Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 13(4), 2315-2324, 2023
Journal of the Institute of Science and Technology, 13(4), 2315-2324, 2023
ISSN: 2146-0574, eISSN: 2536-4618
Bahçe Bitkileri / *Horticulture* **DOI: 10.21597/jist.1293188**
Araştırma Makalesi / *Research Article*
Geliş tarihi / *Received*: 05.05.2023 **Kabul tarihi / *Accepted*: 03.10.2023**

Atıf İçin: Yıldız, B. C., Demir, E. F. ve Hanci, F. (2023). Tatlı Patates ve Gölevezin Bazı Biyoaktif Bileşenleri: Bitki Organlarına Dayalı Karşılaştırmalı Bir Çalışma. *Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 13(4), 2315-2324.

To Cite: Yıldız, B. C., Demir, E. F. & Hanci, F. (2023). Some Bioactive Components Of Sweet Potato and Taro: A Comparative Study Based On Plant Organs. *Journal of the Institute of Science and Technology*, 13(4), 2315-2324.

Tatlı Patates ve Gölevezin Bazı Biyoaktif Bileşenleri: Bitki Organlarına Dayalı Karşılaştırmalı Bir Çalışma

Berk Can YILDIZ[1], Emir Furkan DEMİR[1], Fatih HANCI[1*]

Öne Çıkanlar:
- Alternatif tarım ürünleri
- Fonksiyonel Gıdalar
- Yerel sebze türleri

Anahtar Kelimeler:
- Antioksidan
- Fenolik
- Flavanoid
- Gölevez
- Tatlı patates

ÖZET:

Bu çalışmada, Türkiye'de lokal olarak yetiştirilen tatlı patates ve gölevez bitkilerinin farklı organlarının biyoaktif bileşenlerinin değişkenliğini ve dağılımını değerlendirmek amacıyla yürütülmüştür. Bu iki türün farklı organından (tatlı patatesin yumru ve yaprakları; gölevezin yaprakları, yaprak sapları, ana yumruları ve lateral yumruları) ekstrakte edilen örneklerde değerlendirmeler yapılmıştır. Çalışmada iki farklı türün ve örnek alınan organlarının toplam suda çözülebilir protein, toplam flavonoid, toplam fenolik, H_2O_2 giderme kapasitesi, toplam karotenoid, FRAP antioksidan kapasitesi, CUPRAC antioksidan kapasitesi ve toplam kuru madde parametreleri ölçülmüştür. İncelenen tüm parametreler için organ ortalamaları arasındaki fark istatistiksel olarak anlamlı bulunmuştur. Genel olarak her iki türün yaprakları toplam kuru madde ve CUPRAC antioksidan kapasitesi dışındaki tüm parametreler için en yüksek içeriğe sahip bulunmuştur. Ayrıca parametrelerin gen havuzundaki varyasyonu açıklamadaki etkinliği temel bileşenler analizi kullanılarak incelenmiştir. H_2O_2 giderme kapasitesi, toplam kuru madde içeriği ve CUPRAC antioksidan kapasitesi dışındaki tüm parametreler varyasyona yüksek katkı yapmıştır. Elde edilen bulgulara göre, bu iki tür ve organları arasında yüksek varyasyon olduğu anlaşılmıştır. Bu sonuçlar, ileride bu iki tür ile ilgili yapılacak çalışmalara yol gösterici olacaktır.

Some Bioactive Components of Sweet Potato and Taro: A Comparative Study Based On Plant Organs

Highlights:
- Alternative agricultural crops
- Functional foods
- Local vegetable species

Keywords:
- Antioxidant
- Phenolic
- Flavanoid
- Taro
- Sweet Potato

ABSTRACT:

This study was carried out to evaluate the variability and distribution of bioactive components of different organs of sweet potato and taro plants grown locally in Turkey. Samples extracted from different organs of these two species (tubers and leaves of sweet potato; leaves, petioles, main tubers, and lateral tubers of taro) were evaluated. Total water-soluble protein, total flavonoids, total phenolics, H_2O_2 scavenging capacity, carotenoids, FRAP antioxidant capacity, CUPRAC antioxidant capacity, and total dry matter parameters of two different species and their organs were measured. The difference between the organ averages for all parameters examined was statistically significant. In general, leaves of both species had the highest content for all parameters except total dry matter and CUPRAC antioxidant capacity. The effectiveness of the parameters in explaining variation in the gene pool was also examined using principal component analysis. All parameters contributed highly to the variation except H_2O_2 capacity, total dry matter content, and CUPRAC antioxidant capacity. According to the findings, there is a high variation between each species and between the organs. These results will guide future studies on these two species.

