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Nutritional Traits of Two Romanian Celery Varieties. Note 2: Hydroponic Culture

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Abstract

Currently, cultivated celery varieties are nutritionally valuable foods. The purpose of the research is to determine the gross chemical composition (protein, fat, cellulose, ash, non-nitrogenous extractive substances) of celery roots belonging to two native varieties Dacia and Victoria, grown in a non-conventional hydroponic system. The experiments were carried out in the greenhouse of USAMV Cluj-Napoca, in a hydroponic culture system. The biological material consisted of two native varieties of celery, Victoria and Dacia, which came from SCDL Buzău. The average weight of the hydroponically cultivated Dacia variety is equal to 341 g, and that of the Victoria variety is equal to 242 g. The variety was determined to have a dry substance content equal to 20.41%, which corresponds to a water content of 79, 59% and in the Victoria variety a content in dry matter equal to 21.22%, which corresponds to a water content of 78.78%. In both varieties, regarding the nutritional content, it is found that the largest proportion is occupied by non-nitrogenous extractive substances (10.70%) and by the content in raw ash (6.20%).

Keywords: Box-Plot diagram, crude chemical composition, nutritional value, water content.

1. Introduction

Celery, with the synonyms celer, salina, seler, selina, téler, in Romanian, is known as céleri in French, sellerie in German, apio in Spanish, salleri in Swedish, karafs in Arabic, celderiji in Dutch, sedano in Italian, aipo in Portuguese, sylderey in Russian, serorjini in Japanese, chin in Chinese; karnauli or ajmod in India. All popular Romanian names, like other European names, come from the Latin selinon, in turn borrowed from ancient Greek. The oldest form appears in the Linear B script of the Mycenaean civilization, in the form se-ri-no. The botanical name of the species, graveolens, also comes from the Latin language and means fragrant, aromatic [1]. The origin of celery and its varieties is not clear. Wild forms can be found in the temperate zones of Europe and Western Asia.

Although the Eastern Mediterranean region appears to be the area in which celery cultivation first appeared, the distribution of wild species is still debatable [6].

Celery was not widely cultivated until the Middle Ages, although ancient documents cited in the literature show that celery was cultivated as early as 850 BCE (the plant called "celery" in Homer's Odyssey is believed to be celery). Celery production has seen an important development in the lowlands of Italy and is extensive in France and England. For example, the first mention of its cultivation in France dates back to 1623 [5].

Today, cultivated varieties of celery are often sweet tasting, appetizing and healthy foods, but the plant's wild ancestors were considered poisonous plants.

The ancients associated celery with funerals and considered it to bring bad luck. For example, in India, celery was introduced from France around 1930 by a trading company in Amritsar to Punjab and is now widely grown commercially for seeds and spices in that area [3, 4]. Wild varieties of celery have been used for medicinal purposes for hundreds of years before their use as a food resource.

Early forms of celery that have a specific adaptation to the swampy area of their origin, were characterized by an abundance of bare stems and petioles.

Along with the evolution of its cultivation process, the selection process modified this hereditary characteristic, a phenomenon also accompanied by the reduction of the associated strong and bitter aroma [5].

The purpose of the research is to determine the gross chemical composition (protein, fat, cellulose, ash, non-nitrogenous extractive substances) of celery roots belonging to two native varieties Dacia and Victoria, grown in a non-conventional hydroponic system.

2. Material and Method

The experiments were carried out in the greenhouse of USAMV Cluj-Napoca. The biological material consisted of two autochthonous varieties of celery, Victoria and Dacia. The seeds came from SCDL Buzau.

Microclimate conditions suitable for crops were ensured. Seedlings were placed in the 60-seat "AeroFlo" hydroponic system, which operates 24 hours a day, 24 hours a day. 30 pots were used for the individual hydroponic maintenance of celery plants for cultivation. The temperature was located in the range of 7 - 100C at the time of introducing the seedlings into the system, while during the growth and development the temperature was maintained around 200C. The transparent glass walls of the greenhouse provided the necessary light (8000-9000 lux) for the entire duration of cultivation in the hydroponic system.

