

Research article

Variability of *Cucurbita* spp. Fruit Nutritional Quality and Yield

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ABSTRACT

This study aimed to investigate the inter- and intra-species variability in squashes and pumpkins (*Cucurbita moschata*, *Cucurbita maxima*, and *Cucurbita pepo*), with respect to fruit flesh nutritional quality parameters (contents of dry weight, sugar, protein, carotenoid and total soluble solids, refractive index, and flesh juice pH) and agronomic yield (fruit weight, number of fruits per plant, and yield per plant). The study included a total of thirty phenotypically divergent *Cucurbita* spp. genotypes cultivated over two consecutive growing seasons (2021 and 2022). Significant differences were observed among the species and genotypes regarding all the analyzed parameters, except for the fruit flesh juice pH. The greatest variability was detected for the carotenoid content (45.2, 11.1, and 6.5 mg/kg fresh weight for *C. maxima*, *moschata*, and *pepo*, respectively) and fruit weight (7.6, 4.0, and 2.5 kg for *C. maxima*, *pepo*, and *moschata*, respectively). The seasonal variation was most pronounced in *C. moschata*, indicating its comparatively low tolerance to heat stress. The highest values for the investigated parameters of both nutritional quality (dry weight 16.5%, sugar content 25.5 mg/g fresh weight, protein content 4.1 mg/g fresh weight, and total soluble solids content 8.1 °Brix) and agronomic yield (20.6 kg per plant) were noted in *C. maxima*, which is therefore suggested as the best raw material for the production of pumpkin-based food and feed. The investigated parameters varied in the other two species as well, suggesting the potential for improvements through breeding and applicability for similar purposes. This study highlights the importance of raw material quality for nutrient extraction from *Cucurbita* spp. fruits. Effective cooperation between plant breeders and food technology engineers is essential to deliver high-quality pumpkin-based products while optimizing production and processing costs.

Key words:

carotenoid content, *Cucurbitaceae*, fruit flesh quality, pumpkins, squashes, vegetables

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INTRODUCTION

Squashes and pumpkins are widely cultivated vegetable crops belonging to the genus *Cucurbita*. The most commonly cultivated species within the genus are *Cucurbita moschata*, *Cucurbita maxima*, and *Cucurbita pepo*. According to the [Food and Agriculture Organization of the United Nations data \(2025\)](#), pumpkin, squash and gourd crops occupy more than 2.0 million ha worldwide, with a recent annual production exceeding 32.0 million t. The major producers are India and China, with an annual yield of above 7.5 million t each. In Europe, the principal producers include Ukraine, the Russian Federation, Turkey, and Spain. Although squashes and pumpkins are commonly cultivated in Serbia, they occupy only a minor share of total agricultural land.

The flesh of the *C. moschata* and *C. maxima* fruits is consumed either directly or as an ingredient in a variety of sweet and savory dishes. It can be consumed raw, freshly prepared through cooking or baking, or in processed forms. In contrast, *C. pepo* exhibits greater morphological and compositional diversity, resulting in distinct types adapted to different uses. Oil pumpkin was included in this study due to its considerable agro-economic importance. It is cultivated primarily for its oil- and protein-rich seeds, which are consumed as a snack or used for the extraction of high-quality edible oil. The fruit flesh remaining after seed extraction is typically utilized as animal feed, incorporated into the soil, or discarded as waste.

In recent years, increasing attention has been directed toward the use of squashes and pumpkins to enhance the nutritional value of various food products, including biscuits, flours, juices, and spreads (Hussain et al., 2022; Gavril et al., 2024). While previous research has predominantly focused on food processing technologies (Maran et al., 2013; Delgado-Nieblas et al., 2015; Aljobair, 2024), comparatively limited attention has been given to the origin of the raw material itself. Considering the documented variability across a wide range of *Cucurbita* spp. fruit traits (Kulaitienė et al., 2014; Chaudhari et al., 2017; Öztürk et al., 2022), the potential of these species to serve as high-quality raw material is expected to vary at both interspecific and intraspecific levels.

The present study was conducted to access the *Cucurbita* spp. variability with respect to fruit nutritional quality and agronomic yield parameters. The observed differences could be utilized both in breeding new high-quality varieties and in selecting raw materials for food technology applications.

