Scientific Papers. Series B, Horticulture. Vol. LXV, No. 1, 2021
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDIES AND RESEARCH ON THE SPECIES AND VARIETIES OF DAHLIA IN CULTIVATION

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Abstract

The Asteraceae family (Compositae) contains a multitude of species, over 23,000, spreading all over the globe. The genus Dahlia includes about 42 species, falling into the category of ornamental plants, because the flowers are characterized by a multitude of shapes, sizes and colours. The floral qualities of the species of the Dahlia genus make these plants indispensable in gardens and the decoration of green spaces. In addition to their ornamental qualities, these plants are highly valued for their medicinal qualities and nutritional properties. Although Dahlia tubers have a low caloric value, it is still notable for its high fiber content, especially soluble fiber, such as inulin, but also considerable amounts of minerals (potassium, magnesium, phosphorus, calcium, iron). The paper presents studies and research conducted in recent years on the morphological, physiological, biochemical and nutritional properties of species from Dahlia genus.

Key words*: biochemical, flowers, morphology, nutritional properties, ornamental.*

INTRODUCTION

The genus *Dahlia* belongs to the family Asteraceae (Lord, 2003) or Compositae (Șelaru & Mucescu, 1976) and includes about 15 perennial species (Toma, 2009). It is known, especially, as a plant for ornamenting flower gardens characterized by the variety and brightness of the colour, their composition and size, the duration of flowering of the plant and high production capacity (Șelaru, 1998).

The colour of flowers and calatidia, their special shape and their long shelf life, make dahlia one of the most appreciated species used as cut flowers for summer bouquets (Cantor et al., 2007). Sho Ohno et al. (2011) state that in recent years, more than 50,000 varieties of Dahlia with different colours, shapes and sizes of inflorescences are grown in gardens (Figure 1).

Their easy cultivation technique and also the prolonged flowering, make dahlias among the most popular decorative flowering plants (Kiselev, 1956). Dahlia is widespread everywhere, but shining in the hilly and submontane areas (Șelaru, 2007).

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

The sketches with Dahlia flowers drawn by the Spanish doctor Francisco Hernandez (1570), but also the notes of the Frenchman Nicolas Thierry de Menonville (1787) signaled the existence of these species on the territory of Mexico (Șelaru & Mucescu, 1976). In the wild, dahlias grow in South America in short day conditions and cold nights, which explains their

abundant flowering in August-September when the day shortens and the nights become colder (Kiselev, 1956). The use of Dahlia plants has been varied since Aztec times; the same is true today: dahlias are used in landscaping, as a cut flower in pots, in the cosmetics industry, in the food industry, as a raw material for obtaining dyes, in the diet of diabetics, in the treatment of gastrointestinal problems, obesity and skin infections (www.healthbenefitstimes.com/dahlia).

Currently, Dahlia is widely used for economic purposes: in landscaping, in the flower shop as a cut flower, for the pharmaceutical, cosmetics, food industry and as a raw material for the extraction of dyes (Moldovan I., 2017). In the country of origin, dahlia flowers are used to dye natural fiber materials (Cretu, 2007). The first species of Dahlia appeared in Mexico and were inexhaustible sources for the emergence of new and new varieties, each interesting by the way the flowers are composed, their size or colour (Șelaru & Mucescu, 1976). Dahlias grew and still grow like weeds in the mountainous regions of Mexico and Central America and the Aztecs used them for food (Santana et al., 2016) and medicine, motifs decorated the helmets of the Aztec warriors; the petals were used in ceremonies, including human sacrifice to their sun god (https://www.mexinsurance.com/dahlia/).

When Hernan Cortez and the Spanish conquistadors entered the Aztec city Huaxtepec in 1519, they were the first Europeans to view the most impressive of Emperor Montezuma's botanical gardens. Undoubtedly, one of the most curious sights in the garden at Huaxtepec would have been a specimen of what we know as *Dahlia imperialis* (Figure 2), the tree dahlia that the Aztecs called acocotli, which means water pipe in their language (https://www.mexinsurance.com/dahlia/).

