Scientific Papers. Series D. Animal Science. Vol. LXIX, No. 1, 2026
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

# COMPARATIVE ANALYSIS OF ANTIOXIDANT ACTIVITY AND PHENOLIC CONTENT IN FRESH AND DRIED EDIBLE GREEN PLANTS

**Viorica-Mirela POPA[1], Aurica-Breica BOROZAN[2], Delia-Gabriela DUMBRAVĂ[1], Corina Dana MISCA[1], Camelia MOLDOVAN[1], Carmen Daniela PETCU[3], Mariana-Atena POIANA[1], Diana-Nicoleta RABA[4], Florina Adriana RADU[1]**

[1]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Food Engineering, 119 Calea Aradului, 300645, Timisoara, Romania
[2]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Engineering and Applied Technologies, 119 Calea Aradului, 300645, Timisoara, Romania
[3]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Veterinary Medicine, 105 Splaiul Independenţei, District 5, 050097, Bucharest, Romania
[4]University of Life Sciences "King Mihai I" from Timisoara, Faculty of Management and Rural Turism, 119 Calea Aradului, 300645, Timisoara, Romania

Corresponding author emails: deliadumbrava@usvt.ro, carmen.petcu@fmvb.usamvb.ro

***Abstract***

*The paper evaluates the antioxidant potential and polyphenol content of seven green plants of dietary and therapeutic importance, used in various diets: garden orache (Atriplex hortensis L.), sorrel (Rumex acetosa), patience dock (Rumex patientia) wild garlic (Allium ursinum), lovage (Levisticum officinale), tarragon (Artemisia dracunculus), and dill (Anethum graveolens). The importance of these determinations lies in the need to quantify the actual nutritional value of plants, beyond their traditional use, providing a scientific basis for dietary recommendations. The study focuses on quantifying the total polyphenol content and evaluating the antioxidant capacity, comparing fresh samples with those subjected to conventional drying. The total polyphenol content was determined using the Folin-Ciocalteu spectrophotometric method, while the antioxidant capacity was evaluated using the DPPH method (RSA %). Monitoring these parameters is important for the food industry to optimize preservation methods, and the research highlights the essential role of these green plants in nutrition, promoting their use as natural and accessible sources of antioxidants.*

***Key words****: antioxidant activity, fresh and dried edible green plants, phenolic content.*

## INTRODUCTION

Phytochemical analysis of early plant species such as garden orache (*Atriplex hortensis* L.), sorrel (*Rumex acetosa*), and patience dock (*Rumex patientia*) reveals a complex nutritional profile with high levels of micronutrients and essential bioactive compounds (Zeipina et al., 2015; Dudaš et al., 2025; Helena Korpelainen & Maria Pietiläinen, 2020). The phenolic compounds present in *A. ursinum*, including p-coumaric and ferulic acids, are potent antioxidants that play a role in reducing oxidative stress. Research indicates that these molecules show considerable free radical scavenge activity when extracted with methanol or ethanol, which would be of interest for nutraceutical applications. Both antioxidants are represented in significant amounts, and their activities are necessary to neutralize oxidative stress (Popovschi & Ivanova, 2025). In addition to flavor-carrying organosulfur compounds and amino acids, other compounds, such as polyphenols, greatly contribute to the antioxidant properties of wild garlic. Benkeblia et al. (2007) and Pavlović et al. (2017) (cited by Kovačević et al., 2023) have reported high antioxidant and radical scavenging activity in *Allium ursinum* extracts. On the other hand, aromatic plants such as tarragon (*Artemisia dracunculus*), dill (*Anethum graveolens*), and lovage (*Levisticum officinale*) incorporate essential oils digestive and antimicrobial properties into their phytochemical complex (Chaleshtori et al., 2013; Chahal et al., 2017; Jannesar et al., 2024; Sahlabgi et al., 2025). Their integration into diet goes beyond their gastronomic value,

constituting an effective strategy for strengthening the immune system through the intake of phytonutrients. Thus, the study of their chemical composition remains an area of major interest for food biochemistry and contemporary nutrition sciences.

*Atriplex hortensis* (garden orache), an annual edible halophyte in the Chenopodioideae subfamily, is emerging as a high-potential nutrient source. Taxonomically related to spinach and quinoa, this climate-resilient species demonstrates superior tolerance to abiotic stressors, including drought, extreme temperatures, and nutrient-deficient soils. While its foliage exhibits diverse pigments from lime-green to deep purple. The green variety is particularly notable for its superior concentrations of protein, magnesium, vitamin C, and carotenoids compared to conventional spinach (*Spinacia oeracea*) (Ali et al., 2021; Kumorkiewicz et al., 2025).

Although plants of the genus *Rumex* (family Polygonaceae) are traditionally used in food and herbal medicine due to their beneficial effects, the specific biological properties of many of these species remain insufficiently documented in the scientific literature. Previous research has highlighted the properties of these plants, which are rich in bioactive phytochemicals, reporting anticancer, antioxidant, and anti-inflammatory effects, as well as antidiarrheal, analgesic, anthelmintic, and antimicrobial effects (Mishra et al., 2018; Lee et al., 2005; Vasas et al, 2015; Feduraev et al., 2022; Kurhe & Diwane, 2024. Patience dock (*Rumex patientia* L.), a perennial species of the Polygonaceae family, is widely cultivated in Eastern Europe. Its chemical composition includes anthraquinones, tannins, flavonoids, and phenolic acids, compounds that studies have attributed remarkable anti-inflammatory and antioxidant properties to (Jovin et al., 2011).