MATERIAL AND METHODS

The plant material for this trial comprised the *Cucurbita moschata* (butternut squash), *C. maxima* (pumpkin), and *C. pepo* (oil pumpkin) species. Each species was represented with ten genotypes, singled out from the *Cucurbita* spp. collection of the Institute of Field and Vegetable Crops, National Institute of the Republic of Serbia, Novi Sad. The genotypes within the species were selected to reflect the overall diversity of the collection with respect to fruit morphological characteristics. The two-season field trial (2021, 2022) was conducted at the Institute's experimental site in Bački Petrovac (N 45°20', E 19°40', altitude 82 m). *Cucurbita* seeds were sown manually in the first decade of May. The main plot consisted of a single 10 m row containing five plants spaced 2 m apart, with an inter-row distance of 5 m. The experiment was arranged in a randomized block design with multiple replications. Standard regional agronomic practices were applied, including sprinkler irrigation. The preceding crop was buckwheat. In November of the preceding year, deep autumn ploughing (30 cm) and mineral fertilization (16:16:16 NPK, 200 kg/ha) were performed. In early spring, winter furrows were closed. Prior to sowing, the soil was prepared using a seedbed cultivator. Plant protection measures were applied as required. Fruits were harvested at full maturity in early October.

The official reports of the Republic Hydrometeorological Service of Serbia (2025) were used to describe the weather conditions during the pumpkin growing seasons (May–September). The data on mean and extreme daily air temperatures, as well as precipitation, are presented in Figures 1 and 2. The growing degree days (°C) accumulated during the season were calculated as the sum of daily values according to the equation: daily degree day = $[(T_{\text{max}} + T_{\text{min}}) / 2] - T_{\text{base}}$; where T_{max} , T_{min} , and T_{base} represent maximum, minimum daily air temperature, and base temperature (10 °C), respectively (Wiggans, 1956; Grigorieva et al., 2010). The monthly sums of growing degree days are shown in Figure 3. Precipitation was not a limiting factor for plant development, as any shortfall was mitigated through supplemental irrigation. Both growing seasons exhibited daily temperatures exceeding the long-term average (data not shown), with the 2022 season being moderately warmer than 2021.

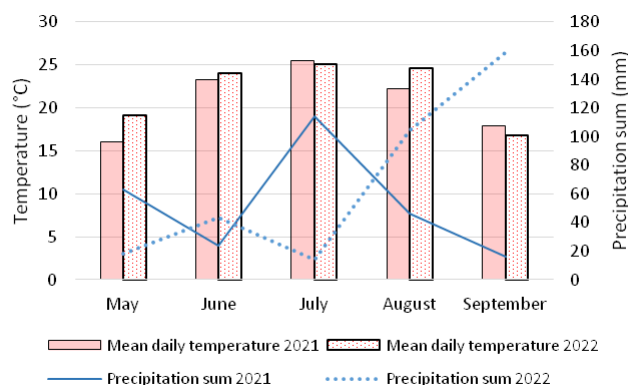


Figure 1. Air temperature and precipitation during the *Cucurbita* spp. growing seasons (2021, 2022)

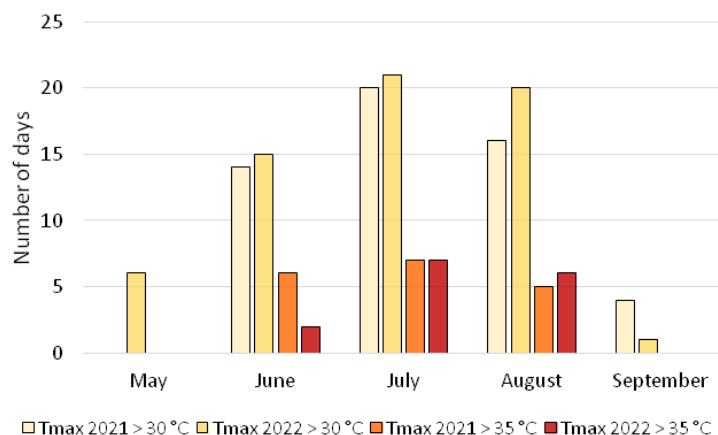


Figure 2. Number of days with maximum daily air temperature (Tmax) > 30 and 35 °C during the *Cucurbita* spp. growing seasons (2021, 2022)

