, serves to improve memory, and aids in the restoration of declining mental function [18, 19], exhibiting an antidepressant effect [20]. Depending on the dose, wormwood can also stimulate the central nervous system and, in some cases, cause seizures or hallucinations.

In addition to its therapeutic properties, wormwood has applications in cosmetics, where it is used for skin and hair conditioning, and in perfumery [21]. In the food industry, wormwood is a key ingredient in absinthe, an alcoholic beverage that was particularly popular in the 19 and 20th centuries due to its psychoactive properties from high α- and β-thujone content [22, 23]. Wormwood is also added to wines to impart aroma and bitterness, with vermouths being a popular type of wine containing it.

Wormwood can be used in various forms (fresh, powder, capsules, essential oil and tincture) [11, 24, 25]; however, the simplest and most accessible method is wormwood tea, prepared from dried raw material.

Although there are many publications dedicated to wormwood essential oil, research on wormwood tea remains limited. This paper aims to fill this gap by determining the antioxidant properties of wormwood tea, quantifying its phenolic compounds, and identifying the main volatile compounds present in the tea.

EXPERIMENTAL

Materials and solutions

Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) (97%) was purchased from VectaCellTM. Gallic acid (99%), DPPH (2,2-diphenyl-1-picrylhydrazyl), Folin–Ciocalteu reagent, methanol (99.8%), ethanol (95%) and acetone (99.5%) were purchased from Sigma-Aldrich. α, β-Thujone (isomers) and sodium carbonate (99%) were obtained from Roth.

A 6.5×10^{-5} mol/l DPPH solution was prepared by dissolving the appropriate amount of DPPH in methanol. A stock solution of Trolox (10 mmol/l) was prepared by dissolving the appropriate amount of Trolox in methanol. The Trolox solutions required for the calibration curve were obtained by diluting the stock solution with methanol. A stock solution of gallic acid (10 mg/ml) was prepared by dissolving the appropriate amount of gallic acid in acetone. The gallic acid solutions required for the calibration curve were obtained by diluting the stock solution with distilled water. A stock solution of thujone (10 mg/ml) was prepared by dissolving the appropriate amount of thujone in ethanol. The thujone solutions required for the calibration curve were obtained by diluting the stock solution with ethanol. A 7.5% Na_2CO_3 solution was prepared by dissolving the appropriate amount of Na_2CO_3 in distilled water.

Wormwood tea raw materials 'T2019' and 'T2023' were collected in the Telšiai District in 2019 and 2023, respectively. The wormwood herb 'Jadvygos žolės' (manufacturer: pharmacist-herbalist J. Balvočiūtė), the wormwood herb 'Dr. P. Karvelis' (manufacturer: A. Karvelis therapy–phytotherapy company) and the wormwood herb 'Širdažolė' (manufacturer: pharmacy 'Širdažolė') were purchased from a pharmacy.

Instrumentation and conditions

For determining the antioxidant activity and total phenol content, a Specord 200 Plus spectrophotometer (Analytik Jena) was used.

Headspace extraction and sample introduction to the chromatographic system were performed using a PerkinElmer Headspace Sampler Turbomatrix 16 (PerkinElmer, USA), equipped with a balanced pressure system. Five milliliters of the sample were added to a 20 ml headspace vial, which was then positioned in the HS autosampler and equilibrated at 95°C for 20 min. The needle and transition line temperatures were set to 110°C. The headspace sampler settings were 1 min for pressurisation and 0.05 min for injection, with helium as the carrier gas at a column head pressure of 16.7 psi.

Headspace gas chromatographic analysis was conducted on a PerkinElmer Clarus 580 series gas chromatograph (PerkinElmer, USA) equipped with a flame ionisation detector (temperature 250°C, hydrogen flow 40 ml/min and air flow 400 ml/min). The GC system used a Zebron ZB-WAXPLUS capillary column (30 m × 0.32 mm i.d., 1 μm film thickness) (Phenomenex). The injector temperature was maintained at 110°C. The oven temperature program was the following: 60°C for 1 min, increased to 200°C at 10°C/min, and held for 5 min.

Solid phase microextraction (SPME) was performed using a Supelco CAR/PDMS (85 μm) fibre housed in a manual holder (Supelco Bellofonte, PA, USA). SPME was carried out in a 20 ml vial sealed with a silicone rubber septum cap. Five milliliters of the sample were placed in the vial, which was then placed in a water-jacketed vessel on a magnetic stirrer and heated to 80°C for 30 min. Desorption was performed in a GC-MS injection port at 200°C for 30 s.