An analysis of the literature on the *Rumex* genus indicates that the species *R. acetosa, R. obtusifolius, R. crispus, R. acetosella, and R. dentatus* receive the most attention in scientific publications. However, comparative studies on the phytochemical composition of plants of this genus that coexist in the same geographical area are extremely rare (Feduraev et al., 2022). Sorrel (*Rumex acetosa* L.) is highly valued by consumers for its distinctive flavor and specific resistance, having high commercial potential. It can enrich the daily diet due to its significant macro- and micronutrient content, while also being an important source of natural antioxidants, such as phenolic compounds and carotenoids (Torres et al., 2019). Sorrel is an herbaceous plant rich in polyphenolic compounds with potential therapeutic benefits. These include flavan-3-ols, such as epicatechin and catechin, along with several essential phenolic acids: gallic, ferulic, protocatechuic, and p-coumaric acids (Kurhe & Diwane, 2024). Sorrel (*Rumex acetosa*) is the most widely used species of the genus, valued for its leaves rich in oxalic acid, (Bello et al., 2019) which give them a distinctive sour taste. However, the presence of high levels of the anti-nutritive factor, oxalic acid, reduces the bioavailability of some minerals, especially calcium, thus causing mineral deficiencies and other serious problems (calcium oxalate stone formation in kidneys, decreased iron absorption) (Tuazon-Nartea & Savage, 2013). With a tradition dating back thousands of years, it is used extensively in food, folk medicine, and as a source of natural dyes, offering rich and sustainable harvests (Korpelainen & Pietiläinen, 2020).

The distinct aromatic profile of the *Allium* genus, together with its nutritional and pharmacological potential, has sparked major interest in food and medical research. The properties of wild garlic are comparable to those of common garlic, with harvesting focusing mainly on its developed, intensely green leaves. Currently, there is an upward trend in the use of this species as a functional food and a basic ingredient in food supplements (Bernas, 2024). Wild garlic (*Allium ursinum* L.) has a centuries-old tradition as a food and remedy. Although it is a geophyte that blooms in spring in its natural environment - moist, shady beech forests - there is little documented information on how its phytochemical composition and antioxidant capacity are influenced by soil variety (Gordanić et al., 2022).

The therapeutic properties of *Allium ursinum* derive from its complex phytochemical profile, defined by the presence of sulfur compounds, phenolic acids, flavonoids, and essential oils

(Lenková et al., 2016). These constituents exhibit diverse bioactive activity, giving the plant high pharmaceutical potential. The strong aroma, specific to wild garlic, is generated by essential oils, while the characteristic smell is due to allicin. This sulfoxide compound is synthesized when plant tissues are mechanically destroyed (Popovschi & Ivanova, 2025). A wide range of studies have confirmed the antioxidant, cytostatic, antimicrobial, and antifungal properties of this species. (Sobolewska et al., 2006; Stajner et al., 2008; Pârvu et al., 2011; Bagiu et al., 2012; Shahrajabian, 2021; Barbu et al. 2023; Kovacević et al., 2023; Kalaba et al., 2024). The therapeutic effects of wild garlic are mainly related to the presence of organosulfur compounds. High concentrations of volatile substances, such as sulphides and disulfides, directly determine its therapeutic quality and value in the food industry as a spice (Boacă et al., 2025). In folk medicine, wild garlic (bear's garlic) is known for its ability to prevent disease and improve health. These benefits are linked to the presence of minerals (such as iron, phosphorus, sodium, and copper) and vitamins A and C, as well as being a rich source of fiber, phenolic compounds, and sulphur compounds (Filipčev et al., 2023).

A member of the *Asteraceae* family, tarragon (*Artemisia dracunculus* L.) is a perennial aromatic plant valued as a natural ingredient in food. With a distinct aroma and remarkable biological activity, its dried leaves are widely used to add flavor and aroma to culinary preparations (Kara & Çağlak, 2022). *Artemisia* species are known for their specific aroma, due to monoterpenes and sesquiterpenes, compounds that give them value in traditional medicine. This plant is used for its nutritional, stimulating, and disinfectant properties, while also having appetizing and vasodilatory effects (Behbahani et al., 2017; Mumivand et al., 2017).

The leaves of tarragon are popular in salads, soups, and grilled meats, whether used fresh or dried. Furthermore, essential oil is a key flavoring and aromatic ingredient in industrial food applications (Chaleshtori et al., 2013). While the stems and leaves of *A. dracunculus* L. are basic ingredients in international and traditional cuisine, the flowers and other parts of the plant are mainly used in alternative medicine (Cristea & Șandru, 2023).

Dill (*Anethum graveolens* L.) is an important source of essential oils, notable for its content of D-carvone and D-phellandrene. Although these compounds are defined for the plant profile, in the case of using the vegetative organs before flowering, carvone is not found among the major constituents of the essential oil (Jannesar et al., 2024).

Phytochemical investigations carried out on dill have confirmed the existence of various classes of bioactive compounds, such as terpenoids, saponins, tannins and flavonoids (including flavonoids), as well as alkaloids and steroids (Nguyen et al., 2020; Kaur et al., 2018; Basavegowda et al., 2022; Jadhav & Pawar, 2023; Thanuma et al., 2025). Tests have also indicated the absence of reducing sugars, glycosides, anthraquinones and paleobotanies in the plant composition (Chahal et al., 2017). Dill (*Anethum graveolens* L.) is a staple herb used to flavor a wide range of dishes, from salads, sauces, and soups to seafood and, especially, pickles (Jadhav & Pawar, 2023). In addition to its distinctive flavor, dill leaves are an important source of minerals, such as phosphorus, potassium, and magnesium and are used both fresh and dried (Isbilir & Sagiroglu, 2011). Phytochemical investigations have revealed the presence of diverse bioactive compounds in the leaves, stems, and roots of dill, such as tannins, terpenoids, cardiac glycosides, and flavonoid (Jana & Shekhawat, 2010) While previous studies have focused primarily on the seeds, the oil extracted from them has been shown to possess valuable antioxidant, antimicrobial, antiproliferative, and anticancer properties (Thanuma et al., 2025). Used since ancient times to alleviate gastrointestinal ailments, dill has a remarkable phytochemical profile. Approximately 90% of the composition of dill fruit extract is represented by D-carvone, D-limonene and alpha-phellandrene (Tizghadam et al., 2021).