A hydroponic system was used in which the draining of the nutrient substance is continuous and with recirculation, and the filling of the vessels with the water containing the nutrient solution is done from the bottom up, ensuring at the same time an adequate ventilation system. The nutrient solution (General Hydroponics Ripen) ensured the necessary nutrients (N, P, K, Ca, Mg, trace elements). From the mother solution, dilutions corresponding to the vegetation phase of the celery plants were used. Due to the fact that young plants of *Apium graveolens* L. do not possess a root system developed to its maximum potential, nor do they consume nutrients in large quantities, the mother solution was administered in higher dilutions (1 – 3 g/l), which provided the necessary supply of nutrients, but in lower concentrations. Smaller dilutions of the mother solution (which provide the necessary large amounts of nutrients) were used during the final period of root, petiole and leaf sheath formation and growth.

The intake of water necessary for the development of celery crops was ensured according to the vegetation phase, being increased in the first part of the development period, but not in excess, because in this situation it could have led to the process of asphyxiation of the roots. The frequency of changing the water that feeds the hydroponic system was made according to the development phase of the *Apium graveolens* L. plants. Thus, in the initial phase of development of the hydroponic celery culture, the change of the water that also contains the nutrient subtans was made once every three weeks. In the intermediate phase of plant development, the water was changed once every two weeks, and in the last phase of development, weekly. Special attention was paid to the quality of the water and, due to the fact that in the interval of use of a batch of water, there is a reduction of the nutrients contained in it. For this reason, it was resorted to refeeding with fresh water, but simultaneously with the administration of additional amounts of nutrients.

The time and amounts administered depended on the conductivity value, for which the range of 1500 μS/cm - 2000 μS/cm was considered optimal. At the same time, the pH was maintained in the range of pH = 5.5 – 6.5. The pH value, along with the conductivity, is an indicator that gave us information about the level of nutrients in the solution. Measurement of pH and conductivity was provided using portable equipment.

At the completion of the hydroponic culture process, the plants were weighed, and the proportion of the root in the total plant was determined. The roots, which represent the part of interest, were subjected to chemical analysis.

Determination of the gross nutrient content of Apium graveiolens L. Dacia and Victoria varieties grown hydroponically, only the fresh substance is reported, because only the ash content and the resulting proportion for this nutritional component are of interest.

In order to develop the culture methodology to carry out the gross chemical analysis of both the celery roots obtained in field and hydroponic culture, the Weende scheme was applied. Also, the macro- and microelements present in the celery roots belonging to the two varieties, namely Victoria and Dacia, grown in a hydroponic system were quantified.

The gross chemical composition of the two celery varieties studied, cultivated hydroponically, was carried out according to the Weende scheme. Qualitative determinations (qualitative performances) were carried out in order to identify the presence in the nutritional content of celery roots of the following components: protein, fat, cellulose, ash (macro- and microelements) and non-nitrogen extractive substances.

Quantitative determinations (quantitative performances) were carried out in order to identify the proportions of crude protein, crude fat, crude cellulose, crude ash and non-nitrogenous extractives in celery roots.

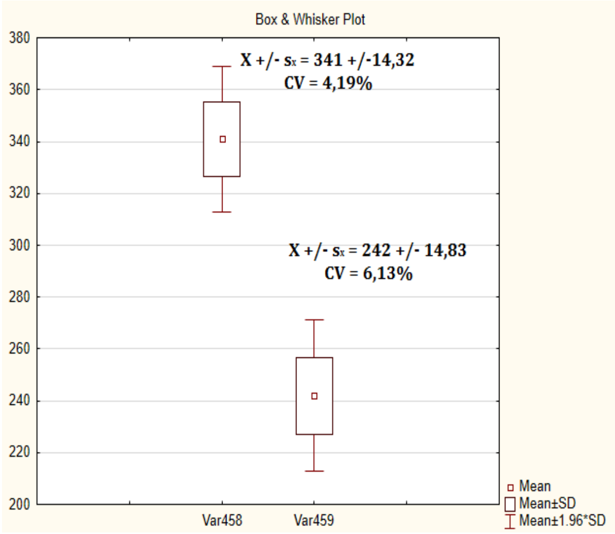
The percentage of dry matter (respectively water, by difference from 100%) of the celery roots belonging to the two autochthonous varieties taken in the study, was determined gravimetrically by drying the roots of the plants that were dried (in an oven at 105°C, for 6 hours).