Hernan Cortez wrote of the flowers known in the Nahuatl language as acocotli, and even sketched them. Sadly this and other Spanish works are all that remains of the Aztec records detailing how dahlias were used in garden and as a medicinal (https://moplants.com/aztec-dahlia-flowers-of-mexico/). The first seeds belonging to the species *Dahlia rosea* and *Dahlia pinnata* appeared in Europe in 1789, more precisely in Spain (Șelaru & Mucescu, 1976).

Figure 2. *Dahlia imperialis*
Source: https://www.pacifichorticulture.org/articles/the-tree-dahlia/

STUDIES AND RESEARCH ON THE IMPACT OF FERTILIZATION ON FLOWER PRODUCTION, BIOMETRIC AND PHYSIOLOGICAL PARAMETERS IN DAHLIA (ASTERACEAE)

Research by Mahgoub et al. (2011) to *Dahlia pinnata* plants sprayed foliar with putrescine and thiamine (vitamin B1) in different concentrations (50, 100, 150 ppm/30 and 60 days) from transplanting and plants sprayed with tap water it was found that the results obtained indicate higher values when using 150 ppm putrescine and thiamine at 100 ppm. Also, spraying plants with putrescine and thiamine significantly increased plant height, number of leaves, number of branches, fresh and dry weight of leaves, stem diameter and fresh and dry weight of stem. The chlorophyll content was higher in foliar sprayed plants compared to untreated ones. Following the results obtained by Abd-Elkader et al. (2020) on certain vegetative parameters and chlorophyll content in plants treated with Tryptophan at 100 ppm , Arginine at 100 ppm, Glycine at 100 ppm, Tryptophan + Arginine + Glycine at 100 ppm per each compared to untreated plants indicated that treatment with mixture of amino acids tryptophan + arginine + glycine gave the maximum chlorophyll a, b and total chlorophyll values, followed by arginine treatment then the tryptophan treatment, whereas untreated plants (control plants) gave a

minimum values of chlorophyll a, b and total in both seasons, respectively. It is evident from the presents data that the plants sprayed with the amino acids mixture (tryptophan + arginine + glycine at 100 ppm) produced the superior values of tallest plants, the maximum branches number /plant, the largest leaves number/plant, and the largest stem diameter.

Kashif et al. (2014) used foliar fertilizers to observe the impact on Dahlia plant growth. Four treatments were applied that were: T0, control (no foliar application of nutrients); T1, NPK (17:17:17); T2, NPK (15:32:7) + micro power); T3, NPK (15:32:7) + chelated mix micro-nutrients. Micro power contain N, 1%; K2O, 1%; Zn, 2.5%; B, 1%; Fe, 1%; Mn, 1% and Cu, 2% nutrients and chelated mix micro-nutrients (CMM) also contained Zn, 1.5%; B, 2%; Fe, 2%; Mn, 2% and Cu, 1% nutrients. The results endorsed the benefits of foliar fertilization by witnessing the improved growth traits of the plant.

