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EVALUATION OF SOME QUALITY PARAMETERS OF 'ENROSADIRA' RASPBERRY VARIETY UPON DIFFERENT GROWING SYSTEMS

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Abstract

The increasing global trend in cultivating berries, particularly raspberries, is driven by their high content of bioactive nutrients. These fruits are not only very attractive for consumers but also offer numerous health and diet benefits. This study focuses on the cultivar 'Enrosadira', a recent Italian variety of raspberry known for its attractive flavor, good yield and high adaptability to different growing conditions. The objective of current research was to asses the influence of cultivation system upon some characteristics of raspberries after first growing season. Yield, fruit weight, total phenolic and flavonoids content, total tannins and antocyanins, total sugar content, soluble solid content (SSC) and carotenoids were evaluated during the trial. The fruit weight varied between 3.17 g to 4.30 g and the total phenolic content differed among growing conditions from 347.83 mg GAE/g FW to 443.76 mg GAE/g FW. The total sugar content ranged from 3.72 g glucose/100 g to 4.04 g glucose/100 g, indicating variability in the sweetness and caloric value of the fruit. The findings from the study enphasized significant variation in the fruits physico-chemical properties on different growing conditions.

Key words*: berries, bioactive nutrients, physicochemical properties, different growing condition.*

INTRODUCTION

The change in raspberry breeding towards sensory qualities and potential health benefits reflects growing interest in how fruit composition influences not only flavor and texture but also the nutritional and therapeutic properties of raspberries. This is in line with broader trends in agriculture where there is increasing recognition of the role that crops can play in promoting health and preventing disease (Motyleva et al., 2022). The adjust in raspberry breeding from traditional agronomic characteristics to those that focus on sensory qualities and health benefits, as noted by Jennings et al. (2016) and Mazzoni et al. (2016), highlights the increasing consumer demand for berries that not only taste good but also offer nutritional and therapeutic benefits. This change is also driven by the growing interest in functional foods-foods that provide health benefits beyond basic nutrition. As such, raspberries, with their high levels of antioxidants, vitamins, and other bioactive compounds, are at the forefront of this movement. Recent research has demonstrated a growing interest in the characterization of essential oils and secondary metabolites from both well-known and lesser-known plants. This trend underscores the untapped potential of natural resources to yield new scientific insights that can benefit human health (Viskelis et al., 2010; Al-Snafi et al., 2016; Bobinaitė et al., 2016; Perrino et al., 2021).

Berries, in particular, have emerged as a valuable source of a diverse array of secondary metabolites, which hold promise for applications in the pharmaceutical, agronomic, and food industries (Oomah et al., 2000; Sagar et al., 2018). The increasing global trend in cultivating small fruits, particularly raspberries, is driven by their high content of bioactive nutrients. These fruits are not only delicious but also offer numerous health benefits, making them a valuable addition to the diet (Tosun et al., 2009).

The estimated global area of raspberry cultivated in 2022 was approximately 116,393 hectares (FAO, 2024). This figure highlights the extensive global interest in raspberries, which continue to grow in both consumption and production. Among the major raspberry producers, Poland stands out as a key player, with an area dedicated to raspberry farming of about 21,700 hectares. This makes Poland one of the top countries in terms of raspberry cultivation area, second only to Russia, which has an even larger area of cultivation. Poland's raspberry industry is significant not only because of the large area under cultivation but also due to its position as a leader in raspberry processing, with a significant portion of its production destined for frozen berries, juices, jams, and other processed products. The country has developed a strong export market for raspberries, particularly within the European Union, and increasingly to other regions (Maj et al., 2024). Raspberries are rich in various bioactive compounds, particularly antioxidants, which contribute to their health benefits (Arnold et al., 2022). There is a type of flavonoid, a class of plant compounds known for their antioxidant and anti-inflammatory properties. In raspberries, flavonols such as quercetin and kaempferol are present, which help neutralize free radicals and may contribute to reducing oxidative stress in the body. These are a type of flavonoid, a class of plant compounds known for their antioxidant and anti-inflammatory properties (Golovinskaia et al., 2021). Raspberries are an excellent source of vitamin C, an essential nutrient that acts as a powerful antioxidant. Vitamin C is involved in the protection of cells from oxidative damage, supports immune function, and aids in collagen synthesis for skin health. The recent findings highlighted the promising role of anthocyanins, a group of naturally occurring pigments found in many fruits, vegetables, and flowers, particularly in deeply colored foods like raspberry, purple sweet potatoes, and red cabbage. With higher levels of phenolics, flavonoids, and anthocyanins, raspberries are a great source of antioxidants, which can help protect against chronic diseases, including heart disease, cancer, and neurodegenerative disorders. Incorporating anthocyanin-rich foods into the diet may offer a natural, preventive approach to managing oxidative stress and reducing the risk of chronic diseases. These findings also encourage further research into anthocyanins as potential therapeutic agents (Bilawal et al., 2021).