Crude protein was determined by the Kjeldahl method, crude fat by the Soxhlet method, crude cellulose by acid hydrolysis, crude ash gravimetrically after calcination at 500 °C, and non-nitrogenous extractive substances by calculating the difference between the total of nutrients already determined and the corresponding 100% percent considere.

The raw data were statistically processed using the STATISTICA v.8.0 program for Windows.

3. Results and Discussions

The average weight of the roots of *Apium graveolens* L. the Dacia variety cultivated hydroponically is equal to 341 g, and that of the Victoria variety also cultivated under hydroponic conditions is equal to 242 g.



Var 458 – Dacia variety; Var 456 – Victoria variety; X – mean (g); s_X – standard deviation (g); CV – coefficient of variation (%).

Figure 1. Box-Plot diagram of the weights of Dacia and Victoria celery varieties cultivated in hydroponic system

The difference between them, equal to 99 g, is statistically ensured at the 0.1% significance level. According to the Box-Plot diagram and the standard deviation values, the degrees of dispersion of the individual values against the mean are similar for both varieties of celery studied, respectively Victoria and Dacia. According to the values of the coefficients of variation, the individual values can be considered homogeneous, and the means representative for the experimental ensemble (Fig. 1.2).

In the *Apium graveolens* L. Dacia variety, a dry matter content equal to 20.41% was determined, which corresponds to a water content of 79.59%. Regarding the nutrient content, the largest proportion of is occupied by non-nitrogenous extractive substances (10.70%) and the content in crude ash (6.20%). Crude protein (1.46%) and crude fat (0.27%) are the least represented nutritional components in celery root, variety Dacia (Table 1).

According to the asymmetry values, except for the content in dry matter, crude protein and crude ash, for the other nutritional components and for the water content, the individual values are higher than the average value (Table 1). For the Victoria variety of *Apium graveolens* L., the present study revealed a dry matter content equal to 21.22%, which corresponds to a water content of 78.78% (Table 2).

Table 1. Nutritional elements composition of Dacia celery variety (%), cultivated in hydroponic system

No. crt.	Issue	Water	DM	CP	CF	CC	CA	NFM
1	No. of samples	30	30	30	30	30	30	30
2	Mean	79.59	20.41	1.46	0.27	1.78	6.20	10.70
3	Standard deviation	0.24	0.24	0.11	0.05	0.15	0.16	0.16
4	Minimum	79.40	20.00	1.30	0.20	1.60	6.00	10.50
5	Maximum	80.00	20.60	1.60	0.34	2.00	6.40	10.90
6	Kurtosis	3.68	3.68	-0.18	0.00	0.87	-1.20	-1.20
7	Skewness	1.85	-1.85	-0.40	-0.14	0.55	0.26	0.52
8	Coefficient of variation	0.30	1.17	7.81	19.35	8.33	2.55	1.48

CP – crude protein; CF – crude fat; CC – crude cellulose; CA. – crude ash; NFM – nitrogen free matter; Kurtosis –vaulting; Skewness – asimetry.