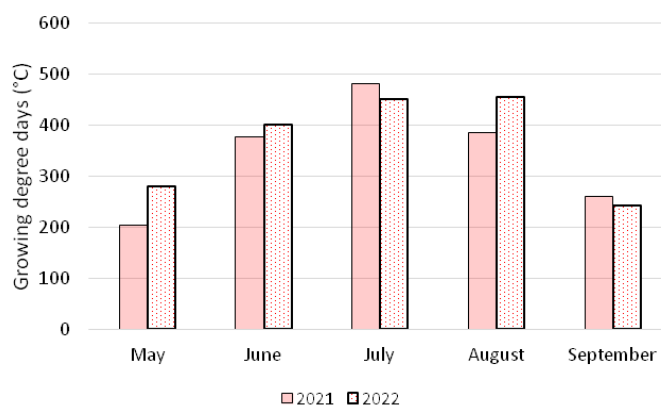


Figure 3. Sum of *Cucurbita* spp. growing degree days

For each genotype, pumpkin flesh from 15 mature fruits was combined to create a composite sample for nutritional quality analysis. The following quality parameters were analyzed: dry weight (%), sugar content (mg/g fresh weight), protein content (mg/g fresh weight), carotenoid content (mg/kg fresh weight), refractive index, total soluble solids content (°Brix), and flesh juice pH. Agronomic parameters were assessed at the main plot level and included fruit weight (kg), number of fruits per plant, and yield per plant (kg). The methods used for chemical analyses are described in detail in [Brdar-Jokanović et al. \(2019\)](#).

Descriptive statistics (mean, minimum, and maximum values) were calculated, and differences among means were evaluated using the least significant difference (LSD) test.

RESULTS AND DISCUSSION

Ten phenotypically divergent genotypes of each species *Cucurbita moschata*, *C. maxima*, and *C. pepo* were included in a two-season field trial to investigate differences in the fruit flesh nutritional quality and agronomic yield. The identified differences may be exploited in breeding programs aimed at improving nutritional quality. Additionally, the results should point to the quality-related challenges in processing pumpkin-based food and feed, whether derived from primary raw material or from by-products remaining after seed extraction in oil pumpkin.

Significant differences in both quality and yield parameters were observed between the growing seasons, among plant species, and among genotypes within species.

The values of the parameters recorded in the individual seasons are compared in [Table 1](#). The most pronounced seasonal variation was observed in *C. moschata*, where genotypes generally performed better in the 2021. This season was characterized by moderately lower daily air temperatures compared with 2022 ([Figures 1, 2, 3](#)), particularly during the fruit ripening period. Although *C. moschata* has been extensively studied within the context

of heat tolerance (Ara et al., 2013; Shen and Yuan, 2020; Hu et al., 2021), such studies are predominately in the field of molecular biology and stress physiology. The presented results indicate comparatively lower tolerance to elevated seasonal temperatures, as reflected in both fruit quality and yield parameters. Consistently with our results, in a study evaluating cytoplasmic and chloroplast chaperone levels in the same three *Cucurbita* species, Murtazina et al. (2024) reported *C. moschata* as the most sensitive. As for the additional two plant species analyzed in our research, the *C. pepo* genotypes exhibited comparatively low seasonal variation in the values of the investigated parameters; with only protein and carotenoid content being significantly higher in 2022. Along with the same two parameters of nutritional quality, *C. maxima* genotypes had significantly higher values of the fruit yield parameters in the warmer season of 2022.

Table 1. Seasonal values of nutritional quality and agronomic yield parameters in *Cucurbita moschata*, *Cucurbita maxima*, and *Cucurbita pepo* genotypes, and the three-species mean (*Cucurbita* spp.)