Gas chromatographic-mass spectrometric (GC-MS) analysis was conducted using a PerkinElmer Clarus 580 series gas chromatograph equipped with a programmable temperature vaporizer injector and coupled to a PerkinElmer Clarus 560 S mass spectrometer (PerkinElmer, USA). The system used an Elite-5MS capillary column (60 m × 0.25 mm i.d., 0.25 μm film thickness) (PerkinElmer, USA), with helium as the carrier gas at a constant flow of 1.9 ml/min. Injection was performed in a splitless mode. The oven temperature program was the following: from 45 to 200°C at 5°C/min, held for 5 min. The transfer line temperature was 280°C. The electron ionisation ion source conditions were set to an electron energy of 70 eV and a temperature of 180°C. Data acquisition was performed in a scan mode over a range of m/z 45–500. The identification of different compounds was achieved by comparing their mass spectra with those in the NIST (National Institute of Standards and Technology) library.

Determination of antioxidant activity using DPPH radical

Antioxidant activity was analysed using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical binding model system [26–28]. This assay is based on the ability of antioxidants to scavenge the DPPH radical cation. The purple-coloured DPPH radical binds a proton, transforming into the non-radical, yellow-coloured DPPH-H. A decrease in absorbance was observed at 517 nm. Data were expressed as Trolox equivalent antioxidant capacity (TEAC) using a Trolox calibration curve.

A freshly prepared 6.5×10^{-5} mol/l DPPH methanol solution was stirred with a magnetic stirrer for 3 h in the dark. Then, 3.8 ml of the DPPH solution was mixed with 0.2 ml of the sample. A control solution using distilled water was prepared similarly. Spectrophotometric readings were taken after 1 h of incubation in the dark at room temperature, at 517 nm using a 10 mm cuvette. DPPH radical inhibition was calculated using the formula

$$\text{DPPH inhibition, \%} = \frac{(A_0 - A_x)}{A_0} \times 100\%,$$

where A_0 is the absorbance of the control solution, and A_x is the absorbance of the sample. Additionally, a Trolox calibration curve in a range of 0.02–0.5 mmol/l was prepared ($R^2 = 0.9914$), and the data were expressed in Trolox equivalent antioxidant capacity (TEAC, mmol/l).

Determination of total phenolic content

The total phenolic content was determined spectrophotometrically using the Folin–Ciocalteu reagent [26, 28, 29]. Five milliliters of 10-fold diluted Folin–Ciocalteu reagent were mixed with 1 ml of the sample and 4 ml of a 7.5% sodium carbonate solution. A blank sample was prepared by replacing the test substance with distilled water. The mixture was incubated in the dark for

30 min at room temperature. The absorbance of the samples was measured at 765 nm. A gallic acid calibration curve in a range of 20–80 mg/l was prepared (R^2 = 0.9973). The total phenolic content was expressed as gallic acid equivalents (GAE, mg/l).

RESULTS AND DISCUSSION

Influence of wormwood tea preparation on antioxidant properties and total phenolic content

As previously mentioned, wormwood can be utilised in various forms, with the simplest and most accessible method being the aqueous infusion of wormwood (wormwood tea), prepared from dried raw material.

Our investigation focused on determining which preparation method yields wormwood tea with the strongest antioxidant properties and the highest phenolic content. For this study, 0.5 g of the herb 'Širdažolė' was weighed and treated as follows:

1. 50 ml of distilled water at 90°C was poured over the herb.
2. 50 ml of distilled water at 100°C was poured over the herb.
3. 50 ml of distilled water at 100°C was poured over the herb and boiled for 5 min.
4. 50 ml of distilled water at 100°C was poured over the herb and boiled for 10 min.
5. 50 ml of distilled water at 100°C was poured over the herb and boiled for 15 min.

After 15 min, the tea was filtered and tested for antioxidant activity and total phenolic content.

The addition of undiluted teas to the DPPH solution resulted in complete bleaching of the solution, indicating a strong ability of the tea to scavenge the radical cation DPPH. When the tea was diluted fivefold, the antioxidant activity, expressed as a percentage of DPPH inactivation, was measured and is presented in Table 1.

The results showed that DPPH inactivation increases with the boiling duration of wormwood tea. After boiling for 15 min, even when diluted fivefold, the tea completely bleached the DPPH solution. When this tea was diluted tenfold, its DPPH inactivation was 77%.

Antioxidant activity data were also expressed as Trolox equivalent antioxidant activity (Table 1).