Table 2. Nutritional elements composition of Dacia celery variety (%), cultivated in hydroponic system

No. crt.	Issue	Water	DM	CP	CF	CC	CA	NFM
1	No. of samples	30	30	30	30	30	30	30
2	Mean	78.78	21.22	1.49	0.39	2.00	6.24	11.10
3	Standard deviation	0.28	0.29	0.11	0.06	0.16	0.15	0.16
4	Minimum	78.40	20.95	1.35	0.33	1.80	6.10	10.90
5	Maximum	79.05	21.60	1.60	0.48	2.20	6.40	11.30
6	Kurtosis	-1.94	-1.94	-2.51	0.00	-1.20	-3.08	-1.20
7	Skewness	-0.63	0.63	-0.23	0.61	0.18	0.32	0.41
8	Coefficient of variation	0.36	1.31	7.65	14.86	7.91	2.43	1.42

CP – crude protein; CF – crude fat; CC – crude cellulose; CA. – crude ash; NFM – nitrogen free matter; Kurtosis –vaulting; Skewness – asimetry.

Regarding the nutrient content, the largest proportion of is occupied by non-nitrogen extractive substances (11.10%) and the content in crude ash (6.24%). Crude protein (1.49%) and crude fat (039%) are the least represented nutritional components in celery root, Dacia variety. According to the asymmetry values, except for the content in water and crude protein, for the other nutritional components and for the content in dry matter, the individual values are higher than the average value (Table 2).

4. Conclusions

The average weight of the roots of *Apium graveolens* L. the Dacia variety grown hydroponically is equal to 341 g, and that of the Victoria variety also grown under hydroponic conditions is equal to 242 g. In the Apium graveolens L. Dacia variety, a content of dry matter equal to 20.41%, which corresponds to a water content of 79.59%. Regarding the nutrient content, the largest proportion of is occupied by non-nitrogenous extractive substances (10.70%) and the content in crude ash (6.20%). For the Victoria variety of *Apium graveolens* L., the present study revealed a dry matter content equal to 21.22%, which corresponds to a water content of 78.78%. Regarding the nutrient content, the largest proportion of is occupied by non-nitrogen extractive substances (11.10%) and the content in crude ash (6.24%).

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Partnerships for Knowledge Transfer, Contract no. 3/AXE 1/1.2.3.G/30.05.2018, ID: P_40_377, COD MySMIS <119675>. Title of the project: "Obtaining a supplement-type food product, on the natural substrate of *Apium graveolens* L. nutritionally optimized by enrichment with selenium and vitamins, for the purpose of improving the quality of life".

References

[1] Choudhary D.K., B.L. Kaul, 1986, Somatic Chromosomes of *Apium graveolens* L. Nat. Acad. Sci. Letters. 8, 167–168.

[2] Lista oficială a soiurilor (hibrizilor) de plante de cultură din România pentru anul 1995 din 22.11.1994, Monitorul Oficial.

[3] Malhotra S.K., 2006a, Underexploited seed spices. In: *Spices*, *Medicinal and Aromatic crops*, ed. J Singh University Press, Hyderabad, India.

[4] MalhotrA S.K., 2006b, Minor seed spices 1 – Ajowan, dill, celery and anise. In *Advances in Spices Research – History and Achievement of Spices Research in India since Independence* Eds Ravindran, P.N., Nirmal, B., Shiva, K.N. and Kallupurakal, J.A., Agribos (India), Jodhpur, 785–801.

[5] Popescu V, Atanasiu N, 2000, Legumicultură, Vol. 2**,** București, Ed. Ceres.

[6] https://seminteplante.ro/7270-seminte-de-telina-dacia-5-grame.html.

[7] https://www.google.com/search?q=cine+produce+soiul+de+telina+victoria&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjUstqy6rjiAhXS4KYKHVbhBZEQ_AUIDigB&biw=1206&bih=700#imgrc=f1-fL_zvZMt5VM:.

[12] McMurry W.C., R.F. Irvine, 1988, Phosphatidyl inositol, 4,5-bisphosphate phosphodiesteriase in higher plants, Biochemical J, 249(3), 877–81.

[13] Sahel M.M., J.H. Zwaving, T.M. Malingre, R. Bos, 1985, The essential oil of *Apium graveolens var. secalinum* and its cercaricidial activites. Pharmaceutisch Weekbla, 7(6), 277–79.

[14] https://ndb.nal.usda.gov/ndb/foods/show/111 43