Parameters	<i>C. moschata</i>		<i>C. maxima</i>		<i>C. pepo</i>		<i>Cucurbita</i> spp.	
Growing seasons	2021	2022	2021	2022	2021	2022	2021	2022
Dry weight (%)	15.0 ^a	11.0 ^b	17.1 ^a	15.9 ^a	10.3 ^a	9.0 ^a	14.1 ^A	12.0 ^A
Sugar content (mg/g)	25.8 ^a	19.1 ^b	26.5 ^a	24.4 ^a	12.6 ^a	14.9 ^a	21.6 ^A	19.4 ^A
Protein content (mg/g)	2.6 ^b	4.6 ^a	2.9 ^b	5.2 ^a	1.9 ^b	3.9 ^a	2.5 ^B	4.6 ^A
Carotenoid content (mg/kg)	11.1 ^a	11.2 ^a	36.9 ^b	53.4 ^a	5.4 ^b	7.6 ^a	17.8 ^B	24.1 ^A
Refractive index	1.345 ^a	1.343 ^b	1.345 ^a	1.344 ^a	1.342 ^a	1.342 ^a	1.344 ^A	1.343 ^A
Total soluble solids content (°Brix)	7.9 ^a	6.9 ^b	8.2 ^a	7.9 ^a	6.0 ^a	6.2 ^a	7.4 ^A	7.0 ^A
pH	7.0 ^a	6.6 ^a	7.2 ^a	7.1 ^a	6.6 ^a	6.5 ^a	6.9 ^A	6.8 ^A
Fruit weight (kg)	3.1 ^a	1.8 ^b	6.9 ^b	8.3 ^a	4.0 ^a	3.9 ^a	4.7 ^A	4.7 ^A
No of fruits per plant	5.5 ^a	6.0 ^a	2.3 ^b	3.1 ^a	3.3 ^a	2.9 ^a	3.7 ^A	4.0 ^A
Yield per plant (kg)	16.2 ^a	11.3 ^b	16.3 ^b	24.8 ^a	13.1 ^a	11.4 ^a	15.2 ^A	15.8 ^A

Legend: ^{a, b, A, B} – values within each row (representing individual species and three-species mean) followed by the same letter are not significantly different at the 0.05 probability level, according to the LSD test

When comparing the seasonal variation for the three-species means, the season of 2022 was characterized by higher protein and carotenoid contents. The dry weight and sugar contents were lower, however the differences were not statistically significant. Similarly, no significant differences were observed in the yield parameters. These results are consistent with the fact that neither growing season can be considered exceptionally warm. The daily air temperature differences between the two seasons were most pronounced in May and August (Figures 1, 2, 3). Since the *Cucurbita* spp. flowering occurs predominately in July, the high temperatures affected plants during early vegetative and late generative phases of development. A multi-season investigation would be required to draw more reliable conclusions on plant heat sensitivity across specific phenological stages.

The inter-species (among the three species) and intra-species (within a species) variations in the investigated parameters of fruit nutritional quality and agronomic yield are shown in Figure 4. Regarding the differences among the species, *C. maxima* demonstrated the highest mean values across all the parameters, with the exception of the number of fruits per plant. The inter-species variability was especially pronounced for carotenoid content and fruit weight, whereas no significant differences were observed for the flesh juice pH. The results were partially anticipated. Variation in the *Cucurbita* spp. fruit carotenoid content (Murkovic et al., 2002; Salehi et al., 2019; Ninčević Grassino et al., 2023) and fruit weight (Martínez-Valdivieso et al., 2015; Martins et al., 2015; Seka et al., 2023) are widely documented and discussed. The pH is an indicator of fruit ripeness and its low variation is due to the fact that only ripe fruits were used for analyses. The pH values are comparable to those reported by Nawirska-Olszańska et al. (2014) and Martínez-Valdivieso et al. (2015). The lowest values of the nutritional quality parameters were noted for *C. pepo*, a plant species that is grown primarily for its seeds, while the rest of the fruit is used as animal feed or organic manure. The values of the *C. pepo* yield parameters were also comparatively low.

Concurrently, the carotenoid content and fruit weight were characterized by exceptionally wide range between minimum and maximum values within the individual species, i.e. the intra-species variability. Although observed in all three *Cucurbita* species, this was most noticeable in *C. maxima*. Other authors reported carotenoid content variations within the *C. maxima* (Kulczyński and Gramza-Michałowska, 2019; Barboza et al., 2023), *C. moschata* (Priori et al., 2017; Men et al., 2021) and *C. pepo* (Obrero et al., 2013) species. As the genotypes of the three species were heterogeneous in terms of fruit morphology, the variation in fruit weight was rather expected, together with the variation in other parameters of agronomic yield.

