COMPARATIVE ANALYSIS OF THE CHEMICAL COMPOSITION OF HELIANTUS TUBEROSUS L. GROWING IN SERBIA AND ROMANIA

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KOMPARATIVNA ANALIZA HEMIJSKOG SASTAVA HELIANTUS TUBEROSUS L. SA PODRUČJA SRBIJE I RUMUNIJE

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ABSTRACT

Helianthus tuberosus L. (Jerusalem artichoke) *belongs to the Asteraceae family, genus Heliathus, and is a native species of Serbia and Romania. The most valuable constituent is inulin, which together with other constituents forms the unique content of its plant material. Inulin has the effect of reducing the risk of cardiovascular diseases; it also has beneficial effects on different gastrointestinal conditions by serving as a prebiotic and has been shown to be important in the prevention and/or the alleviation of the progression of osteoporosis. The aim of this study was the to compare the chemical compositions of* ***H. tuberosus*** *L. tubers growing in two different geographic areas on the Balkan peninsula, namely in Serbia and Romania. We have determined the content of the eight main components in both herbal samples: total proteins, flavonoids, polyphenolic carboxylic acids, reducing sugars, total carbohydrates, antioxidants, inulin and ascorbic acid,. Furthermore, we calculated a caloric value offor each of the herbal samples. The levels of all the investigated compounds, with the exception of the total carbohydrates and antioxidants, were slightly higher in the plants growing in Romania than in the plants growing in Serbia. Because the differences in the contents of both plant groups are very small, we propose that both materials could be considered as a suitable raw plant material for further processing. The caloric value of the plants growing in Serbia was found to be slightly higher than the caloric value of the ones growing in Romania. Both herbal samples are good sources of inulin and represent valuable raw plant material for further processing.*

Keywords: *topinambur, chemical composition, inulin, Jerusalem artichoke*

SAŽETAK

Helianthus tuberosus L. (Jerusalimska artičoka) *pripada rodu Heliathus iz familije* ***Asteraceae****. Raste kao autohtona vrsta na teritorijama Srbije i Rumunije. Ovu biljnu vrstu karakteriše jedinstven hemijski sastav, a kao najdragoceniji konstituens izdvaja se inulin. Povoljan uticaj inulina na zdravlje ljudi uključuje smanjen rizik za kardiovaskularne bolesti, prebiotski efekat, prevenciju i/ili ublažavanje osteoporoze. Cilj studije je bio poređenje hemijskog sastava krtola* ***H. tuberosus*** *L. sa dva različita staništa na Balkanskom poluostrvu, Srbije i Rumunije. Određen je sadržaj osam glavnih komponenti biljnih sirovina sa oba geografska područja: ukupni proteini, flavonoidi, polifenolne karboksilne kiseline, redukujući šećeri, ukupni ugljeni hidrati, antioksidanti, inulin i askorbinska kiselina i izračunata kalorijska vrednost osušenog biljnog materijala. Sadržaj svih ispitivanih jedinjenja osim ukupnih ugljenih hidrata i antioksidanata je bio nešto viši u biljnoj sirovini poreklom iz Rumunije. Postoje jako male razlike u sastavu biljnih sirovina sa pomenutih staništa, pa se može smatrati da su oba biljna materijala pogodna za dalju obradu. Kalorijska vrednost čičoke koja raste u Srbiji je nešto viša od biljne vrste koja raste u Rumuniji. Obe biljne sirovine su dobri izvori inulina i predstavljaju dragoceni biljni materijal za dalju obradu.*

Ključne reči: *čičoka, hemijski sastav, inulin*

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INTRODUCTION

*Helianthus tuberosus L. (*Jerusalem artichoke*)* belongs to the *Asteraceae* family, genus Heliathus. Its origin was located in northern and central parts of the USA, but it was transferred to Europe in the seventeenth century. J. artichoke grows as a native species in Serbia and Romaniaand is and is known by the traditional names cicoka and topinambur. The differences in the characteristics of the wild and the hybrid J. artichoke species have been investigated at the Institute of Field and Vegetable Crops in Novi Sad, Serbia and at the Research Institute for Cereals and Technical plants in Calarasi, Romania (1).