Aromatic plants are widely used in the food and pharmaceutical sectors for their high antioxidant potential. This is generated by phenolic compounds (such as flavonoids, phenolic acids, stilbenes, lignans and tannins) found in various parts of the plant, from leaves and fruits to seeds and rhizomes (Kozłowska et

al., 2021). Aromatic plants used in food are valuable sources of essential nutrients, such as vitamins, minerals and antioxidant compounds. (Nour et al., 2017). Although *Levisticum officinale* (lovage) was once a staple herb in the food industry and in home kitchens, essential for seasoning soups and meat dishes, its popularity has declined drastically (Mohamadi et al., 2017). Today, its culinary utility remains a closely guarded secret among a few culinary experts, largely unknown to the public. Lovage is a relevant aromatic plant, but the literature contains only a limited number of studies on the volatile composition of lovage essential oil from various geographical regions (Spréa et al., 2020). All parts of lovage are intensely aromatic, presenting characteristic earthy notes, like those of celery (Moradalizadeh et al., 2012). Due to its compounds, lovage can act as a natural antioxidant, a property mainly attributed to the high content of polyphenols found in the plant material (Tomsone & Kruma, 2014). Another essential class of bioactive compounds are phenolic acids-such as chlorogenic, ferulic, and caffeic acids-recognized for their antioxidant and cardioprotective effects. Research indicates that lovage leaf extracts possess antioxidant capacity comparable to that of sage and rosemary, two of the medicinal plants with the most intense antioxidant activity (Sahlabgi et al., 2025).

## MATERIALS AND METHODS

### Extracts preparation

The plants analyzed included garden orache, sorrel, patience dock, wild garlic, lovage, tarragon, and dill. All were purchased at the local market in Timișoara, Romania.

The fresh leaves of these plants were cleaned of impurities, washed, and divided into two batches. One batch (fresh) was chopped and used immediately for extraction. The other batch of fresh plant material was dried at room temperature (21°C). The dried leaves were grounded using a mortar and pestle, packed, and stored in airtight containers until further use.

The extracts were obtained from fresh and dried material using 1 g of finely ground material in 20 mL of extraction solvent (70% ethanol). The extractions were performed in the dark at room temperature in a glass-stoppered Erlenmeyer flask, and the extraction time was 24 hours. The resulting extracts were filtered and then subjected to analysis.

### Evaluation of the free radical scavenging activity

The free radical scavenging activity (RSA) was determined using the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) method (Dumbrava et al., 2023) for the obtained extracts. Briefly, 2 g of each sample was extracted with 20 mL of 70% ethanol for 2 hours at 25°C under continuous stirring. After filtration through Whatman No. 1 filter paper, 1 mL of each filtrate was mixed with 2.5 mL of 0.1 mM DPPH solution (in 70% ethanol). The mixture was homogenized and incubated in the dark at room temperature for 30 minutes. Absorbance was measured at 517 nm against a blank with 70% ethanol. A control sample was also prepared (1 mL of 70% ethanol and 2.5 mL of DPPH solution). RSA was calculated using the following equation:

$$RSA\ (\%) = \frac{\mathrm{Ac} - \mathrm{As}}{Ac}\ x\ 100$$

where: Ac is the absorbance of the control sample, As is the absorbance in the presence of the sample.

### Evaluation of the total polyphenol content

Total polyphenols content was determined calorimetrically with the Folin-Ciocalteu reagent (Moldovan et al., 2023), the results being expressed in mg gallic acid equivalents/g.

### Statistical analysis

All TPC and RSA determinations were performed in triplicate, with results expressed as mean ± standard deviation (SD). Data processing was conducted using Microsoft Excel 2010.

## RESULTS AND DISCUSSIONS

### DPPH free radical scavenging activity

The results of RSA are shown in Table 1.

Analysis of the free radical scavenging capacity by the DPPH method revealed significant differences between the seven fresh plant species studied. The values obtained reflect the immediate antioxidant potential of the plant

tissues, before any thermal degradation or drying process. According to experimental data, the DPPH radical scavenging capacity ranges from 55.71± 1.46% (lovage) to 72.65 ±2.27% (patience dock). The most remarkable results were recorded for patience dock (72.65%) and sorrel (70.38%).

Table 1. RSA (%) results in fresh and dried leaves

| Sample | Fresh | Dried |
|---|---|---|
| Garden orache | 61.53±1.47 | 84.34±0.79 |
| Sorrel | 70.38±1.33 | 90.02±1.13 |
| Patience dock | 72.65±2.27 | 91.86±0.27 |
| Wild garlic | 68.27±1.82 | 89.84±1.04 |
| Lovage | 55.71±1.46 | 80.77±0.40 |
| Tarragon | 60.45±1.00 | 92.45±1.18 |
| Dill | 66.82±1.02 | 88.73±1.30 |

All dried samples show higher RSA values than fresh ones, indicating a concentration of antioxidant compounds through the removal of water. The average increase in RSA is approximately 25-30%, confirming that drying enhances the free radical neutralization capacity. The largest increases are observed in tarragon from 60.45→92.45 (+32%), patience dock, from 72.65→91.86 (+19%) and lovage, from 55.71→80.77 (+25%).

Regarding fresh leaf samples, patience dock and sorrel have the best antioxidant activity in the fresh state, indicating a high content of polyphenols and flavonoids.

Drying causes a clear amplification of antioxidant activity in all samples, by increasing the concentration of active substances and reducing oxidative degradation.

In the fresh state, patience dock dominates, and in the dried state, tarragon shows the highest capacity to neutralize DPPH radicals.