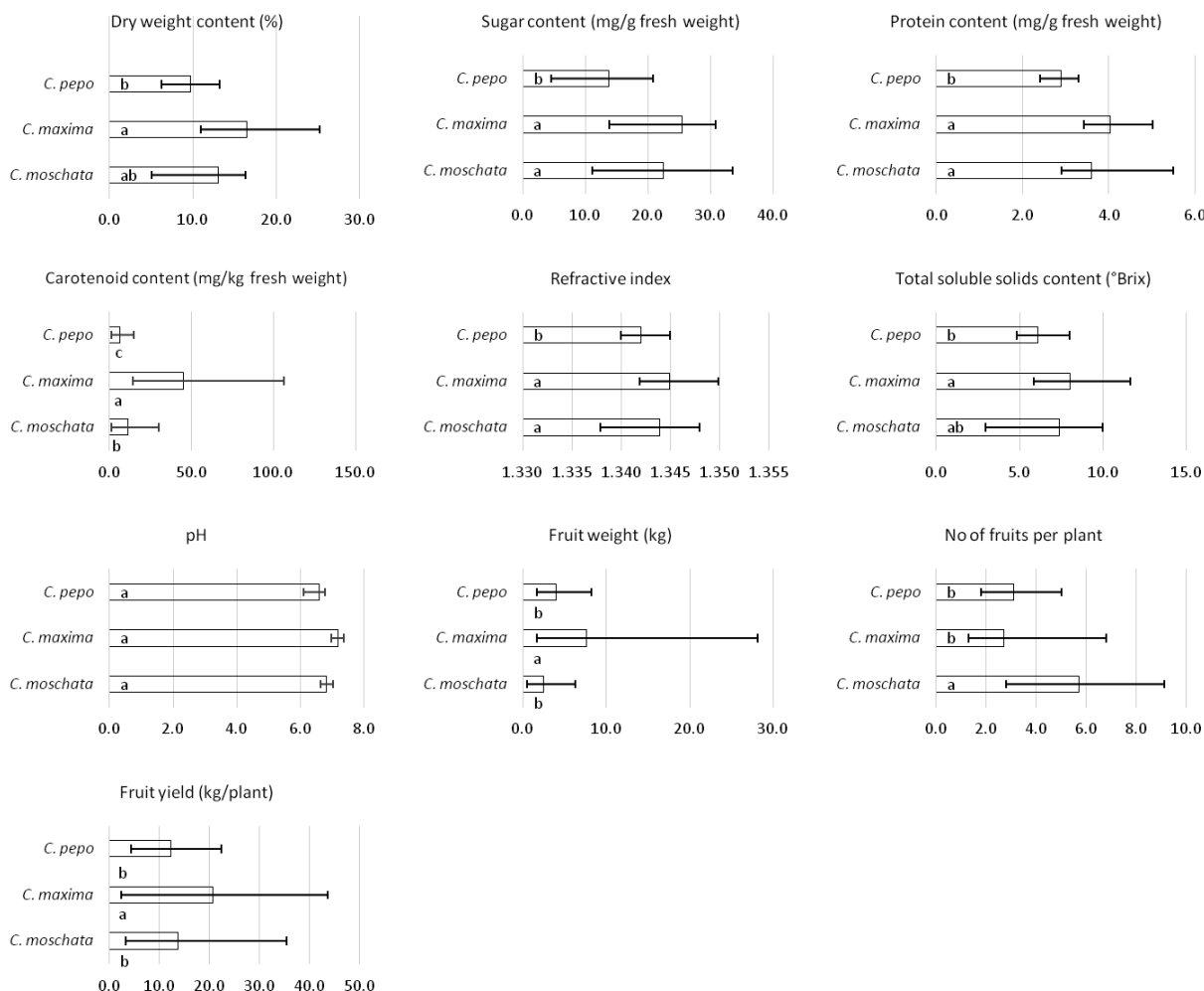


Figure 4. Nutritional quality and agronomic yield parameters in *Cucurbita* genotypes (*C. moschata*, *C. maxima*, and *C. pepo*), two-season means. Values followed by the same letter are not significantly different at the 0.05 probability level, according to the LSD test. Error bars indicate minimum and maximum values.