Although raspberry fruits contain sugar, the relatively low sugar content in this variety makes it suitable for various health-conscious consumers, including those monitoring blood sugar levels (Drobek et al., 2024). The goal of this study is how various environmental factors and cultivation techniques can impact the physicochemical properties of raspberry fruits, which in turn affect their quality and nutritional value.

MATERIALS AND METHODS

Chemicals and Reagents

It is obtained various chemicals and reagents from Merck. Darmstadt. Germany. Including 2,2-Diphenyl-1-picrylhydrazyl (DPPH), 2,6-dichloroindophenol (DCPIP). sodium hydroxide, sodium carbonate, sodium bicarbonate, sodium nitrite. disodium phosphate, aluminum chloride, methanol. acetone, n-hexane, ethanol, citrate/acetate buffer, gallic acid, catechin, vitamin C, cyanidin-3-O-glucoside, metaphosphoric acid, acetic acid, hydrochloric acid, citric acid, and Folin-Ciocalteu reagent (Stockhammer et al., 2009).

Plant material

The experiment was carried out in the Research Institute for Fruit Growing Pitesti - Mărăcineni (RIFG) in South of Romania 44°54'12" Northern latitude, and 24°52'18" Eastern longitude, 284 m altitude, over summer 2024. The biological material studied, the 'Enrosadira' variety, is a Italian primocane raspberry and the fruits ripen in two stages: in early June, on 1-year-old shoots, and in mid-July - early August on annual shoots. It is characterized by a high precocity, which allows obtaining an earlier production in the summer season (Figure 1).

Figure 1. 'Enrosadira' raspberry variety

Culture Systems

System I: Conventional irrigation in open field (1.5 L/day/plant).

System II: Controlled irrigation in open field using the Netafim system, based on the evapotranspiration (ET0) method (Păltineanu et al., 2018).

System III: Conventional irrigation in a solar (1.5 L/day/plant).

System IV: Controlled irrigation in a solar using methodologies from Hargreaves and Samani (1985), revised by Jaafar et al. (2019).

Conventional irrigation (system I and III): applies a fixed amount of water daily (1.5 liters per plant), regardless of the plant's specific water needs or environmental conditions.

Controlled irrigation (system II and IV) is adjusted based on evapotranspiration rates or other environmental data to optimize water use and prevent over- or under-watering. The methodology takes into account local climate conditions and plant growth to deliver more precise irrigation.

Fruit quality parameters

During the peak fruit harvesting period. we recorded various indicators from a sample of 50 fruits, with each measurement and analysis repeated 3 times.

Fruit production (g/plant) was calculated by summing the weights of fruits harvested per plant. Measurements were repeated across three harvests.

The average *fruit weight* was determined by using the HL-400 digital balance to weigh each fruit. The fruit shape index was calculated using the formula fruit length/fruit diameter (Titirică et al., 2023).

Various quality parameters were measured, such as total soluble solids, total sugar content, total polyphenols content (TPC), total flavonoids content (TFC), total tannins content (TTC), total anthocyanins content (TAC), as well as lycopene and β-carotene contents.

Total soluble solid content (TSS) was measured using a Kruss DR201-95 refractometer and the results expressed as °Brix at 20°C, indicating the sugar concentration in the fruit.