Table 1. **Antioxidant activity of differently prepared wormwood teas**

Tea preparation conditions	5-fold diluted tea DPPH inactivation, %	TEAC, mg/l
90°C, 0 min boiled	30	280
100°C, 0 min boiled	36	312
100°C, 5 min boiled	49	375
100°C, 10 min boiled	66	458
100°C, 15 min boiled	100	1030

The total amount of polyphenols in the teas was determined using the Folin–Ciocalteu method, with the results calculated in terms of gallic acid equivalents (Table 2).

Table 2. **Total phenolic content of differently prepared wormwood teas**

Tea preparation conditions	GAE, mg/l
90°C, 0 min boiled	100
100°C, 0 min boiled	116
100°C, 5 min boiled	171
100°C, 10 min boiled	253
100°C, 15 min boiled	430

A clear correlation between the antioxidant activity and the total phenolic content is evident (Fig. 1), indicating that the antioxidant properties of wormwood tea are largely attributable to its phenolic compounds.

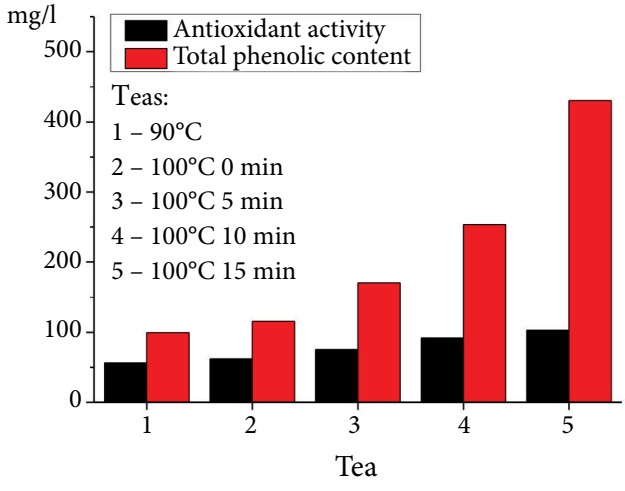

Fig. 1. Antioxidant activity, measured in Trolox equivalents (mg/l), and the total phenolic content, measured in gallic acid equivalents (mg/l), of wormwood teas prepared using different methods

Comparison of wormwood teas from different manufacturers

Next, we compared the antioxidant properties and phenolic content of wormwood teas from different manufacturers. Photos of wormwood grass are presented in Fig. 2.

Since it is generally recommended infusing wormwood tea with boiling water rather than boiling it, we prepared the tea as follows: 0.5 g of wormwood herb was weighed, infused with 50 ml of boiling distilled water, kept for 15 min, and then filtered. The antioxidant activity of those teas using the DPPH method and the total phenol content using the Folin–Ciocalteu method were determined. The results are presented in Table 3. The DPPH radical scavenging activity, expressed in TEAC, ranged from 457 to 623 mg/l, while the total phenol content, expressed in GAE, ranged from 112 to 224 mg/l.

Wormwood stem and wormwood leaf teas were tested separately (Fig. 3). Dr. P. Karvelis wormwood herb raw material was not included in the comparison as it was too finely chopped to separate leaves from stems.

Table 3. **Antioxidant activity and total phenolic content of wormwood teas (*n* = 3)**

Tea	Antioxidant activity		Total phenolic content	
	TEAC, mg/l	RSD, %	GAE, mg/l	RSD, %
Jadvygos žolės	488	7.5	140	18.9
Širdažolė	457	17.0	112	24.3
Dr. P. Karvelis	502	8.0	117	13.9
T2019	623	4.7	224	12.8
T2023	506	2.1	169	10.5

From Fig. 3, it is evident that the antioxidant activity and total phenolic content of wormwood teas from all manufacturers are higher in the leaves compared to the stems. The antioxidant activity of wormwood leaves was more than three times higher than that of the stems, and the total phenolic content was approximately four times higher in the leaves than in the stems. These results align with the recommendations in the literature for collecting wormwood for pharmaceutical raw materials, which suggest harvesting unwooded stems, leaves and flowers at the end of flowering.