The RSA values of the seven dried leaf samples show, overall, a very high antioxidant activity, but each plant stands out with a slightly different profile. Tarragon clearly stands out as having the highest antioxidant capacity, exceeding 92%, suggesting a particularly high concentration of active compounds that remain stable after drying. Patience dock is close behind, with an almost equally high value, indicating excellent efficiency in neutralizing free radicals. Sorrel and wild garlic form an upper intermediate group, both exceeding 89–90%, indicating that drying significantly enhances their antioxidant potential, without any notable loss of bioactive compounds.

Dill falls slightly below this group, but remains in the very high range, with almost 89%, confirming the presence of stable and effective antioxidants. Garden orache has good antioxidant activity, but noticeably lower than the samples, at around 84%. At the end of the range is lovage, which, although it has the lowest value among the dried samples, still exceeds 80%, which still places it in the category of plants with strong antioxidant activity.

Overall, all dried samples demonstrate considerable antioxidant capacity, the differences between them reflecting the peculiarities of the phytochemical composition rather than a loss of activity following drying.

***Total phenolic compound***

Polyphenols are one of the most important classes of plant secondary metabolites and are recognized for their antioxidant, anti-inflammatory, and antimicrobial properties. In this study, the total polyphenol content (TPC), expressed in mg GAE/g (gallic acid equivalent), is analyzed for seven species of green plants: garden orache, sorrel, patience dock, wild garlic, lovage, tarragon, and dill.

The results obtained from the analysis of total phenolic compounds (TPC) were presented in Tables 2 and 3.

Table 2. TPC in fresh leaves

| Sample | mg GAE/g FW | mg GAE/g DW |
|---|---|---|
| Garden orache | 0.71±0.02 | 6.45±0.04 |
| Sorrel | 0.63±0 | 5.80±0.43 |
| Patience dock | 1.94±0.03 | 15.08±1.45 |
| Wild garlic | 0.73 ±0.01 | 6.66±0.27 |
| Lovage | 0.44±0.01 | 2.93±0.04 |
| Tarragon | 0.55±0.01 | 2.75±0.06 |
| Dill | 1.03±0.00 | 5.72±0.04 |

*Evaluation of fresh samples*

In their fresh state but expressed on a dry - weight basis to eliminate moisture variability, the samples show a high polyphenol content. Patience dock stands out clearly, having the highest concentration (15.08 mg GAE/g DW), over five times richer than lovage or tarragon. The intermediate group - wild garlic (6.66), orache (6.45), sorrel (5.80), and dill (5.72) - shows similar average values, suggesting comparable antioxidant potential. Lovage and

tarragon record the lowest concentrations (< 3 mg GAE/g DW).

*Evaluation of dried samples*

After the drying process and correction for residual moisture, the profile changes significantly: garden orache (1.5) and dill (1.48) become the samples with the highest content of extracted polyphenols after drying. In terms of stability, the values are much more homogeneous in the dried samples (range 0.84-1.5) compared to the large variations observed in the fresh state. Although the residual moisture content varies between 8% (dill) and 13.5% (sorrel), it directly influences the final extraction yield but does not compensate for the substantial losses incurred. Since drying was carried out at room temperature (natural drying), the massive degradation of polyphenols (especially in the case of patience dock) cannot be attributed to thermal shock rather than to biochemical and physical processes occurring during slow drying.

Table 3. TPC in dry leaves

| Sample | mg GAE/g DW | Residual water content (%) | mg GAE/g DW |
|---|---|---|---|
| Garden orache | 1.32 | 12 | 1.5 |
| Sorrel | 1.07 | 13.5 | 1.24 |
| Patience dock | 0.81 | 12.5 | 0.93 |
| Wild garlic | 0.99 | 11.5 | 1.12 |
| Lovage | 0.83 | 10 | 0.92 |
| Tarragon | 0.76 | 9.5 | 0.84 |
| Dill | 1.37 | 8 | 1.48 |

*Fresh vs. dried comparison*

Comparative analysis highlights a severe degradation of polyphenols following the drying process.

Comparing the results between fresh and dried samples reveals a phenomenon of phytocompound degradation, suggesting that the drying process at room temperature was destructive to the integrity of polyphenols. Although one might intuit that the removal of water should lead to a "concentration" of the active substance, the data indicates exactly the opposite: the values expressed as dry matter (mg GAE/g DW) decrease drastically in the processed samples compared to their theoretical equivalent in the fresh state.

This major discrepancy, as in the case of patience dock (where the concentration decreases from approximately 15.08 to below 1 mg GAE/g DW), can be explained by the biochemical dynamics of slow drying. At room temperature, the dehydration process takes a long time, maintaining plant cells in a state in which endogenous enzymes, such as polyphenol oxidase, remain active and systematically oxidize phenolic compounds in the presence of atmospheric oxygen.

If in the fresh state the differences between species were very clearly marked (with a ratio of almost 5:1 between the richest and poorest sample), after drying, the values become relatively uniform and low for all samples. This demonstrates that the preservation method has standardized the antioxidant profile, transforming the plants from an excellent source of polyphenols into one with minimal residual biological value. Basically, natural drying facilitated a series of secondary degradation and polymerization reactions that made these compounds no longer detectable by the Folin-Ciocâlteu method.

*Comparison with literature*

The polyphenol content determined from fresh leaves of garden orache, (6.45 mg GAE/g DW) is higher than the range reported by Uslu et al. (2020), who identified values between 1.90 and 4.77 mg GAE/g DW. This indicates that the sample analyzed by you possesses a higher density of antioxidant compounds than the previously studied specimens.

Regarding the values obtained from dried leaves (1.5 mg GAE/gDW), they are relatively close to the values reported by Uslu et al. (2020).

The value of 15.08 mg GAE/g DW obtained in the case of dried samples of Patience dock (*Rumex patientia*) considerably exceeds the value of 2.45 mg GAE/g DW reported by Yuksel et al. (2024). This major difference suggests a high phytochemical potential of the sample analyzed.

In the case of sorrel, the value obtained of 5.80 mg GAE/g DW in fresh leaf samples is slightly lower than the 8.70 mg GAE/g DW identified by Torres et al. (2019), indicating a relative proximity of the results, despite the geographical variability of the plants. Greater differences are observed in dried leaf samples where the TPC is 1.24 mg GAE/gDW.