In the study conducted by Younis et al. (2014), was used source of macro and micro nutrients like Foliber a macro nutrient product containing ingredients with concentration g/L: nitrogen (N) 80, P O 80 and K O 60 and Unipower solution a micro nutrient product containing ingredients with concentration in mg/100 ml: Zinc (Zn) 5000 ± 200, Boron (B) 4000 ± 200, Iron (Fe), 5000 ± 200, Manganese (Mn) 1000 ± 200, Copper (Cu) 1000 ± 100, Chloride (Cl) 1000 ± 100, Molybdenum (Mo) 50 ± 10 and pH of the solution 2.5 ± 0.5 were used. There were 16 treatment combinations comprising T = Control, T = 2.5 Unipower ml/L), T = 5.00 Unipower (ml/L), T = 7.5 Unipower (ml/L), T = 2.00 Foliber (ml/L), T = 2.00 Foliber (ml/L)+ 2.5 Unipower (ml/L), T6= 2.00 Foliber (ml/L) +5.00 Unipower (ml/L), T7= 2.00 Foliber (ml/L) +7.5 Unipower (ml/L), T8= 4.00 Foliber (ml/L), T9= 4.00 Foliber (ml/L)+2.5 Unipower (ml/L), T10= 4.00 Foliber (ml/L)+5.00 Unipower (ml/L), T11= 4.00 Foliber (ml/L) +7.5 Unipower (ml/L), T12= 6.00Foliber (ml/L), T13= 6.00 Foliber (ml/L) +2.5 Unipower (ml/L), T14= 6.00 Foliber (ml/L) +5.00 Unipower (ml/L) and T15= 6.00 Foliber (ml/L) +7.5 Unipower (ml/L). Plants were allowed to grow and data regarding following growth and flowering was collected using standard procedures. The parameters studied were: plant height (cm), number of lateral shoots, length of lateral shoots, number of leaves /plant, leaf area (cm²), days to first flower emergence, root length, blooming period (days), size of flowers (cm), number of flowers/ plant and number of tubers/ plant. In this study, the results associated with plant growth parameters indicated that the maximum values for plant height, number of leaves, number of side shoots, leaf area, number of tubers plant, flower diameter and least days toflower emergence were observed in combined application of macro and micronutrients containing 6 ml/L Foliber and 7.5 ml/L Unipower. This combination has sufficient amounts of the nutrients essential for plant growth so this best combination of macro and micronutrients having 6 ml/L Foliber and 7.5 ml/L Unipower for good vegetative and flower growth in Dahlia is recommended.

Vlad et al. (2013) used foliar fertilizers to observe the quality production of *Dahlia variabilis* "Golden Wonder" cultivar (fam. Asteraceae) flowers. The experiments on the influence of phase fertilization on quality production of Dahlia flowers were conducted during 2010-2012 in a nursery from the locality Leş, situated in Bihor County, North-Western Romania. Propagation was performed by means of root cuttings forced in a warmed greenhouse solarium (16-22°C), using a substrate composed of peat and sand in equal parts. The obtained cuttings were stimulated to root in a substrate of peat and sand in equal proportions. The rooting took place within 30-35 days. The rooted cuttings were planted in the nursery soil with the aim of producing plants devised for cut flowers. During the vegetation period, foliar fertilizations were performed using Wuchsal (N:P:K=1:2:1). Apart from nitrogen, phosphorus and potassium, Wuchsal contains microelements (Fe, Cu, Zn, B, S, Co). Flower yield was enhanced in blocks were the foliar fertilization was applied weekly using a concentration of 0.2 and 0.25% (V4 and V6).Blocks where fertilization was applied every two weeks resulted in enhanced yields as compared to the blank (V3, V5, V7 and V8) - Tabel 1. Excepting the blank, in all blocks the proportion of first quality flowers raised over 80%.The best results with regard to yield and

the number of quality flowers were obtained in block 6 (fertilized with Wuchsal, concentration 0.25% weekly).

Tabel 1: The influence of foliar fertilizers upon the quality of *Dahlia variabilis* flowers (Surce: Vlad, 2013)

Blocks	Flower yield in *Dahlia variabilis*		
	Totals of stalks/m^2	Of which, first quality	
		Absolute stalks/m^2	Relative %
V1 – blank (unfertilized)	68	49	72
V2 – fertilized with Wuchsal, concentration 0.1% weekly	100	85	85
V3– fertilized with Wuchsal, concentration 0.1% every two weeks	90	72	80
V4- fertilized with Wuchsal, concentration 0.2% weekly	120	102	85
V5- fertilized with Wuchsal, concentration 0.2% every two weeks	96	78	81
V6 - fertilized with Wuchsal, concentration 0.25% weekly	128	104	81
V7 - fertilized with Wuchsal, concentration 0.25% every two weeks	108	86	80
V8 - fertilized with Wuchsal, concentration 0.3% every two weeks	115	92	81

The results of the research conducted and presented highlighted the benefits of fertilization on growth and flower production.