[1]Berk Can YILDIZ (**Orcid ID:** 0009-0004-6685-2094), Emir Furkan DEMİR (**Orcid ID:** 0009-0005-9019-3217), Fatih HANCI (**Orcid ID:** 0000-0002-2015-0351), Erciyes University, Faculty of Agriculture, Kayseri, Türkiye

***Corresponding Author**:* Fatih HANCI, e-mail: fatihhanci@erciyes.edu.tr

INTRODUCTION

After grains and legumes, roots and tubers are the third most significant food crop. Cassava (*Manihot esculenta*), potatoes (*Solanum tuberosum*), yams (*Dioscorea alata*), and sweet potatoes (*Ipomoea batatas*) have the highest production values (Afzal et al, 2021). To meet the Global Sustainable Development Goals (SDGs) 1.0, 2.0, and 7.0, small farmers must invest in root and tuber crops that supply both food and energy at a low environmental cost (such as sweet potatoes) (Rukundo et al., 2020).

The sweet potato (*I. batatas*), a member of the family, originates from Latin America. Although there is no definite information about its entry into Turkey, it is stated that it was first brought by immigrants from Crete in the early 20th century (Çalışkan et al., 2007). Today, varieties with different skin and inner colors are grown in the southern provinces of Turkey with names such as HatayNative, HatayRed, Carrot, Kalem and YellowPotato. Sweet potato is an important source of income for smallholder producers in Turkey. Sweet potato production is generally carried out as a small-scale family business, but it can provide high returns to the producer (Çalışkan et al., 2011). Above-ground leaves and branches of sweet potato are also used in animal nutrition. Sweet potato, which is widely produced in countries such as China, Vietnam, Indonesia, Philippines, Papua New Guinea, Cuba, Uganda, is an important industrial plant in terms of starch and alcohol raw material and has an important place in human nutrition (Geren et al., 2010). The sweet potato, one of the oldest known vegetables to mankind, has been cultivated for over 10000 years and has evolved into many morphological types, creating a wide genetic diversity for many of the desirable agronomic traits (Ugent and Peterson, 1988).

The total tuber production of sweet potato, which is widely grown in 107 countries in the world, is 88867913 tons in 2021. This production took place in an area of 7410026 ha. The highest production was in Chine with 47621146 tons and Malawi with 7449971 tons.

Sweet potato, an important representative of tropical root crops with high utilization potential, is currently an underutilized resource in developing countries. Sweet potato has a wide range of uses and can be used for both human and animal nutrition. In addition, its starches are reported to be a source of industrial raw materials. (Tian et al., 2005). Sweet potatoes contain a wide range of phytochemicals with antioxidant capacity (flavonoids), antinyctalopia / xerophthalmia (carotenoids), hepatoprotective/spasmolytic (scopoletin), and antibacterial (friedelin), among other health benefits extensively documented by others (Albuquerque et al., 2019; Petropoulos et al., 2019). Although the control of these processes is undoubtedly related with synergistic actions owing to the phytochemicals present, carotenoids and polyphenolic compounds have piqued the scientific community's interest due to their quantity and diversity in sweet potato (Escobar-Puentes, 2022).

Taro is a broad-leaved, flowering, tropical/semi-tropical tuberous plant from the *Araceae* family (Kristl et al., 2016). Taro is also known by names such as old cocoyam, eddoe dasheen or kolakas, sunchoke. However, the most widely used name around the world is "taro". It is an annual herbaceous plant with a wide wing on the long petioles that come out vertically. Petioles emerge from the growth buds at the top of the tubers. These tubers are underground. Tubers are cylindrical or spherical in shape. Nodules emerge from the sides to surround the tubers (McCartan et al., 1996). The leaves of the gorge are in the shape of an elephant's ear. Botanically, the tubers are known as "corm" and the tubers "cormel".

Fukushima et al. (1962) and Strauss (1983), tavern is a starchy plant class and consists of 5 lineages. It has two main groups according to tuber development. Of these, there is *C. esculenta antiquorum* bears one small main tuber and several tubercles around it. esculenta var. esculenta produces one large main tuber and several tubers (Agbor-Egbe and Rickard, 1990). The total tuber production of taro, which is widely grown in 46 countries in the world, is 12,396,248 tons in 2021. This production took place in an area of 1,793,703 ha. Most of the production is in Africa, Asia, and the Pacific Islands. The highest production was in Nigeria with 3,216,116 tons and Ethiopia with 2,106,018 tons (Anonymous, 2023).

In Turkey, it is locally grown and consumed in the coastal areas of Anamur and Bozyazı districts of Mersin province and Alanya and Gazipaşa districts of Antalya province. It is easily grown in wetlands and riverbeds where the temperature does not fall below 0°C, the altitude is low, irrigation facilities are suitable, the ground water is high, saturated with water. The coastal areas of the Mediterranean, Aegean and Marmara regions have suitable conditions for taro cultivation.

Since raw taro tuber contains various substances that irritate the digestive tract, excessive consumption can be harmful to human health (Göhl, 1981). Since the tuber contains calcium oxalate crystals, it gives a bitter and unpleasant taste. Therefore, it is necessary to melt these crystals by cooking. In countries with intensive cultivation, starch-filled tubers, and secondary tubers, developed leaves and bleached petioles are widely consumed in culinary culture (Ochse, 1931; Lind and Barrau, 1946; Plunknett et al., 1970). In these countries, taros' tuber and secondary tubers are peeled and boiled, like potatoes (De Vries et al., 1967).

