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Description of cultivar

Morphological and nutritional description of Yaretzi: a variety of dahlia for cut or potted flower

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Abstract

The genus *Dahlia* (Asteraceae: Coreopsideae), made up of 42 species characterized by their wide diversity in size, shape, and color of their inflorescences, is highly appreciated for ornamental use and nutritional contribution. The aim of this contribution is to disseminate the morphological and nutritional description of Yaretzi, a variety of dahlia suitable for cut or potted flower. The plant of this variety has a stem diameter of 13.6 mm, 11.29 nodes, 5.78 branches, 90.16 days to flowering, 14.75 flowers, 350.86 g of root weight, 6.97 roots, peduncle diameter of 3.4 mm, and capitula (diameter= 112.36 mm, 138.22 ligules and 170 g of weight). Among the main physicochemical characteristics of ligulate flowers are 5.83 °Brix, 7.81% malic acid, 5.01 mg 100 g^{-1} vitamin C and 0.08 mg 100 g^{-1} chlorophyll. Likewise, 1.46 mg kg^{-1} of total anthocyanins, 0.05 mg Eβ-carotene g^{-1} (total carotenoids), total phenols (31.52 mg GAE g^{-1}), antioxidant capacity (60.63 and 177.42 µmol TE g^{-1}, FRAP, ABTS, respectively), color components (lower and upper part of the ligula) L*= 67.07-73.29, C*= 55.46-53.44, °h= 24.19-23.31. Among the minerals, the high concentration of Fe^{2+} and Zn^{2+} stands out, both nutrients are essential for human health. On the other hand, tuberous roots stood out for having around 24% inulin, a carbohydrate with a promising role as a prebiotic. These results contribute to the diversification of the dahlia, an endemic and microendemic phytogenetic resource of Mexico.

Keywords:

Dahlia spp., bioactive compounds, floriphagia, phytogenetic resources.

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The dahlia or acocoxochitl (*Dahlia* spp.) (Asteraceae: Coreopsideae) is a genus of plants made up of 42 species (ADS, 2024) and, according to multiple studies, around 35 species are endemic and microendemic to Mexico (García-González *et al*., 2024). This plant has a diverse and complex morphology, including its inflorescences with numerous ligulate flowers (Hernández-Epigmenio *et al*., 2022), attractive as a cut flower, potted flower, or for the design and establishment of gardens (Rivera-Espejel *et al*., 2019).

There is evidence of the consumption of tuberous roots and ligulate flowers of dahlia as a fresh product or in preparations in various regions of Mesoamerica (Rivera-Espejel *et al*., 2019). These plant organs are characterized by their content of inulin, mineral nutrients, and bioactive compounds (Rivera-Espejel *et al*., 2019; García-González *et al*., 2024). On the other hand, since 1784, the dahlia has been one of the plant genera with the greatest genetic manipulation as around 65 000 varieties are reported worldwide (Hernández-Epigmenio *et al*., 2022).

In Mexico, the National Catalog of Plant Varieties (CNVV), for its initialism in Spanish reported only 36 varieties of dahlia. This panorama is worrying if this genus of plants is considered as the national flower since 1963. In addition, the destruction of its habitat by anthropogenic activities and climate change may be factors that put this group of plants, a phytogenetic resource in Mexico, at risk of extinction.

In this context, multiple efforts have been made between public agencies, civil organizations, and the Chapingo Autonomous University (UACH), for its acronym in Spanish to conserve *in situ* and exploit this important phytogenetic resource by obtaining varieties with ornamental and food use. To this end, the UACH through the interinstitutional project of conservation and sustainable use of the dahlia, our national flower' with identification number VUSNITT/15/GEN/07474 of the Dahlia Network of the National Seed Inspection and Certification Service of Mexico (SNICS), for its acronym in Spanish, has allowed the obtaining and recent release of various varieties, including Yaretzi (*Dahlia* × *hortorum*) (Figure 1).

Figure 1
From left to right, adult plant, stem, flower capitulum, and tuberous roots of Yaretzi (*Dahlia* × *hortorum*), a variety for cut or potted flower generated at the Chapingo Autonomous University.