The total polyphenol content (TPC) was measured using the method recommended by Matić et al. (2017). Polyphenols react with phosphotungstic acid in an alkaline medium, forming a blue-colored complex. Absorbance measured at 760 nm. Results expressed as mg gallic acid equivalent (GAE) per 100 g FW. ()

The total flavonoid content (TFC) was measured using the method proposed by Tudor-Radu et al. Flavonoids react with aluminum chloride, producing a yellow-orange complex.

Absorbance was measured at 510 nm and the results were expressed as mg catechin equivalent (CE) per 100 g FW.

To determine *the total anthocyanin content (TAC)*, the pH differential method suggested by Di Stefano and Cravero was used. Structural changes in anthocyanins are pH-sensitive.

Absorbance was measured at 520 nm after preparing samples in pH 0.6 and 3.5 buffers (Sucu, et al., 2023) and the results were expressed as cyanidin-3-O-glucoside equivalent (C3-GE) per 100 g FW.

Based on Broadhurst et al.'s method (1978), *the tannin contents (TTC)* was determinated as total tannins (proanthocyanidins) which react with vanillin and hydrochloric acid, forming a red complex. Absorbance was measured at 500 nm and the results were expressed as g E. catechin per 100 g dry matter.

The levels of *lycopene and β-carotene* were determined using the method proposed by Tudor-Radu et al. Carotenoids were extracted using a mixture of hexane, ethanol. and acetone. Results expressed in mg per 100 g FW, with absorbance at 470 nm (β-carotene) and 503 nm (lycopene) (Cáceres, et al., 2014).

Statistical Analysis
The data collected from the experiments were summarized and presented as mean ± standard deviation (SD). This approach to data presentation provides a clear indication of both the central tendency (mean) and the variability (SD), making it easier to assess the consistency of the results. By employing a combination of ANOVA tests and post-hoc analyses, the methodology effectively identified significant trends, key differences, and interaction effects in the data. All statistical analyses were performed using Excel 2021 in conjunction with the XLSTAT add-in.

RESULTS AND DISCUSSIONS

The study highlights the influence of cultivation environments and irrigation technologies on fruit production. The best performance in terms of yield demonstrates that protected cultivation systems, combined with advanced irrigation methods, substantially outperform conventional open field conditions.
The experiment recorded a significant increase in fruit yield under solar conditions for both irrigation systems when compared to open-field growing. This suggests that protected spaces, with their ability to regulate environmental variables such as temperature, humidity, and pest exposure, create optimal growth conditions for crops. Additionally, the use of controlled irrigation technologies in these settings further enhanced production, underscoring the role of precise water management in agricultural efficiency.
In the open field with conventional irrigation, the yield was minimal, averaging 0.31 kg per bush (Figure 2). This reflects the limitations of uncontrolled environmental conditions and traditional irrigation methods.
In contrast, the solar with controlled irrigation achieved the highest yield of 0.87 kg per bush, nearly three times that of the field setup. This stark difference emphasizes the synergy between advanced technology and controlled environments.
These data confirm that integrating protected cultivation spaces with modern irrigation technologies is a robust strategy for achieving higher agricultural productivity. As global food demand grows, adopting such innovative practices will be essential for sustainable farming.