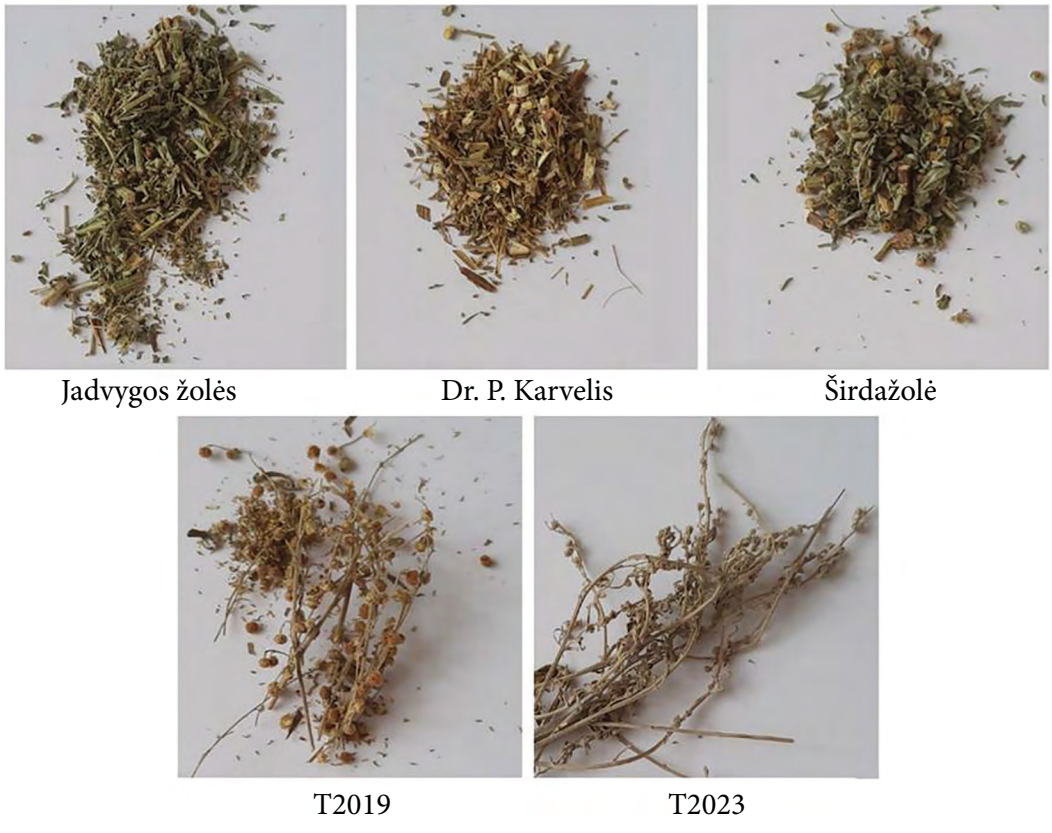

Fig. 2. Photos of wormwood grass

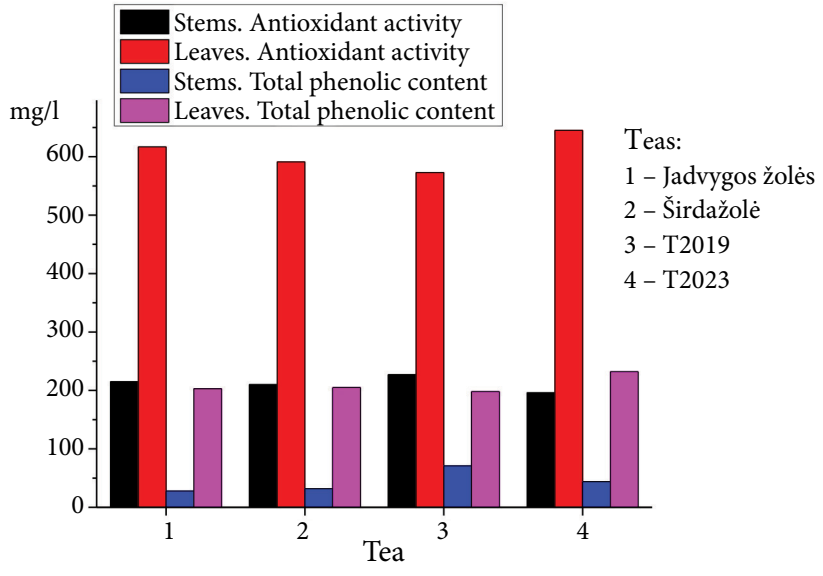

Fig. 3. Antioxidant activity in Trolox equivalents (mg/l) and the total phenolic content in gallic acid equivalents (mg/l) of wormwood tea stems and leaves from different manufacturers

Thujone content in wormwood teas

One of the main substances of wormwood is thujone – a neurotoxic substance that can harm the central nervous system. Since wormwood essential oil can contain more than 50% β-thujone, it is crucial to study the thujone content in teas to ensure it does not exceed safe limits.

β-Thujone content in teas was determined using headspace gas chromatography. We analysed both whole teas and teas prepared from separated leaves and stems. The amounts of β-thujone in the teas are summarised in Table 4.