This investigation pointed out considerable variability in *Cucurbita* spp. fruit nutritional quality and yield. Because *C. maxima* fruits exhibited the highest values for the evaluated quality parameters, this species may be considered the most suitable raw material for the production of pumpkin-based food and feed. Nevertheless, the variability observed within the other two species suggests their potential applicability for similar purposes. This aspect is particularly relevant for oil pumpkins, in which the fruit flesh often remains as a by-product following seed extraction and could be further utilized as a valuable source of high-quality nutrients, particularly carotenoids.

CONCLUSION

The results of this two-season experiment revealed significant differences regarding the parameters of *Cucurbita* spp. fruit flesh nutritional quality and agronomic yield. These differences were recorded among plant species *Cucurbita moschata*, *maxima*, and *pepo*, as well as among the individual genotypes within each species. Seasonal variation in the analyzed parameters was most pronounced in the species *C. moschata*, suggesting a comparatively low tolerance to heat stress. The greatest inter- and intra-species variability was observed for the carotenoid content and fruit weight, in contrast to the consistently low variation in fruit flesh juice pH. Owing to comparatively high values of the investigated parameters in both growing seasons, the species *C. maxima* demonstrated the greatest potential for improving fruit quality and yield. Overall, the results of this study emphasize the importance of raw material quality in nutrient extraction from *Cucurbita* spp. fruit flesh. Cooperation between plant breeders and food technology

engineers is essential to deliver high-quality pumpkin-based products to the market while optimizing production costs.

Authors' Contribution: Conceptualization: M.B.-J.; Methodology: M.B.-J. and B.K.; Software: M.B.-J. and B.K.; Validation: M.B.-J., B.K., and M.M.; Formal Analysis: M.B.-J.; Investigation: M.B.-J., B.K., and M.M.; Resources: M.B.-J.; Data Curation: M.B.-J.; Writing – Original Draft Preparation: M.B.-J.; Writing – Review & Editing: M.B.-J., B.K., and M.M.; Visualization: M.B.-J.; Supervision: M.B.-J.; Project Administration: M.B.-J. All authors have read and agreed to the published version of the manuscript.

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Data availability statement: The data presented in this study are available upon request from the authors.

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Conflict of interest: The authors declare no conflict of interest.