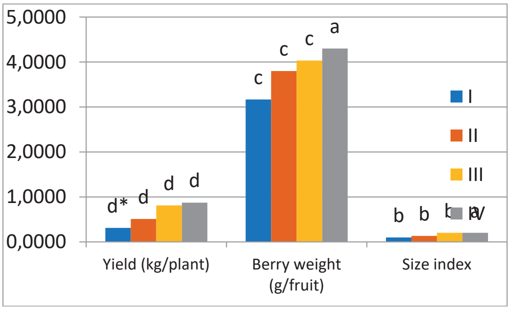

Figure 2. Fruit parameters of raspberry cultivar

Agricultural practices have evolved significantly with the advent of technology, particularly in controlled environments where factors like temperature, humidity, and irrigation can be precisely managed. One of the key indicators of plant health and productivity is the weight of the fruit, which directly correlates to environmental conditions and cultivation methods. The results from the experiment under discussion reveal how protected cultivation, combined with advanced irrigation systems, positively impacts fruit development, particularly in terms of fruit weight.
The study demonstrates that fruits grown under protected conditions, such as solar, consistently had higher average weights compared to those grown in open-field conditions. Protected spaces, such as solar, provide a stable environment that protects plants from extreme weather conditions, pests, and other stressors that can limit growth. These controlled environments not only ensure that plants have optimal growing conditions but also prevent environmental fluctuations that could negatively affect fruit quality. As a result, fruits grown in such spaces can allocate more energy towards development rather than survival, leading to larger, healthier fruits.
Irrigation is other important factor that determines fruit size and quality. This study compared two types of irrigation systems: conventional irrigation and digitized, or controlled, irrigation. It was found that controlled irrigation, especially in solar environments, led to the highest fruit weights. Controlled irrigation systems provide water in a more efficient and targeted way, ensuring that

plants receive the exact amount of water they need without waste or stress. This precise watering contributes to maintain healthier plants, with more resources available for fruit development rather than coping with water deficits or exceses.

The results of the experiment revealed significant differences in the average fruit weight across different cultivation and irrigation systems. In open-field conditions with conventional irrigation, the average fruit weight was 3.17 g. This relatively low value highlights the limitations of traditional farming methods, where environmental conditions are less controlled, and water distribution is less precise.

Under digitized irrigation in open field, fruit weight increased slightly to 3.8 g, suggesting that even in less controlled environments, modern irrigation techniques can lead to some improvement by delivering more consistent water levels to the plants.

In solar, using conventional irrigation, fruit weight increased to 4.03 g, showcasing the positive influence of the controlled environment. The higher weight in solar, even without the added benefit of controlled irrigation, suggests that protected spaces alone can significantly enhance fruit development.

The highest fruit weight was observed in solar with controlled irrigation, where the average fruit weight reached 4.30 g. This result confirms that the combination of both a protected environment and advanced irrigation technology offers the best conditions for optimal fruit development.

The size index reflects the overall growth and dimensional characteristics of fruits under different cultivation and irrigation conditions. The highest value (1.14) confirms the significant advantages of combining solar cultivation with digitized irrigation systems, which optimize both environmental conditions and resource use. Digitized irrigation in open fields produces a similar size index to conventional irrigation in solar (1.07). This suggests that while precise irrigation contributes significantly to growth, the added benefits of a protected environment further enhance fruit size.

The pH values reflect the acidity of the fruit, which impacts taste and shelf life.

The data indicates variability across the cultivation systems: lowest pH (3.57) recorded in systems I and IV, suggesting higher acidity. This is typical in open-field cultivation and under less optimized conditions. Highest pH (4.62) found in system II, indicating reduced acidity and potentially a milder taste. This could be attributed to the use of digitized irrigation in more controlled settings. Total soluble solids (TSS), measured in °Brix, represents the total sugars and other dissolved solids in the fruit, directly correlating with sweetness and flavor intensity: Highest TSS (12.50°Brix) recorded in system II, suggesting the sweetest fruits with enhanced flavor. This is likely due to digitized irrigation optimizing water and nutrient delivery. Lowest TSS (11.30°Brix) found in system IV, suggesting less sweetness compared to other systems.

Total sugar content (TSC) values measure the sugar content in the fruit, reflecting its energy reserves and sweetness: highest TSC (4.04 g/100 g), observed in system III, indicates superior sugar accumulation. Lowest TSC (3.71 g/100 g) found in system I, likely due to open-field conditions with conventional irrigation, which limits the plant's ability to maximize sugar synthesis (Figure 3).