In Turkey, taro tubers and their secondary tubers are harvested at the beginning of winter and are the favorite food of that period. Traditionally, the addition of sour, such as sumac and lemon, makes the flavor of boiled tubers more appealing. The leaves are also boiled and wrapped (Şen et al., 2001). It is known that vitamin A and C deficiency is seen in countries that meet their carbohydrate needs from cereals in their nutrition system. Since sweet potato storage roots contain high levels of vitamins A and C, it is reported that if it is included in the nutrition system, it will eliminate the deficiency of these vitamins (Kapınga et al., 2009). Other phytochemicals with a range of biological activity, as well as nutritional and antinutritional elements, make up the taro's underlying food consistency qualities Kapoor et al., 2021). According to Padhan and Panda (2020), phytochemicals that have health-improving benefits are referred to as nutritional factors, while those that have the opposite effect are known as antinutritional factors. It is considered important to cultivate sweet potato and taro, which are important sources of income for small farmers, have very low input costs under favorable conditions, and have high nutritional values, as alternative crops in different regions of Turkey.

The hypothesis of this study is that some biochemical contents of sweet potato and taro plants, which are new alternative for small farms, vary between organs. The purpose of this study was to assess the variability and distribution of bioactive components in sweet potato and taro leaf, stalk, and storage root. This data will be utilized to develop consumption strategies for the content and profile of some bioactive compounds found in sweet potato and taro, which will improve its usage as a functional food.

MATERIALS AND METHODS

In the study, sweet potato and taro plants sampled from the Bozyazı/Mersin provinces of Turkey were used as plant material. None of these plants are commercial varieties and have been grown in small sections of farms. Main tubers, secondary tubers, stems, and leaves of taro flowers have been used in the study. For candy potato, tuber and leaf samples were analyzed. The technique of Yuan et al. (2012) was applied for leaf analysis. For leaf analysis, all leaves of the vegetation besides the backside two leaves have been collected before harvesting. These leaves had been dried at room temperature for 10 days and ground into powder in an herb grinder. The samples, which were kept in 60% ethanol two instances for two hours, have been kept at 50ºC till the weight loss stopped. Jantaharn et al., (2018) approach used to be used to preparation of tuber, and stalk samples. All the leaves, stalks, and tubers on seven vegetation have been accumulated at some point of the harvesting period. In the study, analyses were held in a randomized block sketch with 6 replications.

The protocol described by Danilcenko et al. (2017) was used to prepare samples for analysis of tubers. They were cut into 5 mm thick pieces after being totally freed from the dirt. Following a 24-hour period of complete drying at 60°C, the samples were ground into a powder in an herb grinder. Each organ's 3 g of powder sample was homogenized for 2 minutes with 25 ml of pure methanol before being stored at +4°C for 16 hours. For examination, the supernatant from the samples was removed, centrifuged for 20 minutes at 10000 rpm, and then refrigerated at -20°C (Thaipong et al. 2006). The antioxidant capacity was assessed using the ferric reducing antioxidant power technique (FRAP) (Zhang et al., 2013) and the copper (II) ion reducing antioxidant capacity determination (CUPRAC) method (Güçlü et al., 2006). To calculate the total quantity of gallic acid equivalent (GAE) phenolic compounds, Singleton and Rossi's (1965) Folin-Ciocalteu technique was applied. The total quantity of flavonoids as Quercetin equivalent (Q) was calculated using the technique described by Zhishen et al. (1999). The capacity to remove hydrogen peroxide (H_2O_2) has been determined using the method proposed by Ruch et al., in 1989. The quantity of soluble protein was calculated using a technique described by Lowry et al. (1951). The ANOVA test was used to assess the significance of the data's variance. Results across groups were compared using the least significant difference (LSD) test in cases where there were significant differences. To determine the connection between each independent variable, the Pearson correlation test was used.