NUTRITIONAL AND MEDICINAL PROPERTIES IN DAHLIA

Studies and research conducted by students and researchers of Chapingo Autonomus University showed that Dahlia tubers have a low caloric value, between 180-193 kcal/100 g of dry matter; provides a low calorie intake, which means that a large amount of this food needs to be consumed. The total dry matter of Dahlia tubers contains between 4.8 - 11.1% fiber, which means a rich source of fiber (https://www.ddfgg.de/dahlien/pdf/DAHLIA-FLOWERS-AND-TUBERS.pdf).

Studies indicate that in the prehispanic era the tuberous roots of this plant were consumed as a source of carbohydrates, that is, as an equivalent of potatoes (*Solanum tuberosum* L.) (Santana et al., 2016).

After Lara-Cortés et al. (2014) in Mexico, Dahlia flowers are commonly consumed in different type of dishes; however, there are no reports on characteristics as a functional food. Compared to other foods, it is a very high percentage of fiber. According to the World Health Organization (2003) fiber intake in children aged 5-8 years is 8 g/day, in children between 9-10 years 22 g/day, for adults between 18-59 years 25-30 g/day. According to the Academy of Nutrition and Dietetics (DNA), an intake of 30 g/day is required for men after the age of 60 (Mahan and Raymond, 2017) and 21 g for women (Palafox and Ledesma, 2015). Nsabimana and Jiang (2011) highlight a large number of substances in the tuberous roots of Dahlia: minerals (Fe, Zn, Na, K, Cu, Mg, Ca, Co, Cr, P), fats, proteins, fiber, ash, vitamins fat-soluble (A, E), water-soluble vitamins (B1, B2, B3, B6, B7, C). Dahlia tubers exhibited varying concentrations of minerals, among which potassium, calcium, magnesium, phosphorus, zinc and chromium were predominant (Nsabimana & Jiang, 2011).

Dahlia is a plant with a high content of soluble fiber (40-80%), such as inulin a carbohydrate storage that has a wide nutritional and pharmaceutical importance (Melanie et al., 2015).

Inulin (Figures 3 and 4) is a carbohydrate with the following properties: lowers lipid metabolism, reduces the risk of colon cancer, lowers body mass, lowers blood sugar, stimulates the immune system and increases intestinal flora (https://laverdadnoticias.com/estiloyvida/Las-dalias-un-gran-aliado-para-las-personas-con-diabetes-tipo-2-20200117-0250.html).

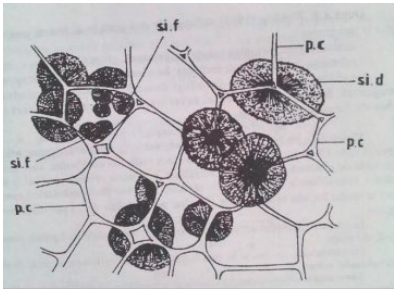

Figure 3. Spherocrystals of inulin in the tuberous root of the Dahlia: p.c - cell wall; d - spheric crystal of inulin developed in contact with cell walls; f - spheric crystal of inulin in training (Source: Burescu, 2002)

It also does not contain other significant soluble carbohydrates, which means that it does not provide energy in this way. A low protein content was found in Dahlia, between 6.5-15.1% (https://www.ddfgg.de/dahlien/pdf/DAHLIA-FLOWERS-AND-TUBERS.pdf).

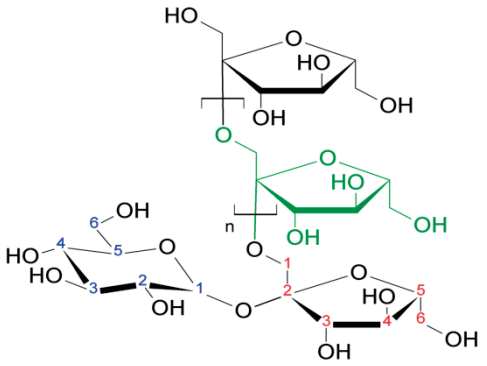

Figure 4. The chemical formula of inulin
Source: https://ro.wikipedia.org/wiki/Inulin%C4%8