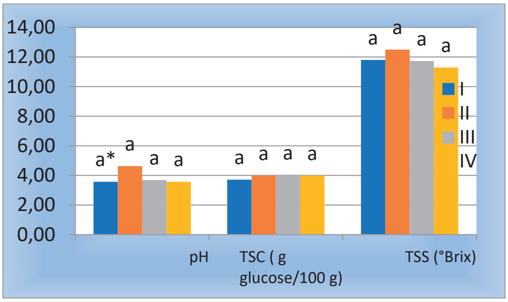

Figure 3. Fruit parameters of raspberry cultivar

The classic exterior method (I) is the most efficient at preserving phenolic compounds, which aligns with their role in protecting against oxidative stress. Systems III and IV show significant degradation of these compounds (-21.6% compared to the classic method). TPC is strongly positively correlated with TTC and TFC, suggesting that the processes affecting phenols also influence flavonoids. TTC is highest for the classic exterior method (I) but decreases significantly with digital and solar methods. Systems (III and IV) show the weakest retention of TTC, indicating that high-temperature exposure negatively affects antioxidant compounds. The classic exterior method (I) preserves flavonoids the best (64.79 mg CE/100 g FW), while solar methods show significant losses. Flavonoid stability is slightly higher in the digital solar method (IV) compared to the classic solar method (III), suggesting minor improvements in stabilization. The classic exterior method (I) is the most efficient at preserving phenolic compounds, which aligns with their role in protecting against oxidative stress.

The open field growing system is the most efficient at preserving phenolic compounds, which aligns with their role in protecting against oxidative stress. Systems III and IV show significant degradation of these compounds (-21.6% compared to the classic method). TPC is strongly positively correlated with TTC and TFC, suggesting that the processes affecting phenols also influence flavonoids (Figure 4). TTC is highest for the classic exterior method (I) but decreases significantly with digital and solar methods. Solar systems (III and IV) show the weakest retention of TTC, indicating that high-temperature exposure negatively affects antioxidant compounds.

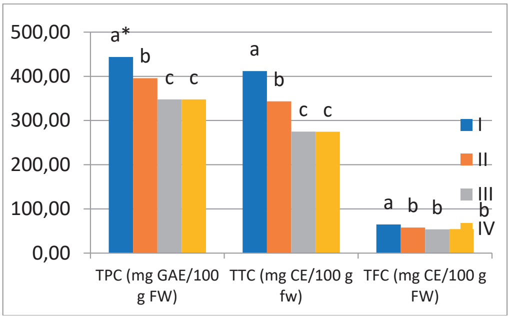

Figure 4. Fruit parameters of raspberry cultivar

The classic exterior method (I) preserves flavonoids the best (64.79 mg CE/100 g FW), while solar methods show significant losses. Flavonoid stability is slightly higher in the digital solar method (IV) compared to the classic solar method (III), suggesting minor improvements in stabilization.

The classic exterior method (I) retains the most lycopene (0.67 mg/100 g FW), an important carotenoid for heart health. There is moderate loss in the digital methods and significant degradation in the solar methods (-30%). Solar methods (III and IV) preserve beta-carotene the best (0.30 mg/100 g FW), which is unusual given the losses in other antioxidant components. The digital exterior method (II) shows a stabilization of beta-carotene (+17.1%) compared to the classic method.

TAC is lowest for the classic exterior method (1.11 mg C3-GE/100 g FW), but it increases dramatically in the solar methods (up to 4.78 mg C3-GE/100 g FW). TAC is negatively correlated with TPC, TTC, TFC, and lycopene, suggesting that the degradation of these compounds is associated with the increase in other antioxidants contributing to TAC.

Classic exterior method (I) is ideal for preserving phenolic compounds, flavonoids, and lycopene, but it does not maximize TAC.

Solar methods (III and IV) increase TAC, but at the cost of losing phenolic compounds, flavonoids, and lycopene (Figure5).

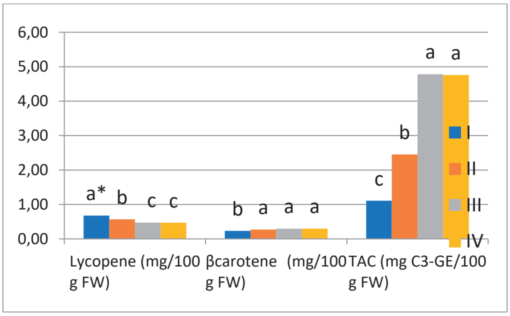

Figure 5. Fruit parameters of raspberry cultivar

β-carotene seems more stable in solar and digital methods but is negatively correlated with other antioxidants, suggesting a different degradation or stabilization mechanism.

