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DAHLIA AN UNFORGETTABLE FLOWER - A NEW PERSPECTIVE FOR THERAPEUTIC MEDICINE

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Abstract: Dahlia is a semi-rustic perennial plant with a long period of decoration from July to late autumn. Nowadays, *Dahlia* was widely used even in economical purpose: in landscaping, in floristry as a cut flower, for the pharmaceutical industry, cosmetic, food and as raw material for the extraction of dyes. Both the tuberous roots and the flowers of this ornamental and medicinal plant are used for therapeutic purposes. The biochemical composition that is very varied containing: flavonoids, carbohydrates (inulin), polysaccharides but also other uses, it is desirable to promote valuable cultivars for use in breeding works for the production of descendants that combine polygene for a high decorative value and an increased inulin content.

Keywords: Dahlia, therapeutic purposes, inulin, polygene, tuberous roots

Introduction

Dahlia plant culture spreads from Spain to different European countries (Tarhon, 1993) and it was brought to Madrid in 1790 (Cristea, 2014).

Dahlia is a perennial semi-rustic plant that gives the best results in hill and submontane areas where it blooms from July to late autumn (Băla, 2007).

Dahlia represents the richest specie as a garden and a balcony flower. The genus includes about 30 perennial species with tuberous roots belonging to the *Asteraceae* family (Lord, 2003). Over the past hundred years, more than 50.000 varieties of *Dahlia*, with different colors, shapes and sizes of inflorescences are grown in gardens (Sho Ohno et al., 2011).

The large number of varieties within the *Dahlia* genus is the result of crosses of several species as: *Dahlia variabilis*, *Dahlia juarezii*, *Dahlia imperialis*, *Dahlia coccinea* and *Dahlia rosea*.

Most varieties are known in the crop resulted from the crossing of the species listed above and belong to the hybrid species *Dahlia hybrida* Hort.

The shape of the inflorescences and the ligated flowers are elements that group the varieties of dahlia in several types (Toma, 2009) (Fig. 1).

Flowers of this species contain a significant amount of flavonoids including anthocyanins, butene and flavones as petals pigments (Muntean et al., 2011). Some cultivars belonging to the *Dahlia pinnata* species have edible tuberous roots that can be used in the human diet. Tuberous roots of dahlia contain inulin, a versatile natural reserve of polysaccharides (Bernal et al., 2005) found in monocotyledonous and dicotyledonous families but mainly in *Asteraceae, Boraginaceae, Asparagaceae* (Koruri et al., 2014), *Liliaceae* and *Amaryllidaceae* (Herrero et al., 2014).

The therapeutic uses of *Dahlia*

There is a large number of minerals in the tuberous roots of *Dahlia.* Human and animal studies have shown that optimal intake of chemical elements (sodium, potassium, magnesium, calcium, manganese, copper, zinc and iodine) could reduce individual risk factors, including those associated with cardiovascular disease (Nsabimana et al., 2011).

The Astec people used dahlia as a treatment against epilepsy (Mareș, 2004).

The root is rich in starch - inulin, which can be converted into fructose, a sweetening substance, useful in diabetes diet (Fălticeanu and Munteanu, 2006).

Nowadays, extracts from dahlia tubers are used in different tests to analyze the liver and kidney well function (http://www.diane.ro/2009/07/legenda-florii-dedalie.html).

The bitter-tasting extracts of the flower petals have the following properties: they increase the appetite, the gastric secretion and the cell wall tone (Laza and Rácz, 1975).

Fig. 1. Types and varieties of *Dahlia hybrida*
(Source: http://justfunfacts.com/interesting-facts-about-dahlias)

Zinc oxide extracted from dahlias is used to measure cholesterol concentration (Jamil-Rana et al., 2014).

Different opportunities how *Dahlia* to can be used

Dahlia was originally regarded as a possible source of food, since at the beginning of the 1840s, in France, the potato harvest was compromised due to ruthless diseases (http://www.diane.ro/2009/07/legenda-florii-de-dalie.html).

Both tuberous roots and dahlia flowers are used in culinary art as an appreciated spice for the specific taste and flavor. The roots are cooked like vegetables, the sweet extract of tubers is used as a drink, as a flavor increasing ingredients (with bitter taste) or even on sweets, combining the characteristics of coffee, chocolate and tea, or the colorful flower petals are used in salads (Fălticeanu et al., 2006).