The tubers of this plant have been used in the human diet. The J. artichoke tuber is composed of up to 80% water, 15% carbohydrate, and approximately 8% protein. It has almost no starch, whereas mono-and polyunsaturated fatty acids are found in trace amounts (1). The tubers are a good source of vitamins (2), minerals (3) and dietary fibre. The most important carbohydrate is inulin, which may be present in 8-21% of the plant's fresh weight (2, 4). Inulin is the most valuable constituent, which together with other constituents forms the unique content of this plant material. Inulin is a carbohydrate formed from fructose units. Fructose chains are linear and linked by a β (1-2) – linkage, and one terminal glucose unit is linked by an α (1-2) - linkage. It has been shown that inulin has numerous beneficial effects on human health. Inulin reduces the risk of cardiovascular disease, which is achieved by lowering the levels of triglycerides (5, 6). It acts beneficially in different gastrointestinal conditions by possessing a prebiotic role (7), and inulin has been shown to be important in the prevention and/or alleviation of osteoporosis progression (8).

The quality of the plant material depends on the geographic area and its climate characteristics as well as the soil type. J. artichoke grows better on relatively infertile land than most crops (1), but fertile soil is required for obtaining high yields and large tuber sizes (9).

The aim of this study was the to compare the chemical composition of *H. tuberosus* L. tubers grown at two different geographic areas on the Balkan peninsula, namely in Serbia and Romania.

MATERIAL AND METHODS

Plant material

J. artichoke tubers were collected when ripe from the Sumadija region of Serbia in the period between October - December 2010. The plant material of Romanian origin was collected on Hofigal's lowland fields in 2011. Preparation of all plant material included washing, peeling, cutting into slices and drying in a mechanical drier at a controlled temperature (40°C). The last step was grinding the dried tubers into a fine powder.

Analyses of plant chemical composition

We have determined and compared the content of the following constituents: total proteins, flavonoids, polyphenolic carboxylic acids, reducing sugars, total carbohydrates, antioxidants, inulin and ascorbic acid. Total proteins in the plant material were determined using the standard Kjeldahl method, which determinates the nitrogen content in the sample (10). Flavonoids were expressed as % of rutin. The content of flavonoids was determined the use ofusing a UV / VIS spectrophotometer; employing the standard curve method, and the absorbances of the herbal extract dilutions were measured at 430 nm (11). The polyphenol carboxylic acid content was expressed as the per cent of caffeic acid. The UV/VIS spectrophotometric method was used, and the absorbances of the ethanolic extract were measured at 660 nm (11).

The content of reducing sugars was determined using the Fehling method of the reduction of copper (II) ions from an alkaline solution of $CuSO_4$ complex to copper (I) ions, which forms a brick red copper (I) oxide precipitate (12). Total carbohydrate content was expressed as a per cent of glucose. The total carbohydrates in J. artichoke were determined using the standard Anthrone method, which is based on the hydrolysis of carbohydrates into simple sugars by dilute hydrochloric acid. The dehydration of glucose produces hydroxymethyl furfural, which after reacting with the Antron reagent, could be measured at 630 nm (13). Determination of the antioxidant content was expressed as g of Trolox/g. Antioxidant activity was determined using the spectrophotometric CUPRAC method. This method measures the absorbance of Cu (I) - neocuproine (2,9-dimethyl-1,10 - phenanthroline) at 450 nm, obtained by the reduction of antioxidant compounds by the CUPRAC reagent (Cu (II) neocuproine) (11).

For the determination of the inulin content, we used the spectrophotometric method. Hydroxymethyl furfural, formed by the hydrolysis of inulin in an acidic medium, reacts with resorcinol and produces a red coloured product. Absorbance was measured at 520 nm. A standard inulin solution was used for the preparation of the calibration curve (14). The ascorbic acid content (‰) was determined after titration with Tillman's reagent. The method is based on the oxidation of ascorbic acid to dehydroascorbic acid, while the Tillman's reagent is reduced to its leuko-base (15).