RESULTS AND DISCUSSION

The differences between the results obtained for all measured parameters were statistically significant ($p<0.01$). The findings and statistical groupings obtained in the study are shown in Figures 1 and 2. According to the findings, sweet potato leaves have the highest total carotenoid concentration (1170.667 mg/g), followed by taro leaves (618.406 mg/g). The carotenoid content of sweet potato leaves was 2.87 times higher than that of tubers of the same plant. A similar situation was also found in the taro plant. The carotenoid content of the leaves was 2.02 times higher than the main tuber; 3.93 times higher than the petioles; and 8.07 times higher than the secondary tubers. In terms of H_2O_2 scavenging capacity, the variation between both species and their organs was relatively small. Taro leaves and petioles had the highest results for this parameter and were statistically in the same grouping (53.863% and 53.712%, respectively). The tuber of taro and the leaves of sweet potato had the lowest values compared to the others (50.114% and 47.059% respectively). The leaves of both plants ranked the highest in terms of total phenolic matter content. This value was 45.338 GAE mg/g for sweet potato leaves and 36.291 GAE mg/g for taro leaves. The phenolic content of the main and lateral tuber of taro was found to have the lowest value compared to the other parts examined (12.429 GAE mg/g and 10.841 GAE mg/g). The ranking of the species and organs analyzed according to total flavonoid amounts was the same as for total phenolic matter. However, for this parameter, the variation between different organs of the same species was much wider than for phenolic matter. In fact, the total amount of flavonoids in sweet potato leaves was 6.24 times higher than in tubers (296.619 Q mg/g and 47.571 Q mg/g, respectively). Similarly, the total flavonoid value obtained from the leaves of taro is 8.08 times higher than that of the main tubers and 12.46 times higher than that of the secondary tubers. Plant extracts' antioxidant activity may be assessed using a variety of techniques, but no single standard has been established due to the extracts' complexity. To assess the antioxidant activity in the various parts of the two species, the CUPRAC radical scavenging test and FRAP assay were utilized in the current investigation. As a result of FRAP analysis, the highest value was obtained in the leaves of sweet potato (63.052 mM Trolox / g).

It was followed by the leaf values of taro (60.158 mM Trolox / g). In the CUPRAC results, the reverse order was observed. As a result of this analysis, the tubers of sweet potato and the main tuber of taro had the highest values (0.177 mM Trolox / g and 0.141 mM Trolox / g, respectively). Another prominent result is that the secondary tubers of taro had the lowest value in both antioxidant capacity determination methods. As in the case of total flavonoids and total phenolic substances, the leaves of both species were found to have higher soluble protein content than the other organs. The lowest values of soluble protein were obtained from the main and lateral tubers of taro (12.032 mg/g and 8.582 mg/g, respectively). Except for the stems of taro, the dry matter percentages of all plant organs examined were close to each other. The highest dry matter percentage was obtained from the leaves of sweet potato plant (22.871%).

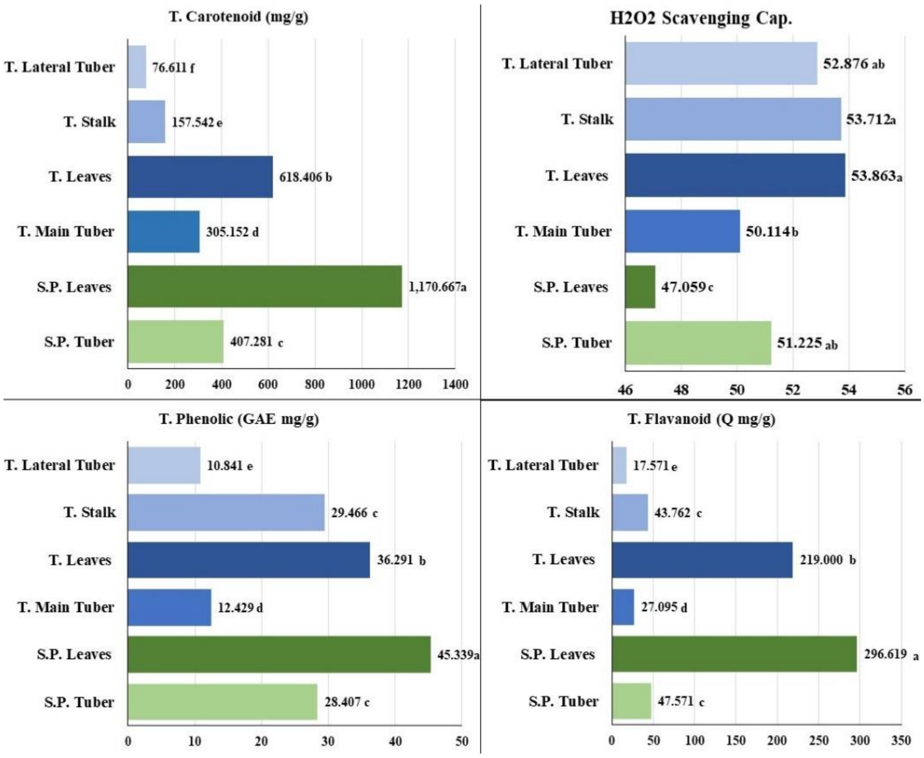

Figure 1. Total carotenoids, total flavonoids, total phenolics, and H_2O_2 scavenging capacity of the samples analyzed. T: Taro, S.P: Sweet potato. The differences between the values indicated with different letters for each parameter are statistically significant (p<0.01)

Following the results obtained were standardized, the effectiveness of the investigated parameters in describing the variation in the gene pool was assessed using principal component analysis. Two of the five main components have been shown to have eigenvalues larger than "1" (Table 1). 81.293% of the total variance was explained by the first two main components. To assess the degree of influence in explaining the variance of each analyzed parameter, parameters with an Eigen value larger than |0.3| were taken into consideration among the first two main components (Table 1). Total phenolic content, H_2O_2 removal capacity, antioxidant capacity determined by FRAP, total flavonoid, dry matter, and soluble protein were found to be the most significant factors in this context's first principal component, which explained 62.361% of the total variation. In this context, in the first principal component (explaining 62.361% of the total variation), total phenolic amount, H_2O_2 removal capacity, antioxidant capacity based on FRAP, total flavonoid, dry matter, soluble protein were found to be the most effective parameters in explaining the variation.