Flowers of dahlia, rose, viola, lilacs or lemons, if they are placed under the crystallization process, can be used especially for sweets and cake decoration, especially for wedding cakes.

Cantor and Buta (2010) mentions that petals from the inflorescences of *Dahlia* have a bitter flavor and are used in the salad and meat sauce decoration.

Spectacular petals and dahlia flowers, plumeria and lilac make up a wide range of cosmetics: perfume water, moisturizing bath milk, velvety body cream, face-to-body soap-hair, scented soap, lip balm, compact powder (www.lerbolario.ro/beauty_products_catalogue).

Creţu (2007) is mentioning that in the origin area, the dahlia is used for the dyeing of natural fiber materials, which will get a yellow-hot color.

The presence of inulin in the tuberous roots of the Dahlia

Inulin was first isolated and stored from the *Inula helenium* plant from which has inherited the name. The nutritional and functional attributes of inulin are very valuable and consequently have many food, pharmaceutical and chemical applications (Lara-Cortés et al., 2014) and industrial (Drághia and Chelariu, 2011).

Dahlia is valuable for inulin that has uses in medicine and in the food industry (Traynor și colab. 2006; Zubaidah și Akhadiana, 2013; http://www.botanical.com).

Burescu (2002) mentions that inulin is a polysaccharide, resulting from the polymerization of fructose in colloidal solution in the vacuoles of plant cells belonging to the *Asteraceae* family.

Today, the main sources of inulin are the fleshy roots of *Dahlia sp.*, *Cichorium intybus* and tubers of *Helianthus tuberosus*. All these species belong to the *Asteraceae* family, presenting inulin in the underground parts of the reserve, representing up to 75% of their dry matter (Machado et al., 1998). Previous studies made by Zubaidah and Akhadiana (2013) have shown that the tuberous roots of *Dahlia* are richer in inulin more than other species such as *Dioscorea esculenta* and *Pachyrhizus erosus*. They also mention that the inulin amount of this species is at the same time more soluble.

Dobrota (2013) states that fructans are reserve carbohydrates found in 15% of the superior plants belonging to *Asteraceae*, *Campanulaceae*, *Boraginaceae*, *Poaceae* and *Liliaceae*.

Dahlia tuberous roots have a large volume of carbohydrates represented by inulin which can be found in the inner cortex and in the parenchyma tissue (Konovalov, 2014).

Melo-De-Pinna and Menezes, (2003) whit a view on carbohydrates, have identified that inulin in endoderm and pericic in the roots of plants from the *Asteraceae* family.

They described the crystals of inulin in polarized light has the shape of crosses of Malta.

Because inulin is the main carbohydrate in the tuberose roots of dahlia, being a source of food for the plant when it enters the vegetation phase, is contributing significantly to the development of new shoots. So, it can be stated that the carbohydrates deposited in the tuberous roots, respectively the inulin, provide for the plant's perennial characteristic with a direct influence on the development in the beginning of a new vegetative stage.

The back-up substances represented by inulin at dahlia are enzymatically hydrolyzed. The inulin deposited in the vacuoles of the tuberous cells, in the form of colorless crystals (Fig. 2) consists of 35 fructose molecules linked by β-2.1-glycosidic bonds, at the end of the chain a glucose molecule (Fig. 3) (Burzo et al., 2000).