The results regarding the total polyphenol content of wild garlic (6.66 mg GAE/g DW) in

fresh leaves show an interesting variability compared to the literature: they are significantly higher than those reported by Barbu et al. (2023) - 0.354 mg GAE/g DW - and lower than the range of 1.41-2.14 g GAE/100g DW (equivalent to 14.1-21.4 mg/g) found by Bernas et al. (2023). At the same time, it is closest to the result reported by Boacă (2025) of 3.61 mg GAE/g DW. The TPC content in dried leaves (1.12 mg GAE/g DW) is comparable to that in the literature of 1.41-2.14 g GAE/100g DW (Bernas et al., 2023).

The value determined for fresh tarragon leaves of 2.75 mg GAE/g DW is comparable to the 3.75 mg GAE/g DW reported by Kara (2022). The value obtained for dried leaves is much lower than the value of 24.10 mg GAE/g DW mentioned by Behbahani (2017), which highlights the major impact that the plant variety and the extraction method can have on the result.

For dill (*Anethum graveolens*), the result of 5.72 mg GAE/g DW for fresh leaves is between the extremes of the literature: it is much higher than the range of 0.57-1.11 mg GAE/g DW reported by Leahu et al. (2023), but in dried leaves, the TPC value (1.48 mg GAE/g DW) is considerably lower than the value of 16.91 mg GAE/g DW found by Jadhav (2023).

The content of 2.93 mg GAE/g DW obtained in fresh lovage leaves is in full agreement with the value of 3.59 mg GAE/g DW reported by Tomsone (2014). In contrast, compared to the TPC values in dried lovage leaves (0.92 mg GAE/g DW), the value of 20.84 mg GAE/g DW published by Sahlabgi (2025) represents a much higher threshold, which probably reflects the use of optimized extraction techniques or a plant material with an unusual metabolic concentration.

Table 4. Correlation between RSA% and TPC in fresh leaves

| Fresh samples | RSA % | TPC |
|---|---|---|
| Garden orache | 61.53 | 6.45 |
| Sorrel | 70.38 | 5.8 |
| Patience dock | 72.65 | 15.08 |
| Wild garlic | 68.27 | 6.66 |
| Lovage | 55.71 | 2.93 |
| Tarragon | 60.45 | 2.75 |
| Dill | 66.82 | 5.72 |

0.744513

| Fresh | RSA% | TPC |
|---|---|---|
| RSA% | 1 | 0.744513 |
| TPC | 0.744513 | 1 |

As indicated in Table 4, RSA% exhibits a strong positive correlation with TPC (r = 0.74) in fresh leaf samples.

In the case of fresh plants, there is a close and direct link between polyphenols and antioxidant activity.

The higher the TPC (total polyphenols) content of the plant, the greater its ability to neutralize free radicals (RSA %).

Table 5. Correlation between RSA% and TPC in dried leaves

| Dried samples | RSA % | TPC |
|---|---|---|
| Garden orache | 84.34 | 1.5 |
| Sorrel | 90.02 | 1.24 |
| Patience dock | 91.86 | 0.93 |
| Wild garlic | 89.84 | 1.12 |
| Lovage | 80.77 | 0.92 |
| Tarragon | 92.45 | 0.84 |
| Dill | 88.73 | 1.48 |

-0.21452

| Dried | RSA% | TPC |
|---|---|---|
| RSA% | 1 | -0.21452 |
| TPC | -0.21452 | 1 |

As shown in Table 5, a negative correlation (-0.21) is observed between RSA and TPC in the dried samples.

After drying, although the RSA% values increased significantly (from ~60-70% to ~80-90%), the TPC values decreased drastically.

As a drying process seems to have degraded the polyphenols (low TPC), which could be attributed to the concentration or creation of other antioxidant substances that maintain the RSA % very high.

## CONCLUSIONS

This research allowed the quantification and comparison of the polyphenolic profile for seven plants of food and phytotherapeutic importance: garden orache, sorrel, patience dock, leurda, lovage, tarragon and dill.

The comparative analysis of the seven green plants investigated reveals major differences between the fresh and dried states, both in terms of total polyphenol content (TPC) and antioxidant capacity (RSA %). In the fresh samples, TPC varies considerably among species, with high values in patience dock (15.08 mg GAE/g DW) and low levels in lovage and tarragon (<3 mg GAE/g DW), confirming the importance of these plants as natural sources of bioactive compounds. However, conventional room temperature

drying leads to a drastic reduction in TPC across all samples, with values converging into a narrow range (0.84-1.50 mg GAE/g DW), regardless of the initial content. This uniformity indicates massive polyphenol degradation, most likely caused by prolonged enzymatic oxidation during slow dehydration.

In contrast to the decline in TPC, drying results in a significant increase in RSA % in all samples. Values rise from 55-73% in fresh leaves to 80-92% in dried samples, with tarragon, sorrel, and patience dock reaching the highest levels (>90%). This dissociation between TPC and RSA suggests that post drying antioxidant activity is no longer determined exclusively by polyphenols but may be influenced by the formation of secondary compounds with increased reactivity in the DPPH system or by greater accessibility of non-phenolic antioxidants.

Overall, the results demonstrate that natural drying, although a traditional preservation method, does not maintain the integrity of phenolic compounds and significantly reduces the nutritional value associated with them. Nevertheless, the increase in RSA% indicates that dried plants retain, to some extent, their antioxidant potential, but through mechanisms different from those in fresh state. These findings highlight the need to optimize preservation methods to maintain the bioactive profile of green plants and provide a solid scientific basis for dietary recommendations and applications in the food industry.

## REFERENCES


Ali, B., Musaddiq, S., Iqbal, S., Rehman, T., Shafiq, N., & Hussain, A. (2021). The therapeutic properties, ethno pharmacology and phytochemistry of Atriplex species: a review. *Pakistan Journal of Biochemistry and Biotechnology*, 2(1), 49-64.