Table 4. **β-Thujone content in wormwood teas**

Tea	β-Thujone content, mg/l
Jadvygos žolės (stems)	33
Jadvygos žolės (leaves)	39
Jadvygos žolės (stems and leaves)	37
Širdažolė (stems)	33
Širdažolė (leaves)	66
Širdažolė (stems and leaves)	36
Dr. P. Karvelis (stems and leaves)	55
T2019 (stems)	35
T2019 (leaves)	67
T2019 (stems and leaves)	55
T2023 (stems)	51
T2023 (leaves)	90
T2023 (stems and leaves)	79

The highest β-thujone content was detected in the T2023 raw material, which was dried at ambient temperature at home. The drying conditions for the raw material purchased from the pharmacy are not specified, but it is likely that to speed up the process, drying was conducted in special ovens at temperatures of 50–80°C [30]. Consequently, some β-thujone (boiling point 203°C) may have been lost during drying. Comparing wormwood raw materials collected from the same area and dried under the same conditions (T2019 and T2023) showed that the earlier collected material had less β-thujone, likely due to the gradual loss of this volatile compound over time.

Given thujone's potential negative health effects, minimising its presence in tea is desirable. We investigated whether boiling the tea affects its thujone content. Using the T2023 raw material, which had the highest β-thujone concentration, we prepared the tea as follows: 2.5 g of wormwood herb was infused with 250 ml of boiling water for 15 min, and a sample (5 ml) was taken for thujone analysis. The remaining tea was then boiled, with samples taken after 5, 10 and 15 min.

The β-thujone content in the tea was 83 mg/l without boiling, decreasing to 47 mg/l after 5 min of boiling, and 40 mg/l after 15 min. 'Širdažolė' manufacturers recommend using 1–2 tablespoons (2.5 – 5 g) of wormwood in 500 ml of boiling water, steeping for 15–45 min, and consuming 1/2 – 2/3

of a glass per day. Our preparation method used the maximum recommended amount of wormwood (0.5 g in 50 ml of water). Drinking half a glass (120 ml) of tea made from the most thujone-rich wormwood herb would provide 10.8 mg of thujone, and 14.4 mg for 2/3 glass. The average β-thujone content of the five teas that we tested was 52 mg/l, equating to 6.2 mg for 1/2 glass and 8.3 mg for 2/3 glass per day. The maximum recommended daily dose of thujone is 7 mg [31]. Therefore, when preparing wormwood tea, either use less wormwood herb (1 tablespoon) or boil the tea to reduce the thujone content. Boiling for 5 min nearly halves the thujone content.

Identification of volatile components in wormwood tea using GC-MS

Gas chromatography-mass spectrometry was employed to identify the volatile components present in wormwood tea. Since teas are aqueous solutions and cannot be directly introduced into the GC-MS system, solid-phase microextraction was conducted to extract volatile substances from the headspace above the tea prior to analysis.

In the SPME process, 5 ml of wormwood tea was poured into a 20 ml vial, sealed with a silicone gasket, and subjected to SPME for 30 min at 80°C to capture the volatile compounds. Those sorbed compounds were then desorbed in a gas chromatograph injector at 200°C for 30 s. The chromatogram of 'Širdažolė' tea is shown in Fig. 4a.

For comparison, dry wormwood herb was also analysed using SPME and GC-MS. Here, 0.5 g of wormwood herb was placed in a 20 ml vial, sealed with a silicone gasket, and left for 30 min for SPME extraction from the headspace at 80°C. Similar desorption conditions were applied in a GC injector at 200°C for 30 s. The resulting chromatogram is presented in Fig. 4b.