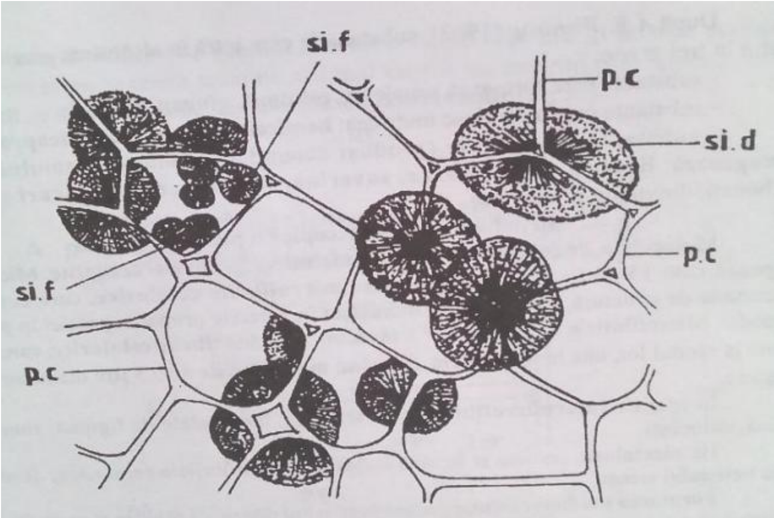

Fig. 2. Spherocrystals of inulin in the tuberous root of the Dahlia: p.c – cell wall;
d – spheric crystal of inulin developed in contact with cell walls;
f – spheric crystal of inulin in training
(Source: BURESCU, 2002)

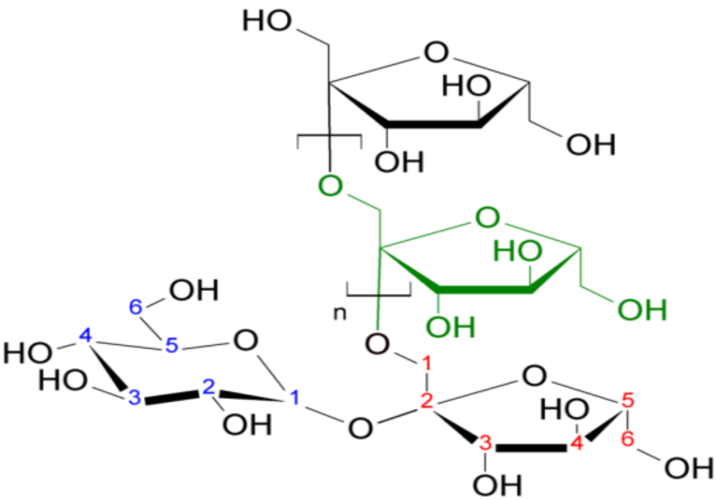

Fig. 3. General structural formula of inulin
(Source: https://ro.wikipedia.org/wiki/Inulin%C4%83)

Inulin acts as a substitute for fat, sugar and soluble dietary fiber (Lord, 2003; Saengthongpinit and Sajjaanantakul, 2005) in the food industry, having the advantage of a very low calorific value (Ohno et al., 2013) and prebiotic one (Zubaidah and Akhadiana, 2013; Kosasih et al., 2015). It is also used as a stabilizer, excipient or injectable in the clinical measurement of renal function in pharmaceutical applications (Saengthongpinit and Sajjaanantakul, 2005; Deguchi et al., 2013). Moreover, inulin has important biological effects, being a potent activator of the complementary system when it is in the form of particles having anti-carcinogenic properties (Bernal et al., 2005; Koruri et al., 2014) and immune modulators.

Some studies have shown that inulin stimulates the immune system of the body and reduces the incidence of colon cancer (Deguchi et al., 2013). All these investigations have shown that the effects of inulin on the gastrointestinal tract, constipation, mineral absorption and glycemic level.

In the chemical industry, inulin is used to produce alcohol, including ethanol, as a source of sugars or as a precursor in the production of various chemicals such as glycerol found in detergents (Barclay et al., 2010). Given the importance and benefits of inulin, there is an increasing interest in recent years for its use in processed foods due to its adaptive characteristics and is also suitable for diabetics (Hakiki et al., 2015).

Due to the importance of carbohydrates (such as inulin) deposited in tuberous roots, cultivars with a higher dry substance content and soluble solids can be considered more valuable as in the case of *Helianthus tuberosus* (Baldini et al., 2000; Fuchs 1993; Stauffer and et al., 1980), and Oxalis tuberosa (Lim, 2016).

Analyzing the difference between the studied Dahlia cultivars as 'Star Favorite' (25.47% soluble dry substance), 'Hayley Jane' (23.97% soluble dry substance) and 'Tsuki Yori No Sisha' (22.56% soluble dry substance), the presence of a rich early vegetative appliance had a beneficial effect on storing a quantity (24.27% soluble dry substance), 'Park Princess' (20.23% soluble dry substance), the unforced roots favor the accumulation of soluble dry substance. A positive influence on the content of soluble dry substance (%) in the tuberous roots is given by the weight of the forced roots which on specific cultivars: 'Star Favorite', 'Hayley Jane' and 'Tsuki Yori No Sisha' except for the 'Kennemerland' cultivar (Ciobanu et al., 2016).