REFERENCES

- Aljobair, M.O. 2024. Enrichment of bread with green pumpkin, watermelon and cucumber peels: Physicochemical, pasting, rheological, antioxidant and organoleptic properties. *Journal of Food Quality*, 6649325, 12 pages. <https://doi.org/10.1155/2024/6649325>
- Ara, N., Nakkanong, K., Lv, W., Yang, J., Hu, Z. & Zhang, M. 2013. Antioxidant enzymatic activities and gene expression associated with heat tolerance in the stems and roots of two Cucurbit species (“*Cucurbita maxima*” and “*Cucurbita moschata*”) and their interspecific inbred line “*Maxchata*”. *International Journal of Molecular Sciences*, 14(12): 24008-24028. <https://doi.org/10.3390/ijms141224008>
- Barboza, M., Lima, F.L.d.S., Ribeiro, R.M.P., Pereira, C.C.A., Santos, M.G.d., Silveira, F.P.d.M., Nascimento, A.K.Q.d., Passos, A.B.R.d.J., Chagas, P.S.F.d., Ribeiro, J.E.d.S., Lima, J.V.L., Júnior, J.T.d.S., Nunes, G.H.d.S., Silveira, L.M.d. & Júnior, A.P.B. 2023. Determination of total carotenoids and β -carotene in germplasm of pumpkin caboclo (*Cucurbita maxima*). *Agronomy*, 13(4): 1109. <https://doi.org/10.3390/agronomy13041109>
- Brdar-Jokanović, M., Koren, A., Ljevnaić-Mašić, B., Kiproviski, B. & Sikora V. 2019. Yield and quality parameters of Hokkaido type pumpkins grown in Serbia. *Genetika*, 51(2): 377-387. <https://doi.org/10.2298/GENSR1902377B>
- Chaudhari, D.J., Acharya, R.R., Gohil, S.B. & Patel, N.A. 2017. Genetic divergence study in pumpkin (*Cucurbita moschata* Duch. Ex. Poir). *Journal of Pharmacognosy and Phytochemistry*, 6(4): 744-747.
- Delgado-Nieblas, C.I., Zazueta-Morales, J.J., Gallegos-Infante, J.A., Aguilar-Palazuelos, E., Camacho-Hernández, I.L., Ordorica-Falomir, C.A., Pires de Melo, M. & Carrillo-López, A. 2015. Elaboration of functional snack foods using raw materials rich in carotenoids and dietary fiber: effects of extrusion processing, *CyTA - Journal of Food*, 13(1): 69-79. <https://doi.org/10.1080/19476337.2014.915892>
- Food and Agriculture Organization of the United Nations (FAO). 2025. Food and Agriculture Data. Production. [Cited 20 January 2025]. <https://www.fao.org/faostat/>
- Gavril (Rațu), R.N., Stoica, F., Lipșa, F.D., Constantin, O.E., Stănciuc, N., Aprodu, I. & Râpeanu, G. 2024. Pumpkin and pumpkin by-products: A comprehensive overview of phytochemicals, extraction, health benefits, and food applications. *Foods*, 13(17): 2694. <https://doi.org/10.3390/foods13172694>
- Grigorieva, E.A., Matzarakis, A. & de Freitas, C.R. 2010. Analysis of growing degree-days as a climate impact indicator in a region with extreme annual air temperature amplitude. *Climate Research*, 42: 143-154. <https://doi.org/10.3354/cr00888>
- Hu, Y., Zhang, T., Liu, Y., Li, Y., Wang, M., Zhu, B., Liao, D., Yun, T., Huang, W., Zhang, W. & Zhou, Y. 2021. Pumpkin (*Cucurbita moschata*) HSP20 gene family identification and expression under heat stress. *Frontiers in Genetics*, 12: 753953. <https://doi.org/10.3389/fgene.2021.753953>
- Hussain, A., Kausar, T., Sehar, S., Sarwar, A., Ashraf A.H., Jamil, M.A., Noreen, S., Rafique, A., Iftikhar, K., Aslam, J., Qudsoos, M.Y., Majeed, M.A. & Zerlasht, M. 2022. Utilization of pumpkin, pumpkin powders, extracts, isolates, purified bioactives and pumpkin based functional food products: A key strategy to improve health in current post COVID 19 period: An updated review. *Applied Food Research*, 2(2): 100241. <https://doi.org/10.1016/j.afres.2022.100241>
- Kulaitienė, J., Jarienė, E., Danilčenko, H., Černiauskienė, J., Wawrzyniak, A., Hamulka, J. & Juknevičienė, E. 2014. Chemical composition of pumpkin (*Cucurbita maxima* D.) flesh flours used for food. *Journal of Food, Agriculture and Environment*, 12(3-4): 61-64.
- Kulczyński, B. & Gramza-Michałowska, A. 2019. The profile of carotenoids and other bioactive molecules in various pumpkin fruits (*Cucurbita maxima* Duchesne) cultivars. *Molecules*, 24(18): 3212. <https://doi.org/10.3390/molecules24183212>