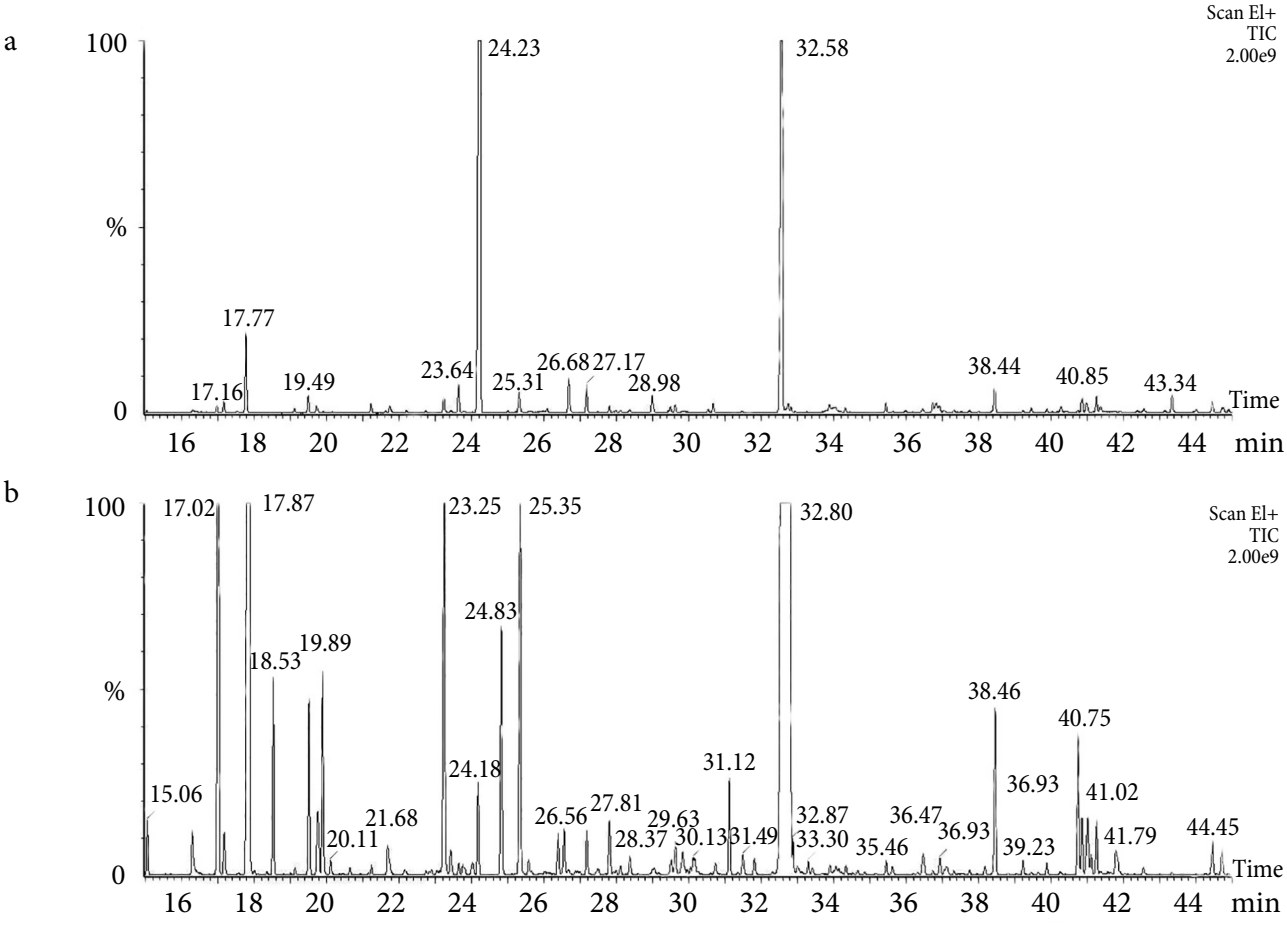

Fig. 4. GC-MS chromatograms of the headspace above wormwood tea (a) and dry wormwood herb 'Širdažolė' (b) obtained using SPME. Chromatographic conditions are detailed in the 'Experimental' section

Comparison of the chromatograms (Fig. 4) revealed the presence of α- and β-thujone, trans-sabinyl acetate and β-pinene in both wormwood tea and dry herb samples. The main compounds are listed in Table 5, identified by comparing their mass spectra with the NIST library.

The table results highlight the components with the highest peaks in the chromatograms. Notably, trans-sabinyl acetate, with a peak at 32.8 min, is prominently featured in the chromatogram of dry wormwood herb. This finding aligns with the results presented for wormwood essential oils from Lithuania [32].

Table 5. **Volatile components of wormwood obtained from SPME and GC-MS analysis of dry herb from headspace**

t, min	Compound
17.0	Sabinene
17.8	β-Pinene
18.5	α-Phellandrene
19.5	p-Cymene
19.9	1,8-Cineole
23.3	β-Linalool
23.6	α-Thujone
24.2	β-Thujone
25.4	trans-Sabinol
31.1	trans-Chrysanthenyl acetate
32.8	trans-Sabinyl acetate
38.5	(Z)-β-Farnesene
40.9	α-Curcumene

In contrast, β-thujone, with a peak at 24.2 min, dominates in the chromatogram of wormwood tea. The ratio of peak areas between trans-sabinyl acetate and β-thujone is 147 in the dry herb, indicating a higher concentration of trans-sabinyl acetate relative to β-thujone. Conversely, in wormwood tea, β-thujone's peak area surpasses that of trans-sabinyl acetate (a ratio of peak areas between trans-sabinyl acetate and β-thujone is 0.73). This difference can be attributed to β-thujone's greater solubility in water (407 mg/l) compared to trans-sabinyl acetate (13.2 mg/l), resulting in less transference of trans-sabinyl acetate from the wormwood to the tea.