Bagiu, R.V., Vlaicu B. and Butnariu*, M. (2012). Chemical Composition and in Vitro Antifungal Activity Screening of the *Allium ursinum* L. (Liliaceae). *International Journal of Molecular Sciences,* 13, 1426-1436.

Barbu, I.A., Ciorîță, A., Carpa*, R., Mot, A.C., Butiuc-Keul A. and Pârvu, M. (2023). Phytochemical Characterization and Antimicrobial Activity of Several *Allium* Extracts. *Molecules*, 28, 3980.

Basavegowda, J., Raveesha, K.A.R., & Amruthesh, K.N. (2022). Bioactivity and Phytochemical Studies of Seed Extracts of *Anethum graveolens Linn*., *Letters in Applied NanoBioScience*, 11(2), 3560-3572.

Behbahani, B. A., Shahidi, F., Yazdi, F. T., Mortazavi, S. A., & Mohebbi, M. (2017). Antioxidant activity and antimicrobial effect of tarragon (Artemisia dracunculus) extract and chemical composition of its essential oil. *Journal of Food Measurement and Characterization*, 11(2), 847-863.

Bello*, O.M., Fasinu, P.S., Bello, O.E., Ogbesejana, A.B., Adetunji, C.O., Dada, A.O., Ibitoye, O.S., Aloko, S., Oguntoye, O.S. (2019). Wild vegetable *Rumex acetosa* Linn.: Its ethnobotany, pharmacology and phytochemistry – A review. *South African Journal of Botany,* 125,149–160.

Benkeblia, N., Lanzotti, V. (2007). *Allium* Thiosulfinates: Chemistry, Biological Properties and Their Potential Utilization in Food Preservation. *Food*, 1, 193–201

Bernaś, E., Słupski*, J., Gębczyński, P., Ražná, K. and Žiarovská, J. (2024). Chemical Composition and Genome Pattern as a Means of Identifying the Origin of Preserved Wild Garlic (*Allium ursinum* L.) in Poland. Agriculture, 14(1), 20, https://doi.org/10.3390/agriculture14010020

Boacă, V., Bordean, D.M., Gavrilă, C., Rădulescu, L., Ban-Cucerzan, A., & Băghină, N.G. (2025). Crafting unique blends: exploring combinations of onion, garlic, wild garlic and leek. *Scientific Papers. Series B, Horticulture*, LXIX (2).

Chahal, K. K., Monika, A. K., Bhardwaj, U., & Kaur, R. (2017). Chemistry and biological activities of Anethum graveolens L.(dill) essential oil: A review. *Journal of pharmacognosy and phytochemistry*, 6(2), 295-306.

Chaleshtori, R.S., Rokni, N., Razavilar, V., & Kopaei, M.R. (2013). The Evaluation of the Antibacterial and Antioxidant Activity of Tarragon (*Artemisia dracunculus* L.) Essential Oil and Its Chemical Composition. *Jundishapur Journal of Microbiology*, 6(9).

Cristea, R.M.I., & Șandru, D.M. (2023). Investigating the Polyphenolic Profile and the Antioxidant and Antibacterial Activity of Tarragon (*Artemisia dracunculus* L.) Cultivated in Central Romania. *Acta Chim. Slov*., 70, 345–352, DOI: 10.17344/acsi.2023.8225.

Dudaš S., Uzelac I., Vojinović M.Z., Peršić M., & Tomičić, M. (2025). Garden orache – weed or cultivated alternative vegetable? *6th International Rural Tourism Congress: Rural tourism: sustainable, digital, inclusive: Conference proceedings*. https://www.croris.hr/crosbi/publikacija/prilog-skup/894527

Dumbrava, D. G, Raba, D. N., Moldovan, C., Popa, V. M., Misca, C. D., Poiana, M. A., Druga, M., & Petcu, C.D., (2023). A meat products alternative: vegan cashew pariser – antioxidant, nutritional and sensory characteristics, *Scientific Papers. Series D. Animal Science*, LXVI (2), 500-506.

Feduraev, P., Skrypnik, L., Nebreeva, S., Dzhobadze, G., Vatagina, A., Kalinina, E., Pungin, A., Maslennikov, P., Riabova, A., Krol, O., & Chupakhina, G. (2022). Variability of phenolic compound accumulation and antioxidant activity in wild plants of some Rumex species (Polygonaceae). *Antioxidants*, 11(2), 311.

Filipčev, B., Kojić, J., Miljanić, J., Šimurina, O., Stupar, A., Škrobot, D., Travičić, V., & Pojić, M. (2023). Wild Garlic (*Allium ursinum*) Preparations in the Design of Novel Functional Pasta. *Foods*, 12, 4376.

Gordanić, S., Radanović, D., Vuković, S., Kolašinac, S., Kilibarda, S., Marković, T., Moravčević, D., & Kostić, A. Ž. (2022). Phytochemical characterization and antioxidant potential of *Allium ursinum* L. cultivated on different soil types - a preliminary study. *Emirates Journal of Food and Agriculture*, 34(11), 904-914 doi: 10.9755/ejfa.2022.v34.i11.2958.

Hazarika, U., Kovács, Z., Bodor, Z., & Gosztola, B. (2022). Phytochemicals and organoleptic properties of French tarragon (*Artemisia dracunculus L.*) influenced by different preservation methods. *LWT-Food Science and Technology*, 169, 114006.

Isbilir, S.S., Sagiroglu, A. (2011). Antioxidant Potential of Different Dill (*Anethum graveolens* L.) Leaf Extracts. *International Journal of Food Properties*, 14(4), 894-902, DOI: 10.1080/10942910903474401.