- Maran, J.P., Mekala, V. & Manikandan, S. 2013. Modeling and optimization of ultrasound-assisted extraction of polysaccharide from *Cucurbita moschata*. *Carbohydrate Polymers*, 92(2): 2018-2026. <https://doi.org/10.1016/j.carbpol.2012.11.086>
- Martínez-Valdivieso, D., Gómez, P., Font, R., Alonso-Moraga, Á. & Del Río-Celestino, M. 2015. Physical and chemical characterization in fruit from 22 summer squash (*Cucurbita pepo* L.) cultivars. *LWT - Food Science and Technology*, 64(2): 1225-1233. <https://doi.org/10.1016/j.lwt.2015.07.023>
- Martins, S., Ribeiro de Carvalho, C. & Carnide, V. 2015. Assessing phenotypic diversity of *Cucurbita* Portuguese germplasm. *Agriculture and Forestry*, 61(1): 27-33. <https://doi.org/10.17707/AgricultForest.61.1.03>
- Men, X., Choi, S.-I., Han, X., Kwon, H.-Y., Jang, G.-W., Choi, Y.-E., Park, S.-M. & Lee, O.-H. 2021. Physicochemical, nutritional and functional properties of *Cucurbita moschata*. *Food Science and Biotechnology*, 30: 171-183. <https://doi.org/10.1007/s10068-020-00835-2>
- Murkovic, M., Mülleler, U. & Neunteufl, H. 2002. Carotenoid content in different varieties of pumpkins. *Journal of Food Composition and Analysis*, 15(6): 633-638. <https://doi.org/10.1006/jfca.2002.1052>
- Murtazina, N.D., Sharapova, L.S. & Yurina, N.P. 2024. The dynamics of cytoplasmic HSP70 and chloroplast HSP70B chaperone levels under heat stress differs in three pumpkin species with different stress resistance. *Applied Biochemistry and Microbiology*, 60: 686-693. <https://doi.org/10.1134/S0003683824604372>
- Nawirska-Olszańska, A., Biesiada, A., Sokół-Łętowska, A. & Kucharska, A.Z. Characteristics of organic acids in the fruit of different pumpkin species. 2014. *Food Chemistry*, 148: 415-419. <https://doi.org/10.1016/j.foodchem.2013.10.080>
- Ninčević Grassino, A., Rimac Brnčić, S., Badanjak Sabolović, M., Šić Žlabur, J., Marović, R. & Brnčić, M. 2023. Carotenoid content and profiles of pumpkin products and by-products. *Molecules*, 28(2): 858. <https://doi.org/10.3390/molecules28020858>
- Obrero, Á., González-Verdejo, C.I., Die, J.V., Gómez, P., Del Río-Celestino, M. & Román, B. 2013. Carotenogenic gene expression and carotenoid accumulation in three varieties of *Cucurbita pepo* during fruit development. *Journal of Agricultural and Food Chemistry*, 61(26): 6393-6403. <https://doi.org/10.1021/jf4004576>
- Öztürk, H., Dönderalp, V., Bulut, H. & Korkut, R. 2022. Morphological and molecular characterization of some pumpkin (*Cucurbita pepo* L.) genotypes collected from Erzincan province of Turkey. *Scientific Reports*, 12: 6814. <https://doi.org/10.1038/s41598-022-11005-1>
- Priori, D., Valduga, E., Villela, J.C.B., Mistura, C.C., Vizzotto, M., Valgas, R.A. & Barbieri, R.L. 2017. Characterization of bioactive compounds, antioxidant activity and minerals in landraces of pumpkin (*Cucurbita moschata*) cultivated in Southern Brazil. *Food Science and Technology, Campinas*, 37(1): 33-40. <http://dx.doi.org/10.1590/1678-457X.05016>
- Republic Hydrometeorological Service of Serbia. 2025. Products [Cited 20 January 2025]. <http://hidmet.gov.rs>
- Salehi, B., Sharifi-Rad, J., Capanoglu, E., Adrar, N., Catalkaya, G., Shaheen, S., Jaffer, M., Giri, L., Suyal, R., Jugran, A.K., Calina, D., Oana Docea, A., Kamiloglu, S., Kregiel, D., Antolak, H., Pawlikowska, E., Sen, S., Acharya, K., Bashiry, M., Selamoglu, Z., Martorell, M., Sharopov, F., Martins, N., Namiesnik, J. & Cho, W. C. 2019. *Cucurbita* plants: From farm to industry. *Applied Sciences*, 9(16): 3387. <https://doi.org/10.3390/app9163387>
- Seka, D., Kouago, B.A. & Bonny, B.S. 2023. Assessment of the variability of the morphological traits and differentiation of *Cucurbita moschata* in Cote d'Ivoire. *Scientific Reports*, 13: 3689. <https://doi.org/10.1038/s41598-023-30295-7>
- Shen, C. & Yuan, J. 2020. Genome-wide characterization and expression analysis of the heat shock transcription factor family in pumpkin (*Cucurbita moschata*). *BMC Plant Biology*, 20: 471. <https://doi.org/10.1186/s12870-020-02683-y>
- Wiggans, S.C. 1956. The effect of seasonal temperatures on maturity of oats planted at different dates. *Agronomy Journal*, 48(1): 21-25. <https://doi.org/10.2134/agronj1956.00021962004800010006x>

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