However, the obtained results do not allow for the quantitative assessment of tea composition due to variations in compound volatility and SPME extraction efficiency. For an accurate quantitative analysis, calibration using analyte standards would be necessary.

CONCLUSIONS

Wormwood is a medicinal plant well-known in folk medicine and is gaining increasing attention in modern medical practice, cosmetics, and the food industry due to its numerous healing properties. While wormwood can be used fresh, as a powder, in capsules, as an essential oil, or as a tincture, the most accessible method of use is wormwood tea, prepared from dried raw material.

This paper focuses on the examination of wormwood tea. Although it is generally recommended to pour boiling water over wormwood rather than boil it, the results showed that the antioxidant properties and total phenol content increased with the boiling duration of the tea. It was found that teas made from wormwood leaves exhibited higher antioxidant activity and phenolic content compared to those made from wormwood stems. Additionally, the antioxidant properties and total phenol content of wormwood teas prepared using raw material from different manufacturers were investigated. The DPPH radical scavenging activity, expressed in TEAC, ranged from 457 to 623 mg/l, while the total phenol content, expressed in GAE, ranged from 112 to 224 mg/l. These findings suggest that the antioxidant properties of wormwood tea are largely influenced by phenolic compounds.

The main volatile components of wormwood teas were identified as β-thujone and trans-sabinyl acetate, with an average β-thujone content of 52 mg/l. β-Thujone is a neurotoxic substance that can harm the central nervous system. It was determined that boiling the tea for 5 min nearly halved the thujone content while increasing the antioxidant activity of the tea.

Received 18 June 2024
Accepted 19 July 2024

References

1. M. H. Sultan, A. A. Zuwaiel, S. S. Moni, et al., *Curr. Pharm. Biotechnol.*, **21**, 1711 (2020).
2. D. W. Lachenmeier, *J. Ethnopharmacol.*, **131**, 224 (2010).
3. A. Szopa, J. Pajor, P. Klin, et al., *Plants*, **9(9)**, 1 (2020).