Studies conducted by Nsabimana and Jiang (2011) have shown that *Dahlia* tuberous roots are rich in carbohydrates, fibers, proteins, essential minerals and vitamins. Some cultivars belonging to the species *Dahlia* *pinnata* are edible tuberous roots which can be used in the human diet. *Dahlia* tuberous roots contain inulin, a versatile natural reserve of polysaccharides (Bernal et al., 2005) found in monocotyledonous and dicotyledonous families but mainly in *Asteraceae*, *Boraginaceae*, *Asparagaceae* (Koruri et al., 2014), *Liliaceae* and *Amaryllidaceae* (Herrero et al., 2014).

The molecular characteristics of inulin are different, depending on several factors, such as the plant from which it is extracted, climate and growth conditions, harvest maturity and storage time after harvesting (Baranska et al., 2013).

Ciobanu et al., 2016, highlighted the fact that the substrate made up of peat (70%) and sawdust (30%) is the most beneficial for the tuberous roots keeping and storage after harvesting period, while the sand substrate is the least suitable because it does not favor the preservation weight and number of tubers per root. On the other hand, the detailed analysis of the FT-IR and FT-Raman spectra of the tuberous roots revealed that the accumulation of inulin in the tuberous roots is positively influenced by the storage in the sand substrate, and depends on the type of cultivar.

Other biochemical compounds identified in the tuberous roots of *Dahlia*

Among the biochemical compounds generally from plant tissues in tuberous roots of *Dahlia* are lignin, cellulose, hemicelluloses and pectin are found in the cell walls. Other chemical compounds existing in the tuberous roots are polyacetines, tetrahydropyrans, suberine (aliphatic acids, ferulic acid and glycerol).

Polyacetyles are compounds in which structure enters one or more triple bonds. Over 1100 different acetylenes and other related substances can be found in *Asteraceae* plants. The different tribes of this family are characterized by individual acetylene sets, allowing their use as chemotaxome biomarkers. These asteraceae compounds have antimicrobial, anti-inflammatory and neurotoxic, phototoxic properties. The diversity of these compounds is very broad, showing aliphatic and cyclic structures containing oxygen, nitrogen, and sulfur (Konovalov, 2014).

Previous authors, such as Lam (1973) and Lam et al., (1991) studied polyacetines using spectroscopic methods in different organs of *Dahlia* plants belonging to *D. pinnata, D. rudis, D. imperialis, D. tenuicaulis, D Mercki, D. coccinea, D. tubulata, D. australis* and *D. sherffi*. They have identified that tuberous roots are the richest in these compounds, but their type and proportion in tissues varies with species, whereas differences in identified types of acetyls varied in different plants even from the same species in *D. coccinea.*

In the study on the morphological and structural analyzes of plants by physical and spectroscopic vibration methods (Ciobanu et al., 2016), they have established that peat and sawdust substrate promotes the formation of polyacetylenes within the tuberous roots, most likely because this substrate facilitates the occurrence and pathogen development. It has also been observed that increasing the concentration of polyacetylene depends on the type of cultivar analyzed.

By analyzing the sections of *Dahlia* tuberous roots in the optical microscope, outwardly the stacked and impregnated suberine cells can be identified, being felogenic products (Ingram et al., 2008; Graça, 2015). Suberine is a lipophilic macromolecule, found in plants for plant protection purposes. The depolymerization phase can release 80-90% monomers of the aliphatic acid type, 5-20% glycerol and small amounts of phenolic acids of the ferulic acid type (Graça, 2015).

Conclusion

Dahlia enjoys great popularity among flower growers for the summer season due to the beauty of the flowers and the long period of decoration. Both the flowers and the tuberous roots of *Dahlia* have many uses in landscaping, but they have also gained ground as medicinal herbs, in cosmetics, food or raw extraction to permeate and coloring various material. Because of the biochemical composition that is very varied but also for other functions, it is recommended to use dahlia for the extraction of inulin as a potential user in natural medicine and drug, considering the cultivated variety. Also, in the improvement work, it will be envisaged to obtain descendants that combine polygene for a high decorative value and an increased content of inulin.

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