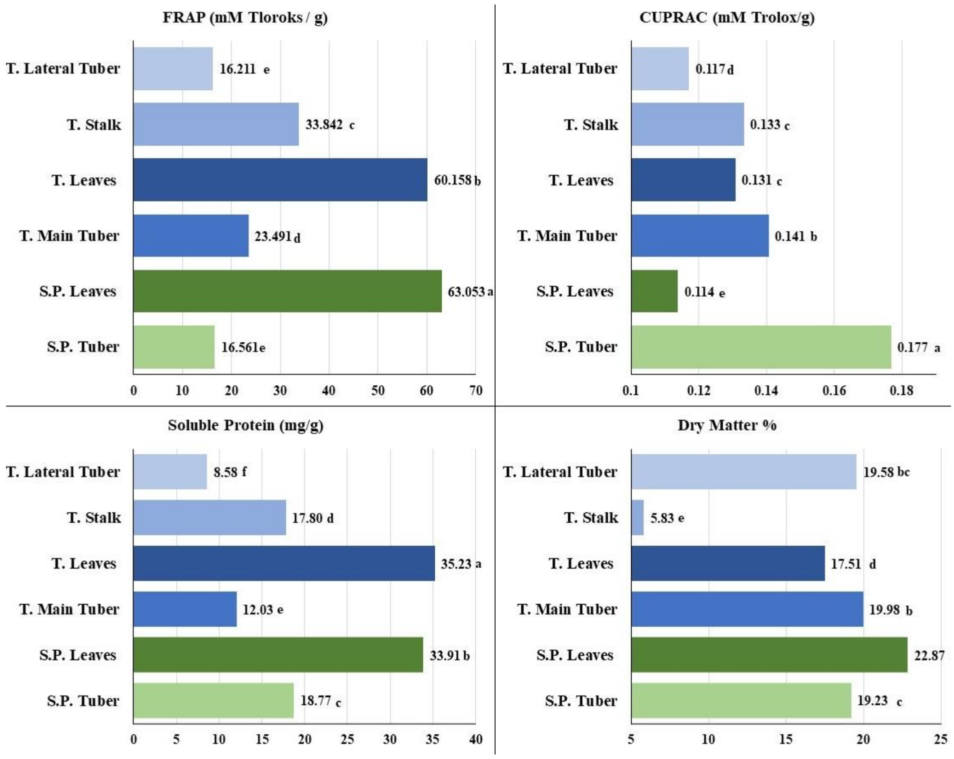

Figure 2. Antioxidant capacity (FRAP and CUPRAC), soluble protein and dry matter amount of the samples analyzed. T: Taro, S.P: Sweet potato. The differences between the values indicated with different letters for each parameter are statistically significant ($p<0.01$)

When the positioning of the studied plant species and organs in the plane of basic coordinates is evaluated in accordance with the eigenvalues of the first two basic components, it can be observed that the tubers of the sweet potato and taro are situated in locations that are relatively dissimilar from the others. As with other parameters, FRAP, total phenolic content, and soluble protein value are found in more remote regions when the distribution of the measured characters is examined.

Table 1. Eigen values of each trait

	PC 1	PC 2	PC 3	PC 4	PC 5
Eigenvalue	4.989	1.565	0.996	0.393	0.057
Variance (%)	62.361	19.562	12.454	4.916	0.707
T. Carotenoid	0.434*	-0.174	0.098	-0.111	0.009
H_2O_2 Scavenging Cap.	-0.246	0.582*	-0.017	0.650*	0.229
T. Phenolic	0.393	0.239	0.305*	-0.237*	0.655*
T. Flavonoid	0.444*	0.049	-0.054	0.147	0.100
FRAP	0.414*	0.253	-0.136	0.086	-0.618*
CUPRAC	-0.169	-0.100	0.915*	0.109*	-0.255
S. Protein	0.414*	0.223	0.188	0.275	-0.164
Dry Matter	0.167	-0.669*	-0.060	0.627*	0.189

According to Tumwegamire et al.'s (2011) study, sweet potato tubers range in dry matter ratio from 19.4% to 39.3%. According to our research, the average total dry matter ratio of sweet potatoes was 22.871% for the leaves and 19.23% for the tubers. This finding agrees with the research done by Tumwegamire et al. (2011). According to Lebot et al. (2004), the taro tuber's dry matter percentage was 27.09. In research involving 40 taro varieties in India, Angami et al. (2015) reported that the dry matter of the tubers ranged between 17.17% and 27.50%. The dry matter of the taro used in this study was 19.976% for the main tubers and 19.577% for the lateral tubers. There is agreement among others consequently.