4. M. K. McMullen, J. M. Whitehouse, P. A. Whitton, A. Towell, *J. Ethnopharmacol.*, **154(3)**, 719 (2014).
5. S. C. Kim, A. T. Adesogan, J. H. Kim, Y. D. Ko, *Anim. Feed Sci. Technol.*, **128**, 1 (2006).
6. M. R. Pino-Otín, J. Val, D. Ballestero, E. Navarro, E. Sanchez, A. M. Mainar, *Ecotoxicol. Environ. Saf.*, **180**, 565 (2019).
7. L. F. Julio, A. Gonzalez-Coloma, J. Burillo, C. E. Diaz, M. Fe Andres, *Crop Prot.*, **94**, 33 (2017).
8. T. Liu, H. Wuc, H. Wu, J. Zhang, *Ind. Crops Prod.*, **133**, 295 (2019).
9. A. Boudjelal, A. Smeriglio, G. Ginestra, M. Denaro, D. Trombetta, *Plants*, **9(12)**, 1744 (2020) [https://doi.org/10.3390/plants9121744].
10. W. Ding, X. Shao, S. Ding, et al., *Drug Delivery and Translational Research* (2024) [https://doi.org/10.1007/s13346-024-01520-1].
11. K. Msaada, N. Salem, O. Bachrouch, et al., *J. Chem.* (2015) [http://dx.doi.org/10.1155/2015/804658].
12. M. Akhbari, Z. Aghajani, B. Esmaeili, *J. Essent. Oil Bear. Plants*, **17(5)**, 954 (2014).
13. J. M. Canadanovic-Brunet, S. M. Djilas, G. S. Cetkovic, V. T. Tumbas, *J. Sci. Food Agric.*, **85**, 265 (2005).
14. I. Koyuncu, *Cell. Mol. Biol.*, **64(3)**, 25 (2018).
15. G. Shafi, T. N. Hasan, N. A. Syed, et al., *Mol. Biol. Rep.*, **39**, 7373 (2012).
16. A. Hadi, N. Hossein, P. Shirin, N. Najmeh, M. Abolfazl, *Int. J. Pharm. Sci. Rev. Res.*, **24(2)**, 237 (2014).
17. G. E.-S. Batiha, A. Olatunde, A. El-Mleeh, et al., *Antibiotics*, **9(6)**, 1 (2020).
18. K. Bora, A. Sharma, *J. Ethnopharmacol.*, **129(3)**, 403 (2010).
19. G. Wake, J. Court, A. Pickering, R. Lewis, R. Wilkins, E. Perry, *J. Ethnopharmacol.*, **69**, 105 (2000).
20. M. Mahmoudi, M. Ebrahimzadeh, F. Ansaroudi, S. Nabavi, S. Nabavi, *Afr. J. Biotechnol.*, **8**, 7170 (2009).
21. *CosIng – Cosmetic Ingredients* [https://ec.europa.eu/growth/tools-databases/cosing/].
22. D. W. Lachenmeier, S. G. Walch, S. A. Padosch, L. U. Kroner, *Crit. Rev. Food Sci. Nutr.* **46**, 365 (2006).
23. S. A. Padosch, D. W. Lachenmeier, L. U. Kroner, *Subst. Abus. Treat. Prev. Policy* (2006) [https://doi.org/10.1186/1747-597X-1-14].
24. L. Wang, T. Li, B. Xin, Y. Liu, F. Zhang, *J. Microencapsul.*, **37**, 324 (2020).
25. A. Arino, I. Arberas, G. Renobales, J. B. Domínguez, *Eur. Food Res. Technol.*, **209**, 126 (1999).
26. S. Jurkoniene, R. Mockeviciute, J. Jankauskiene, E. Jankovska-Bortkevic, G. Armalyte, V. Gaveliene, *Agric. Sci. Technol.*, **1(6)**, 615 (2021).
27. B. Fumie, T.-N. Norie, S. Koichiro, *Plant Biotechnol.*, **21(5)**, 387 (2004).
28. V. Briedis, V. Povilaitytė, S. Kazlauskas, P. R. Venskutonis, *Medicina*, **39**, 104 (2003).
29. S. Kupina, C. Fields, M. C. Roman, S. L. Brunelle, *J. AOAC Int.*, **101(5)**, 1466 (2018).
30. A. K. Babu, G. Kumaresan, V. A. A. Raj, R. Velraj, *Renew. Sustain. Energy Rev.*, **90**, 536 (2018).
31. *Public Statement on the Use of Herbal Medicinal Products Containing Thujone* [https://www.ema.europa.eu/en/documents/public-statement/draft-public-statement-use-herbal-medicinal-products-containing-thujone_en.pdf].
32. A. Judzentiene, J. Budiene, *J. Essent. Oil Bear. Plants*, **13(3)**, 275 (2010).

Vida Vičkačkaitė, Julija Pronckutė, Vilius Poškus

PELYNO (*ARTEMISIA ABSINTHIUM* L.) ARBATŲ ANALIZĖ

S a n t r a u k a

Artemisia absinthium L., paprastai žinomas kaip pelynas, yra vaistinis augalas, nuo seno naudojamas tradicinėje medicinoje. Pelynas turi daug gydomųjų savybių, įskaitant teigiamą poveikį kepenims, šlapimo pūslei, skrandžiui ir žarnynui. Jis gerina virškinimą, turi antidiabetinį poveikį, pasižymi antioksidacinėmis, priešuždegiminėmis ir priešvėžinėmis savybėmis. Nors pelynas gali būti naudojamas įvairiomis formomis, paprasčiausias ir prieinamiausias būdas yra pelynų arbata. Šiame darbe ištirtos skirtingais metodais paruoštų pelyno arbatų antioksidacinės savybės ir bendras fenolių kiekis. DPPH radikalų surišimo aktyvumas, išreikštas Trolox ekvivalentišku antioksidaciniu aktyvumu, svyravo nuo 457 iki 623 mg/l, o bendras fenolio kiekis, išreikštas galo rūgšties ekvivalentu, svyravo nuo 112 iki 224 mg/l. Rezultatai rodo, kad pelynų arbatos antioksidacinėms savybėms didelę įtaką turi fenoliniai junginiai. Nustatyta, kad arbatos, pagamintos iš pelyno lapų, pasižymi didesniu antioksidaciniu aktyvumu ir fenolių kiekiu, palyginti su arbatomis, pagamintomis iš pelyno stiebų. Pagrindiniai lakieji pelyno arbatos komponentai yra β-tujonas ir trans-sabinilo acetatas, β-tujono kiekis pelynų arbatose svyruoja nuo 36 iki 79 mg/l. Virinant arbatą, β-tujono kiekis sumažėja.