The digital exterior method (II) offers a balance between preserving compounds and increasing TAC, making it a viable alternative.

CONCLUSIONS

The findings from this study demonstrated the substantial benefits of combining protected cultivation with controlled irrigation systems.

The increase in average fruit weight in solar environments with digitized irrigation underscores the importance of these innovations in modern agriculture.

Protected spaces create stable and optimal growing conditions, while controlled irrigation ensures that plants receive consistent and adequate water, leading to improved fruit development.

The enhanced fruit weight observed in this study is a showcase of how controlled environments and advanced irrigation can help meet these challenges by improving productivity and ensuring higher-quality crops.

The progression of the size index underscores the critical role of advanced technologies in improving fruit growth.

Protected cultivation paired with digitized irrigation delivers the highest performance, making it a key strategy for achieving superior agricultural productivity. These findings highlight the potential for integrating these technologies to optimize fruit size and overall crop quality.

The study highlighted the importance of protected cultivation and digitized irrigation systems in boosting fruit yield, weight, and quality. While solar systems significantly enhance total antioxidant capacity, they may compromise the retention of certain beneficial compounds like phenolics and flavonoids.

The classic exterior method remains optimal for preserving these compounds but does not maximize TAC. The digital exterior method offers a balanced approach, stabilizing beta-carotene while preserving antioxidants, making it a promising alternative for sustainable fruit production in the future.

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REFERENCES

Arnold, H., Dobson, G., Foito, A., Austin, C., Sungurtas, J., Allwood, J. W., McDougall, G. J. (2022). Assessing available phytochemicals from commercial blackcurrant and raspberry pomaces. *Journal of Berry Research*, *12*(3), 415–431.

Bilawal, Akhunzada, Muhammad Ishfaq, Munkh-Amgalan Gantumur, Abdul Qayum, Rujie Shi, Saqib Ali Fazilani, Asif Anwar, Zhanmei Jiang, and Juncai Hou (2021). A review of the bioactive ingredients of berries and their applications in curing diseases. *Food Bioscience*, 44: 101407.

Cáceres, J. O., Cámara, M., Manzoor, S., Cámara, R. M., Fernández-Ruiz, V., & Cortes Sánchez Mata, M. (2014, June). New developments in lycopene analysis by spectroscopic and chromatographic techniques, accompanied with mathematical modelling. In *XIII International Symposium on Processing Tomato*, 1081 (pp. 259–265).

Drobek, M., Cybulska, J., Zdunek, A., Sas-Paszt, L., & Frąc, M. (2024). Effect of microbial biostimulants on the antioxidant profile, antioxidant capacity and activity of enzymes influencing the quality level of raspberries (*Rubus idaeus* L.). *Food Chemistry*, *454*, 139746.

FAO (Food and Agriculture Organization of the United Nations). 2024. Available online: https://www.fao.org/faostat/ en/#data/QI (accessed on 13 November 2024).

Golovinskaia, Oksana, and Chin-Kun Wang (2021). Review of functional and pharmacological activities of berries. *Molecules*, *26*, no. 13: 3904.

Jennings, S. N., Graham, J., Ferguson, L., & Young, V. (2015, June). New developments in raspberry breeding in Scotland. In *XI International Rubus and Ribes Symposium, 1133* (pp. 23–28).

Jaafar, H. H., & Ahmad, F. (2019). Determining reference evapotranspiration in greenhouses from external climate. *Journal of Irrigation and Drainage Engineering*, *145*(9), 04019018.

Hargreaves, G. H., & Samani, Z. A. (1985). Reference crop evapotranspiration from temperature. *Applied engineering in agriculture*, *1*(2), 96–99.

Maj, G., Buczyński, K., Klimek, K. E., & Kapłan, M. (2024). Evaluation of growth and energy parameters of one-year-old raspberry shoots, depending on the variety. *Energies*, *17*(13), 3153.