Jadhav, V. K., & Pawar, S. S. (2023). Qualitative and quantitative analysis of *Anethum graveolens* L. leaves in various extracts. *Advances in Zoology and Botany*, 11(5), 392-398

Jana, S., & Shekhawat, G.S. (2010). *Anethum graveolens*: An Indian traditional medicinal herb and spice, *Pharmacognosy reviews*, 4(8), 179.

Jannesar, N., Bassiri, A., Ghavami, M., Chenarbon, H. A., & Tarzi, B. G. (2024). Investigation of physicochemical and antibacterial properties of dill (*Anethum graveolens* L.) microencapsulated essential oil using fluidized bed method. *Food Chemistry*: X, 23, 101708.

Jovin, E., Simin, N., Orcic, D., Balog, K., Beara, I., Lesjak, M., & Dukic, N. M. (2011). Antioxidant and anti-inflammatory properties of *Rumex patientia* L. *Planta Medica*, 77(12), 157.

Kalaba, V., Ilić, T., Kalaba, D., Đurđević-Milošević, D., & Marjanović Balaban Z. (2024). Antibacterial activity of *Allium ursinum* tincture on pathogens isolated from food. *Scientific Conference SANUS* 2024, Prijedor, doi: 10.7251/SANUS2401299Z.

Kara, A., & Çağlak, E. (2022). Phytochemical Research and Evaluation of Tarragon (*Artemisia dracunculus* L.) as a Food Additive. Recep Tayyip Erdogan University *Journal of Science and Engineering*, 3(2), 50-60. Doi:10.53501/rteufemud.1160846.

Kaur, N., Chahal, K.K., Singh R. and Urvashi. (2018). Phytochemical screening and antioxidant activity of *Anethum graveolens* L. seed extracts. *The Pharma Innovation Journal*, 7(6), 324-329.

Korpelainen, H., & Pietiläinen, M. (2020). Sorrel (*Rumex acetosa L.*): not only a weed but a promising vegetable and medicinal plant. *The Botanical Review*, 86(3), 234-246.

Kovaćević, T.K., Major N., Sivec, M., Horvat, D., Krpan, M., Hruškar, M., Ban, D., Išić, N., & Ban, S.G. (2023). Phenolic Content, Amino Acids, Volatile Compounds, Antioxidant Capacity, and Their Relationship in Wild Garlic (*A. ursinum* L.) *Foods*, 12, 2110.

Kozłowska, M., Ścibisz, I., Przybył, J.L., Ziarno, M., Żbikowska, A., Majewska, E. (2021). Phenolic Contents and Antioxidant Activity of Extracts of Selected Fresh and Dried Herbal Materials. *Polish Journal of Food and Nutrition Sciences*, 71 (3), 269–278, DOI: 10.31883/pjfns/139035

Kumorkiewicz-Jamro, A., Pachulicz, R. J., Fitter, S., Górska, R., Duggan, J., Vandyke, K., Pukala, T. L., Wybraniec, S., & Zannettino, A. C. W. (2025). *Atriplex hortensis* var.'rubra'extracts and purified amaranthin-type pigments reduce oxidative stress and inflammatory response in LPS-stimulated RAW264. 7 cells. *Food Chemistry*, 462, 140920.

Kurhe, M.D.K., & Diwane, M.C.M. (2024). *Rumex acetosa*: A Comprehensive Review of its Ethnobotany, Chemistry, Pharmacology and Toxicity. *International Journal of Research Publication and Reviews*, 5(3), 6258-6266.

Leahu, A., Damian, C., Oroian, M., Miclescu, V., & Ropciuc, S. (2013). Variation in content of antioxidant and free radical cavenging activity of basil (*Ocimum Basilicum*), dill (*Anethum graveolens*) and parsley (*Petroselinum sativum*). *Journal of Faculty of Food Engineering, Ştefan cel Mare University*, 12(4), 347 - 353

Lee, N.J., Choi, J.H., Koo, B.S., Ryu, S.Y., Han,Y.H., Lee S.I., & Lee, D.U. (2005). Antimutagenicity and Cytotoxicity of the Constituents from the Aerial Parts of *Rumex acetosa*. *Biological and Pharmaceutical Bulletin*, 28(11) 2158—2161.

Lenková, M., Bystrická, J., Tóth, T., & Hrstková, M. (2016). Evaluation and comparison of the content of total polyphenols and antioxidant activity of selected species of the genus Allium. *Journal of Central European Agriculture*, 17(4), 1119-1133.

Mishra, A.P., Sharifi-Rad, M., Shariati, M.A., Mabkhot, Y.N., Al-Showiman, S.S., Rauf, A., Salehi, B., Župunski, M., Sharifi-Rad, M., Gusain, P., Sharifi-Rad, J., Suleria, H.A.R., & Iriti, M. (2018). Bioactive compounds and health benefits of edible Rumex species-A review. *Cellular and Molecular Biology*, 64(8), 27-34.

Mohamadi, N., Rajaei, P., Moradalizadeh, M., Amiri, M.S. (2017). Essential oil Composition and Antioxidant Activity of Levisticum officinale Koch. at Various Phenological Stages. *Journal of Medicinal Plants*, 16(61), 45-55.

Moldovan, C., Popa, V. M., Raba, D. N., Borozan, A. B., Miscă, C. D., Poiană, M.A., Petcu, C.D., & Dumbravă, D. G. (2023). Sensory and physico-chemical characteristics of muffins obtained from non-conventional aglutenic flours. *Scientific Papers. Series D. Animal Science*, 66 (1).

Moradalizadeh, M., Akhgar, M.R., Rajaei, P., & Faghihi-Zarandi, A. (2012). Chemical composition of the essential oils of *Levisticum officinale* growing wild in Iran. *Chemistry of Natural Compounds,* 47(6).

Mumivand, H., Babalar, M., Tabrizi, L., Craker, L. E., Shokrpour, M., & Hadian, J. (2017). Antioxidant properties and principal phenolic phytochemicals of Iranian tarragon (Artemisia dracunculus L.) accessions. *Horticulture, Environment, and Biotechnology*, 58(4), 414-422.