In Dahlia tubers are found lipids in small amounts, about 1%. Dahlia tubers contain significant amounts of potassium, magnesium, phosphorus, calcium, iron, and in the presence of vitamin B are an important source of minerals for bones, especially in women, helping to absorb calcium; Potassium also helps the proper functioning of the kidneys and heart, muscle contraction and the transmission of nerve influx. The Aztecs used Dahlia as a treatment for epilepsy (Mareș, 2004). Both the tuberous roots and the flowers of this ornamental and medicinal plant are used for therapeutic purposes (Moldovan I., 2017). For the past 20 years, Chapingo Autonomous University in Mexico has conducted many studies on the growth, reproduction and use of Dahlia species. The results are publicized to encourage as many people as possible to grow dahlias for both food and their medicinal benefits for people with diabetes, gastrointestinal problems, high cholesterol and blood triglycerides and obesity. Flowers are also promoted in the diet, with a recipe book based on Dahlia flowers and tubers (Martinez-Montes et al., 2008). The flower petals are consumed by adding to salads, the sweet extract from the tubers is combined with cold, hot water, milk or sprinkled on ice cream. (https://www.healthbenefitstimes.com/dahlia).

Lara-Cortés et al. (2014) studied the composition, minerals, vitamin C, phenolic compounds, total anthocyanins, carotenoids and antioxidant activity of Dahlia flowers. In general, the highest values of phenolic compounds, anthocyanins and antioxidant capacity were found in purple Dahlia (127.5 mg AG.g^{-1}, 257.5 mg pelargonidine, 100 g^{-1} and 24% of inhibition). The type and concentration of phenolic compounds varied depending on the colour of the flower. The highest value of the phenolic compound was for hesperidin (398.9 mg.g^{-1}), while the most detected phenolic compounds in flowers were gallic and caffeic acids. Based on these results, we can recommend the consumption of Dahlia flowers as a functional food, because they provide phenolic compounds (especially dark Dahlia flowers, because they have the highest phenolic composition and antioxidant activity). Dahlia tuber fibers function as a prebiotic, meaning the food of the intestinal microbiota that ensures better digestion and better intestinal transit helping to maintain gastrointestinal health and prevent health problems such as colon cancer (Nsabimana and Jiang, 2011). According to the recommendations of the American Diabetes Association (ADA), people with diabetes should consume between 10-13 g of fiber per 1000 kcal to maintain the health of the body. In order to maintain good health, it is necessary for the continuous fiber intake to vary between 20-35 g/day, depending on the age and clinical condition of the person (according to American Diabetes Association). The Dietary Guidelines for Americans recommend a minimum of 14 grams of fiber per 1,000 calories. Foods that are naturally high in fiber and contain at least 2.5 grams are often labeled as a "good source," and foods labeled as "excellent source" contain more than 5 grams of fiber per serving (https://www.diabetes.org/healthy-living/recipes-nutrition/understanding-carbs/get-to-know-carbs). Abscisic acid is an important plant stress-induced phytohormone. Gouveia et al. (2020) also found in tuberous dahlia roots. Recent results of Italian researchers confirm that the health benefits observed in people with diabetes are related to the plant hormone, abscisic acid, present in large quantities in latent plants and it plays an important role in

managing glucose homeostasis in humans (Zocchi et al., 2017).

CONCLUSIONS

The special floricultural qualities of the species of the genus *Dahlia* make these plants suitable for cultivation in gardens and green spaces. The genus *Dahlia* is distinguished by a multitude of species and varieties as different as possible. They are easy to grow, the decoration period is quite long, and the flowers are numerous and with an impressive colour. The nutritional and medicinal properties of these plants have been known since Aztec times, and all these uses have led to the study of *Dahlia* species and varieties by researchers around the world. Thus, numerous morpho-anatomical, physiological, nutritional and medicinal researches with a great scientific value have been carried out, which confirms that these plants bring benefits to humans.

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