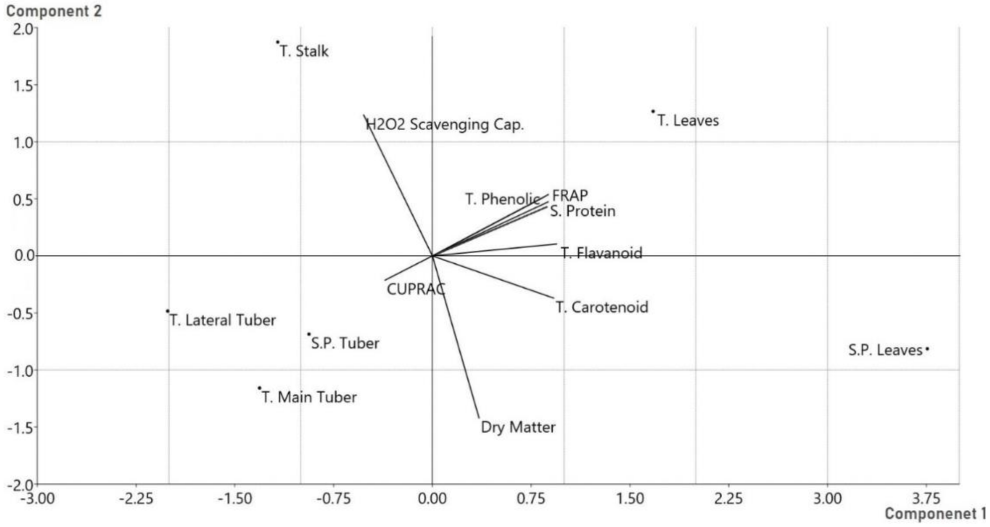

Figure 3. Distribution of the analyzed parameters and the evaluated plant material in principal component coordinates

According to Cartier et al. (2017), the total flavonoid concentration of sweet potato tubers ranges from 5.75 mg/g to 84.4 mg/g. The same study revealed that the total phenolic content ranged from 1,40 to 11.50 mg/g. These results are comparable in terms of total flavonoid substance (47.571 mg/g), even if they are lower than the total phenolic substance values found in our study (28.407 mg/g). In another study examining the total amount of phenolic substances in sweet potato tubers, it was reported that this value varied in a wide range of 30.73 to 492.89 in 10 different genotypes (Sun et al., 2019).

According to Akyüz (2019), the taro tuber extract contains a total phenolic content of 2,4 mg/g and a flavonoid level of 2.05 mg/g. The overall concentration of flavonoids and phenolic mattes was found to be much greater in our investigation (12.429 mg/g and 27.095 mg/g, respectively) than in that study.

Seven distinct sweet potato cultivars' carotenoid content was examined by Islam et al. in 2016. In the entire study, the samples' results ranged from 1.02 to 61.95 mg/g (with an average of 18.74 mg/g). This value was determined in our investigation to be 16.561 mg/g.

CONCLUSION

This study provided new information on some biochemical composition in sweet potato and taro plants. In terms of chemical structure, phenolic compounds, and antioxidant capabilities, two species and their organs showed significant variances. Since many factors, including treatment after harvest, location, genetic divergence, season, temperature, and storage, affect biochemical content in plants, more research is required to identify the critical variables that affect the overall and specific biochemical properties of local sweet potato and taro to increase their productivity and nutritional value. The two species used in the study have reached great economic value in some parts of the world but are not yet widely produced in Turkey. However, changing climatic conditions and emerging trends towards different products in the food spectrum indicate that these two species may increase their market value soon. In this study, high variation in terms of biochemical content was found both between the two species and between the organs. These results will guide future studies on these two species.

ACKNOWLEDGEMENTS

This research was supported by The Scientific and Technological Research Council of Türkiye-TÜBİTAK (2209-A - Research Project Support Programme for Undergraduate Students Project No. 1919B012214990).

Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

Berk Can YILDIZ: laboratory analyzes, Data curation. Emir Furkan DEMİR: Methodology, Formal analysis Fatih HANCI: Methodology, laboratory analyzes, data curation, writing draft, Visualization.

REFERENCES

Afzal, N., Afionis, S., Stringer, L., Favretto, N., Sakai, M., Sakai, P. (2021). Benefits and trade-offs of smallholder sweet potato cultivation as a pathway toward achieving the sustainable development goals. Sustainability, 13, 552.

Agbor-Egbe, T., Rickard, J.E. (1990). Evaluation of the chemical composition of fresh and stored edible aroids. J. Sci. Food Agric. 53:487-495.

Akyüz, M. (2019). Determination of Antioxidant Activity of Ethanol Extract of Gölevez [(*Colocasia esculenta* (L.)] Tubers. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 22, 388-394.