Nguyen, V.T., Nguyen, N.Q., An, T.N.T., Van, N.T., & Anh, N.H.T. (2020). Evaluation of polyphenol

content and antioxidant activities of Dill leaves extract *Anethum graveolens* L. *IOP Conference Series: Materials Science and Engineering*, 1, 012032, DOI 10.1088/1757-899x/991/1/1/012032.

Nour, V., Trandafir, I., & Cosmulescu, S. (2017). Bioactive Compounds, Antioxidant Activity and Nutritional Quality of Different Culinary Aromatic Herbs. *Notulae Botanicae Horti Agrobotanici*, 45(1), 179-184.

Pavlović, D.R., Veljković, M., Stojanović, N.M., Gocmanac-Ignjatović, M., Mihailov-Krstev, T., Branković, S., Sokolović, D., Marćetić, M., Radulović, N., & Radenković, M. (2017). Influence of Different Wild-Garlic (*Allium ursinum*) Extracts on the Gastrointestinal System: Spasmolytic, Antimicrobial and Antioxidant Properties. *Journal of Pharmacy and Pharmacology*, 69, 1208–1218.

Pârvu, M., Pârvu, A.E., Vlase, L., Roşca-Casian, O., & Pârvu, O. (2011). Antifungal properties of *Allium ursinum* L. ethanol extract. *Journal of Medicinal Plants Research*, 5(10), 2041-2046.

Popovschi, E., & Ivanova, R. (2025). Botanical, phytochemical, pharmacological overview of wild garlic (*Allium ursinum*). *Studia Universitatis Moldaviae (Seria Ştiinţe Reale şi ale Naturii*), 181(1), 273-281.

Sahlabgi, A., Lupuliasa, D., Stoicescu, I., Vlaia, L.L., Licu, M., Popescu, A., Scafa-Udris, A., Ene, R., Hîncu, L., Lupu, C.E., & Mititelu, M. (2025). Determination of the phytochemical profile and antioxidant activity of some alcoholic extracts of *Levisticum officinale* with pharmaceutical and cosmetic applications. *Separations*, 12, 79. https://doi.org/10.3390/separations12040079.

Shahrajabian, M.H. (2021). Spear Thistle (*Cirsium vulgare L.*) and Ramsons (*Allium ursinum* L.), Impressive Health Benefits and High-Nutrient Medicinal Plants. *Pharmacognosy Communications*, 11(3), 168-171.

Sobolewska, D., Janeczko, Z., Kisiel, W., Podolak, I., Galanty, A., & Trojanowska, D. (2006). Steroidal glycosides from the underground parts of *Allium ursinum* L. and their cytostatic and antimicrobial activity. *Acta Poloniae Pharmaceutica ñ Drug Research,* 63(3), 219-223.

Spréa, R.M., Fernandes, A., Calhelha, R.C., Pereira, C., Pires, T.C.S.P., Maria José Alves, M.J., Canan, C., Barros, L., Amaral, J.S., & Ferreira, I.C.F.R. (2020). Chemical and bioactive characterization of the aromatic *plant Levisticum officinale* W.D.J. Koch: a comprehensive study. *Food & Function*, 11, 1292, DOI: 10.1039/c9fo02841b.

Štajner, D., Popović, B.M., Čanadanović-Brunet, J., & Štajner, M. (2008). Antioxidant and scavenger activities of *Allium ursinum*. *Fitoterapia*, 79, 303-305.

Thanuma, J., Phetcharaburanin, J., Dokduang, H., Loilome, W., Klanrit, P., Wangwiwatsin, A., & Namwat, N. (2025). Metabolomic analysis of bioactive compounds in dill (*Anethum graveolens* L.) extracts. *PeerJ*, 13, e19567.

Tizghadam, P., Roufegari-Nejad, L., Asefi, N., & Jafarian Asl, P. (2021). Physicochemical characteristics and antioxidant capacity of set yogurt fortified with dill (*Anethume graveolens*) extract. *Journal of Food Measurement and Characterization*, 15(4), 3088-3095.

Tomsone, L., & Kruma, Z. (2014). Influence of freezing and drying on the phenol content and antioxidant activity of horseradish and lovage. *Conference Proceedings–Baltic Conference on Food Science and Technology "FOODBALT*, 192-197.

Torres, M. P., Carlos, L. D. A., Pedrosa, M. W., Silva, A. P. C. M., Silva, E. C. D., & Ferraz, L. D. C. L. (2019). Profile of phytochemistry and antioxidant activity of sorrel in function of organic fertilization and density of plantio. *Bioscience Journal (Online*), 775-783.

Tuazon-Nartea, J., & Savage, G. (2013). Investigation of Oxalate Levels in Sorrel Plant Parts and Sorrel-Based Products. *Food and Nutrition Sciences*, 4, 838-843.

Uslu, N., Acar, R., Seymen, M., Dursun, N., Türkmen, Ö., & Özcan, M.M. (2020). The effect of sowing dates on total phenol, antioxidant activity and phenolic compounds of orache garden leaves harvested from plants growing garden house and field conditions. *Journal of Agroalimentary Processes and Technologies*, 26(4), 347-352

Vasas, A., Orbán-Gyapai, O., & Hohmann, J. (2015). The Genus *Rumex*: Review of traditional uses, phytochemistry and pharmacology. *Journal of Ethnopharmacology*, 175, 198-228.

Yüksel, E., Ceylan, S., & Bekis, M. (2024). Antioxidant activities of traditional medicinal plant species from the Kars (Turkey). *BioResources*, 19(1), 1209-1217

Zeipiņa, S., Alsiņa, I., Lepse, L., & Dūma, M. (2015). Antioxidant activity in nettle (*Urtica dioica* L.) and garden orache (*Atriplex hortensis* L.) leaves during vegetation period, *Chemical Technology*, 66(1), 29-33.