Matić, P., Sabljić, M., & Jakobek, L. (2017). Validation of spectrophotometric methods for the determination of total polyphenol and total flavonoid content. Journal of AOAC International, 100(6), 1795–1803.

Mazzoni, L., Perez-Lopez, P., Giampieri, F., Alvarez-Suarez, J. M., Gasparrini, M., Forbes-Hernandez, T. Y., ... & Battino, M. (2016). The genetic aspects of berries: from field to health. *Journal of the Science of Food and Agriculture*, *96*(2), 365–371.

Motyleva, S. M., Evdokimenko, S. N., Podgaetsky, M. A., Tumaeva, T. A., Burmenko, Y. V., Svistunova, N. Y., ... & Kulikov, I. M. (2022). Mineral composition of repair raspberry (*Rubus idaeu*s L.) fruits. *Vavilov Journal of Genetics and Breeding*, *26*(7), 622.

Tosun, M., Ercisli, S., Karlidag, H. Ü. S. E. Y. İ. N., Sengul, M. (2009). Characterization of red raspberry (*Rubus idaeus* L.) genotypes for their physicochemical properties. *Journal of Food Science*, *74*(7), C575-C579.

Viskelis, P.; Rubinskiene, M.; Bobinaite, R.; Dambrauskiene, E. Bioactive compounds and antioxidant activity of small fruits in Lithuania. *J. Food Agric. Environ.* 2010, *8*, 259–263.

Perrino, E.; Valerio, F.; Gannouchi, A.; Trani, A.; Mezzapesa, G. (2021). Ecological and Plant Community Implication on Essential Oils Composition in Useful Wild Officinal Species: A Pilot Case Study in Apulia (Italy). *Plants*, *10*, 574.

Al-Snafi, A.E. (2016). Medicinal plants possessed anti-inflammatory antipyretic and analgesic activities (part 2) - plant based review. *Sch. Acad. J. Pharm.*, *5*, 142–158.

Bobinaitė, R.; Viskelis, P.; Bobinas, Č.; Mieželienė, A.; Alenčikienė, G.; Venskutonis, P.R. (2016). Raspberry marc extracts increase antioxidative potential, ellagic acid, ellagitannin and anthocyanin concentrations in fruit purees. *LWT Food Sci. Technol.*, *66*, 460–467.

Păltineanu, C., Olga, V., Emil, C., Sorina, D. (2018). Irrigation regime in orchards and berries depending on the current climatic conditions and hydrophysical indices of the soils.

Sagar, N.A.; Pareek, S.; Sharma, S.; Yahia, E.M.; Lobo, M.G. (2018). Fruit and Vegetable Waste: Bioactive Compounds, Their Extraction, and Possible Utilization. Compr. *Rev. Food Sci. Food Saf.*, 17, 512–531.

Stockhammer, S., Stolze, K., Rohr-Udilova, N., Chizzola, R., Zitterl-Eglseer, K., & Franz, C. (2009). Antioxidant activity of phytogenous industrial waste and derived extracts for the production of feed and food additives. *International Journal of food science & technology*, *44*(4), 702–710.

Sucu, S., Altıncı, N. T., Yağcı, A., Kılıç, D., Şahin, S., & Cangi, R. (2023). Effects of Selenium Biofortification on Phytochemical Characteristics of Some Table Grape Cultivars. *Black Sea Journal of Agriculture*, *6*(5), 558–563.

Titirică, I., Roman, I. A., Nicola, C., Sturzeanu, M., Iurea, E., Botu, M., Sestras, A. F. (2023). The main morphological characteristics and chemical components of fruits and the possibilities of their improvement in raspberry breeding. *Horticulturae*, *9*(1), 50.

Tudor-Radu, M., Vîjan, L. E., Tudor-Radu, C. M., Ion, T. I. Ț. A., Rodica, S. I. M. A., & Mitrea, R. (2016). Assessment of ascorbic acid, polyphenols, flavonoids, anthocyanins and carotenoids content in tomato fruits. Notulae botanicae horti agrobotanici Cluj-Napoca, *44*(2), 477–483.