The release of new plant varieties, including the dahlia, should incorporate information on the content of mineral nutrients and bioactive compounds that allow the use of this ornamental species to be revalued and diversified. Therefore, this contribution aims to disseminate the morphological and nutritional description of Yaretzi, a variety of dahlia for cut or potted flower generated at the UACH.

Origin of the Yaretzi dahlia variety

This work was conducted in the 'San Martin' experimental field of the Department of Phytotechnics (UACH) (19° 29' 23" north latitude; 98° 53' 37" west longitude), with an altitude of 2 246 m, average

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annual temperature and rainfall of 15.6 °C and 608 mm, respectively. To obtain this variety, in 2017, a population of 500 genotypes of dahlias (*Dahlia* x *hortorum*) obtained from the UACH germplasm bank were planted in the field under conditions of open pollination. At the end of the cycle, the seed of the selected genotypes was collected and a population of half-sibling families (HSF) was obtained, they were placed separately in paper bags and stored in a cool and dry place.

In 2018, based on ligula color, capitulum diameter, capitulum shape, plant height, and leaf type, 50 seeds from each HSF population under open-pollinated conditions were described. As a result, two genotypes (DHEFCHMII-01 and DHEFCHMII-12) were obtained and used as parents in the reciprocal crosses (DHEFCHMII-01 x DHEFCHMII-12) and (DHEFCHMII-12 x DHEFCHMI-01), respectively.

At the end of the cycle, seeds were collected from each parent and stored in paper bags. In 2019, the evaluation (plant height, color and number of ligulate flowers, type, diameter, and arrangement of the capitulum and peduncle length) and selection of the outstanding plants obtained in the reciprocal crosses of the previous cycle (F1 progeny) were carried out.

Subsequently, in 2020, the tuberous roots were used to obtain cuttings, which were directly rooted and cultivated in order to characterize the variety of interest called Yaretzi, assessing its distinctiveness, homogeneity and stability, and color descriptors were evaluated with the color chart indicated by the Royal Horticultural Society.

In 2021, propagation by cuttings of the variety selected for its desirable, homogeneous, and stable characteristics was carried out. In that same year, the description of the variety called Yaretzi was made according to the criteria considered by the International Union for the Protection of New Varieties of Plants in the technical guide TG/226/1 (UPOV, 2006), where 57 morphological traits of plant, leaf, stem, and capitulum were considered.

Morphological description, physicochemical characterization, and nutritional value

The multiplication and obtaining of cuttings began on January 28, 2023; to this end, the tubers were sown in a mixture of perlite and peat in a 1:1 (v:v) ratio. The plants emerged after eight days and were transplanted with a length between 8 and 10 cm in a total of 30 plants. Irrigation was carried out manually and fertilization was done using the general formula (12 N: 12 P_2O_5: 17 K_2O), divided, at transplanting and prior to flowering. Finally, in December, defoliation occurred and the tuberous roots were harvested.

The morphological description included days to flowering, height (cm), number of nodes, number of branches, stem diameter (mm), number of flowers, capitulum diameter (mm), fresh capitulum weight (g), capitulum diameter (mm), number and color of ligules (L, C*, °h) (McGuire, 1992). The number and fresh weight (g) of tuberous roots were determined. The total soluble solids content (TSS, °Brix), total titratable acidity (% malic acid), and vitamin C were evaluated in the flowers, all according to the method proposed by the Association of Official Analytical Chemists (AOAC, 1975).

Likewise, the following was determined: the total chlorophyll content (µg g^{-1}) (Craker, 1971), mineral nutrients (N, P, K, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+} and B) expressed in g kg^{-1} (macroelements) and mg kg^{-1} (microelements) (both on a dry weight basis) (Cruz-Alvarez *et al*., 2020), total phenols (mg GAE g^{-1} FW) (Singleton and Rossi, 1965), antioxidant capacity (ABTS (2,2-azino-bis [3-ethylbenzothiazoline-6-sulfonic]) (µmol TE g^{-1}) (Re *et al*., 1999), FRAP (ferric reducing antioxidant power) (µmol TE g^{-1}) (Benzie and Strain, 1996), total carotenoids (mg EβC g^{-1} FW) (Ordoñez-Santos *et al*., 2009), and total anthocyanins (mg kg^{-1} FW) (cyanidin-3-glucoside equivalents) (Lee *et al*., 2005). A proximate analysis (%) of tuberous roots was performed, including moisture, dry matter, crude protein, crude fat, crude fiber, and ash (Tomasik, 2003). Likewise, the inulin content (%) was determined (Toneli *et al*., 2007).