Albuquerque, T.M.R., Sampaio, K.B., de Souza, E.L.(2019). Sweet potato roots: Unrevealing an old food as a source of health promoting bioactive compounds–A review. Trends Food Sci. Technol. 85, 277–286

Angami, T., Jha, A. K., Buragohain, J., Deka, B. C., Verma, V. K., and Nath, A. (2015). Evaluation of taro (*Colocasia esculenta* L.) cultivars for growth, yield and quality attributes. Journal of Horticultural Sciences, 10(2), 183-189.

Anonymous (2023). Food and Agriculture Organization of the United Nations, Statistics Division, URL: http://faostat3.fao.org/home/E, (accessed date: May 02, 2023).

Cartier, A., Woods, J., Sismour, E., Allen, J., Ford, E., Githinji, L., and Xu, Y. (2017). Physiochemical, nutritional and antioxidant properties of fourteen Virginia-grown sweet potato varieties. Journal of Food Measurement and Characterization, 11, 1333-1341.

Çalışkan, M.E., Can, E., Çalışkan, S., Gazel, M. (2011). The Studies on Establishment of A Seed Production System for sweet potato, Türkiye IV Seed Congress, 14-17 June 2011, Samsun.

Çalışkan, M.E., Söğüt, T., Boydak, E., Ertürk, E. ve Arıoğlu, H. (2007). Growth, yield and guality of sweet potato (*Ipomoea battatas* (L.) Lam) cultivars in contrasting environments in Turkey, Turkish Journal of Agriculture and Forestry, 31: 213-227.

Danilcenko, H., Jariene, E., Slepetiene, A., Sawicka, B., Zaldariene, S. (2017). The distribution of bioactive compounds in the tubers of organically grown Jerusalem artichoke (*Helianthus tuberosus* L.) during the growing period. Acta Sci Pol. Hortorum Cultus, 16:97–107.

De Vries, C.A., Ferwerda, J.D., Flach, M. (1967). Choice of food crops in relation to actual and potential production in the tropics. Neth. J. Agric. Sci. 15:241-248.

Escobar-Puentes, A.A., Palomo, I., Rodríguez, L., Fuentes, E., Villegas-Ochoa, M.A., González-Aguilar, G.A., Olivas-Aguirre, F.J., Wall-Medrano, A. (2022). Sweet Potato (*Ipomoea batatas* L.) Phenotypes: From Agroindustry to Health Effects. Foods , 11, 1058

Fukusima, E., Iwasa, S., Tokumasu, S., Iwasa, M. (1962). Chromosome numbers of the taro varieties cultivated in Japan. Chromosome Inf. Serv. 3:38-39.

Geren, H., Öztürk, G., Kavut, T.Y., Yıldırım, Z., 2010. An investigation on insolubility possibilities of vines of sweet potato (*Ipomoea batatas* L.) genotypes grown under Bornova conditions, Journal of Agriculture Faculty of Ege University, 47(2):171-179.

Göhl, B. (1981). Tropical Feeds. Food and Agriculture Organization, Animal Production and Health Series 12, 314, Rome.

Güçlü, K., Altun, M., Özyürek, M., Karademir, S. E., and Apak, R. (2006). Antioxidant capacity of fresh, sun-and sulphited-dried Malatya apricot (*Prunus armeniaca*) assayed by CUPRAC, ABTS/TEAC and folin methods. International journal of food science & technology, 41, 76-85.

Gülçin, İ., Taslimi, P., Aygün, A., Sadeghian, N., Bastem, E., Kufrevioglu, O. I., Türkan, F., Şen, F. (2018). Antidiabetic and antiparasitic potentials: Inhibition effects of some natural antioxidant compounds on α-glycosidase, α-amylase and human glutathione S-transferase enzymes. International journal of biological macromolecules, 119, 741-746.

Islam, S. N., Nusrat, T., Begum, P., and Ahsan, M. (2016). Carotenoids and β-carotene in orange fleshed sweet potato: A possible solution to vitamin A deficiency. Food Chemistry, 199(1), 628-631.

Jantaharn, P., Mongkolthanaruk, W., Senawong, T., Jogloyd, S., McCloskey, S. (2018). Bioactive compounds from organic extracts of *Helianthus tuberosus* L. flowers. Ind Crops Prod, 119:57–63.

Kapinga, R., Byaruhanga, P., Zschocke, T., Tumwegamire, S. (2009). Growing orange fleshed sweet potato for a healthy diet. A supplementary learners' resource book for upper primary schools. International Potato Center (CIP), Kampala, Uganda, 142 pp.

Kapoor, B., Singh, S., and Kumar, P. (2022). Taro (*Colocasia esculenta*): Zero wastage orphan food crop for food and nutritional security. South African Journal of Botany, 145, 157-169.

Kristl, J., Ivancic, A., Mergedus, A., Sem, V., Kolar, M., and Lebot, V. (2016). Variation of nitrate content among randomly selected taro (*Colocasia esculenta* (L.) Schott) genotypes and the distribution of nitrate within a corm. Journal of Food Composition and Analysis, 47, 76-81.