The caloric value of the J. artichoke was calculated using the following formula:

Kcal = 4 x (% proteins + % total carbohydrates) + 9 x (% lipids) (16).

RESULTS

We have determined the contents of the eight main components in both herbal samples. The analysis of the plant material from Serbia showed the following results: 19,70 % of total proteins, 0,31 % of flavonoids, 0,21 % of polyphenol carboxylic acids, 9,85 % of reducing sugars, 34,83 % of total carbohydrates, 1,37 g Trolox/g of antioxidant, 24,7 % of inulin and 74,3 ‰ of ascorbic acid. We have obtained slightly different results from Romania's plant material. The Romanian J. artichoke showed the follow-

ing results: 21,10 % of total proteins, 0,37 % of flavonoids, 0,22 % of polyphenolic carboxylic acids, 12,79 % of reducing sugars, 28,79 % of total carbohydrates, 1,33 g Trolox/g antioxidant, 25,40 % of inulin and 81,15 ‰ of ascorbic acid. The comparative analysis of the J. artichoke chemical compositions from Serbia and Romania is shown in Table 1.

No	Analysis	*H. tuberosus* Serbia	*H. tuberosus* Romania
1	Total proteins %	19,17	21,10
2	Flavonoids %	0,31	0,37
3	Polyphenol carboxylic acids %	0,21	0,22
4	Reducing sugars %	9,85	12,79
5	Total carbohydrates %	34,83	28,79
6	Antioxidant g Trolox/g	1,37	1,33
7	Inulin %	24,70	25,40
8	Ascorbic acid ‰	74,30	81,15

Table 1. The comparative results of the J. artichoke chemical compositions from Serbia and Romania

The caloric value of J. artichoke growing in Serbia was 218,70 Kcal, and that of J. artichoke growing in Romania was 204,10 Kcal. Hence, the caloric value of J. artichoke growing in Serbia is greater than that of the one from Romania.

DISCUSSION

Our results indicate that the levels of all investigated compounds, with the exception of the total carbohydrates and antioxidants, were slightly higher in the plants growing in Romania than in the plants growing in Serbia. Because the differences in the contents of both samples are very small, we propose that they both could be considered as suitable raw plant material for further processing. J. artichoke has been extensively used as a source of carbohydrates, especially inulin. Therefore, this study complements current research data on J. artichoke growing in the Balkans, and it may substantially contribute to the production of different J. artichoke extracts because selecting a raw plant material for production depends on the chemical content of the plant material and the desired content of the final product.

Plants rich in inulin have recently been thoroughly investigated recently due to the prebiotic effect of inulin (17, 18). This study confirms that J. artichoke is a significant source of inulin, thatwhich could be found in plants growing in countries on the Balkan peninsula – Serbia and Romania. Our results showing that both samples contained up to 25% of inulin confirmed that both plant materials could be used as valuable sources of inulin because the obtained values for inulin are slightly higher than the literature data, which ranges up to 21% (1). The caloric value of the plants growing in Serbia was found to be slightly higher than the caloric value of those plants growing in Romania, and this difference could be associated with the higher content of total carbohydrates present in the Serbian plants. The slightly higher levels of antioxidants in the plants growing in Serbia could not be associated with its content of flavonoids, polyphenol carboxylic acids or ascorbic acid as the main contributors to the antioxidant activity because the levels of these compounds were slightly lower in the plants growing in Serbia than in Romania. Therefore, the authors suggest further investigation of the antioxidant potential of the J. artichoke growing on the Balkan peninsula, and an improvement in sampling by increasing the number of different locations sampled in both countries.

J. artichoke growing on the Balkan peninsula in both Serbia and Romania is a good source of inulin and represents a valuable raw plant material for further processing, although the plants growing in Romania are slightly more suitable due to their chemical composition.

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