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Variety description

The Yaretzi variety has an average plant height of 100.81 cm, stem diameter of 13.6 mm, 11.29 nodes, 5.78 branches, 90.16 days to flowering, 14.75 flowers, 350.86 g root weight, 6.97 roots, 3.4 mm peduncle diameter, 112.36 mm capitulum diameter, 138.22 ligules per capitulum, and 17.04 g capitulum weight. On the other hand, ligulate flowers have 5.83 °Brix, 7.81% malic acid, 5.01 mg 100 g^{-1} vitamin C, and 0.08 mg 100 g^{-1} chlorophyll.

Also, 1.46 mg kg^{-1} (cyanidin-3-glucoside equivalents) of total anthocyanins, 0.05 mg Eβ-carotene g^{-1} (total carotenoids), total phenols (31.52 mg GAE g^{-1}). A set of molecules with high biological activity with benefits for human health care, verified by the values of antioxidant capacity (60.63 and 177.42 µmol TE g^{-1}, FRA, ABTS, respectively), so the flowers of this variety of dahlia could be considered as a product for fresh consumption and low caloric level but with their respective contribution of bright colors expressed by its components (lower and upper part of the ligula) L*= 67.07-73.29, C*= 55.46-53.44, °h= 24.19-23.31.

On the other hand, the flowers had a variable mineral concentration of N, P, K, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, and B. However, a high value of Fe^{2+} and Zn^{2+} was found, with 65.75 and 20.25 mg kg^{-1} (Table 1). In this regard, the participation of Fe^{2+} in the transport of oxygen through hemoglobin, DNA synthesis (structural part of the ribonucleotide reductase enzyme), electron transport (oxido-reductive properties), among others, has been demonstrated (Toxqui *et al*., 2010).

Table 1. Concentration of mineral nutrients in dahlia flowers (*Dahlia* × *hortorum*) variety Yaretzi.

N	P	K	Ca^{2+}	Mg^{2+}
		(g kg^{-1})		
23.6	2.5	24.5	4.4	3.5
Fe^{2+}	Cu^{2+}	Zn^{2+}	Mn^{2+}	B
		(mg kg^{-1})		
65.75	24.75	20.25	5.5	14.26

Data are expressed on a dry weight basis.

On the other hand, zinc plays an important role in multiple enzymes linked to protein metabolism and in the synthesis of nucleic acids (carbonic anhydrase, carboxypeptidase, alkaline phosphatase, and DNase and RNase polymerase) and its deficiency in the human body leads to anemia, Fe^{2+} deficiency, hypogonadism, dwarfism, hepatosplenomegaly, and geophagy (Zn deficiency syndrome) (Rosas-Romero and Covarrubias-Gómez, 2020).

The proximate analysis (% dry basis) of the tuberous roots reveals values of 78.73% moisture, 21.27% dry matter, 8.7% crude protein, 1.99% crude fat, 12.62% crude fiber, and 4.96% ash. Nevertheless, it was outstanding for having an average inulin value of 23.61%, a carbohydrate that has shown a promising role in human health care due to its prebiotic potential, where it is used as a fat substitute and food texture modifier (García-González *et al*., 2024).

Conclusions

The Yaretzi dahlia plant has outstanding morphological characteristics for the commercial production of cut or potted flowers. On the other hand, ligulate flowers have multiple phytochemical and mineral nutrients, such as Fe^{2+} and Zn^{2+}, that allow them to be considered as a product for fresh consumption and contribute to the care of human health.

Likewise, tuberous roots have an average inulin value of 23.61%, a carbohydrate with a promising role in human health care due to its prebiotic potential, where it is used as a fat substitute and modifier of the texture of food. These results allow us to explore and diversify the use of this ornamental plant, which contribute to the conservation of this important endemic and microendemic phytogenetic resource of Mexico.

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