Lebot, V., Prana, M. S., Kreike, N., Van Heck, H., Pardales, J., Okpul, T., T. Gendua, M. Thongjiem, H. Hue, N. Viet Yap, T. C. (2004). Characterization of taro (*Colocasia esculenta* (L.) Schott) genetic resources in Southeast Asia and Oceania. Genetic Resources and Crop Evolution, 51, 381-392.

Lind, H.Y. Barrau, M.L. (1946). Ways to use vegetables in Hawaii. Hawaii Agric. Expt. Sta. Bull. 97, Honolulu, Hawaii.

Lowry, O.H., Rosebrough, N.J., Farr, A.L., Randall, R.J. (1951). Protein measurement with the Folin phenol reagent. J Biol Chem, 193:265-275.

McCartan, S. A. Staden, J. V. and Finnie, J. F. (1996). In Vitro Propagation of Taro. Southern African Society For Horticultural Sciences, 6;1-3.

Ochse, J.J. (1931). Vegetables of the Dutch East Indies. Dept. Agric., Indus. Comm., Neth. E. Indies, Buitenzorg, Java, Indonesia.

Padhan B, Panda D. (2020). Potential of Neglected and Underutilized Yams (Dioscorea spp.) for Improving Nutritional Security and Health Benefits. Front Pharmacol., 24;11:496.

Petropoulos, S.A., Sampaio, S.L., Di Gioia, F., Tzortzakis, N., Rouphael, Y., Kyriacou, M.C., Ferreira, I. (2019). Grown to be blue—Antioxidant properties and health effects of colored vegetables. Part I: Root vegetables. Antioxidants 8, 617.

Plunknet, D.L., De La Pena R.S. and Obrero, F. (1970). Taro (*Colocasia esculenta*). Field Crop, 23, 412-426.

Ruch, R.J., Cheng, S.J., Klaunıg, J.E. (1989) Prevention of cytotoxicity and inhibition of intracellular communication by antioxidant catechins isolated from Chinese green tea. Carcinogenesis 10:1003-1008.

Rukundo, P., Shimelis, H., Laing, M., Mashilo, J. (2020). Genotype-by-environment interaction for dual-purpose traits in sweet potato. J. Crop Improv. 34, 800–823.

Singleton, V.L., Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American journal of Enology and Viticulture, 16(3), 144-158.

Strauss, M. S. (1983). Anatomy and morphology of taro [*Colocasia esculenta* (L.) Schott]. A Rewiew of Colocasia esculenta and Its Potentials. Wang, J. (ed.), 20-23. University of Hawaii Press. Honolulu.

Sun, Y., Pan, Z., Yang, C., Jia, Z., and Guo, X. (2019). Comparative assessment of phenolic profiles, cellular antioxidant and antiproliferative activities in ten varieties of sweet potato (*Ipomoea Batatas*) storage roots. Molecules, 24(24), 4476.

Şen M, Akgül A, Özcan M (2001). Physical and chemical characteristics of taro (*Colocasia esculenta*(L.) Schoott) corms and processing to chips and puree. Turkish Journal of Agriculture and Forestry, 25(6), 427- 432.

Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L., Hawkins Byrne, D. (2006) Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. J Food Compos Anal, 19:669-675.

Tian Q., Konczak I., Schwartz S.J. (2005). Probing anthocyanin profiles in purple sweet potato cell line (*Ipomoea batatas* L. Cv. Ayamurasaki) by high-performance liquid chromatography and electrospray ionization tandem mass spectrometry. J. Agric. Food Chem., 53:6503–6509.

Tumwegamire, S., Kapinga, R., Rubaihayo, P. R., LaBonte, D. R., Grüneberg, W. J., Burgos, G., Felde, T. z., Carpio, R., Pawelzik, E., & Mwanga, R. O. (2011). Evaluation of Dry Matter, Protein, Starch, Sucrose, β-carotene, Iron, Zinc, Calcium, and Magnesium in East African Sweet potato [*Ipomoea batatas* (L.) Lam] Germplasm, HortScience horts, 46(3), 348-357

Ugent, D. and Peterson, L. (1988). Archeological remains of potato and sweet potato in Peru. CIP (International Potato Centre) Circular, 16: 3.

Yuan, X., Gao, M., Xiao, H., Tan, C., Du, Y. (2012). Free radical scavenging activities and bioactive substances of Jerusalem artichoke (*Helianthus tuberosus* L.) leaves. Food Chem, 133:10–14.

Zhang, R., Zeng, Q., Deng, Y., Zhang, M., Wei, Z., Zhang, Y., Tang, X. (2013). Phenolic profiles and antioxidant activity of litchi pulp of different cultivars cultivated in Southern China. Food Chem, 136:1169-1176.

Zhishen, J., Mengcheng, T., Jianming, W. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem, 64:555-559.