Citrullus spp. Germplasm Diversity in Tunisia: An Overview

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Introduction

The genus *Citrullus*, a member of the *Cucurbitaceae* family, includes several known diploid species including *C. lanatus* (Thunb.) Matsum. & Nakai, *C. amarus* Schrad., *C. mucosospermus* (Fursa) Fursa, *C. colocynthis* (L.) Schrad., *C. ecirrhosus* Cogn, *C. rehmii* de Winter, and *C. naudinianus* (Sond.) Hook (Chomicki and Renner, 2015; Paris 2015).

The annual *C. lanatus* (2n=22), the dessert watermelon, is the most known among all *Citrullus* species. It is a warm-season annual vegetable fruit with sweet flesh and is one of the most extensively consumed vegetable fruit crops throughout the world. Indeed, it is grown on 3.5 million hectares worldwide and the annual world production exceeded 118 million tons in 2017 (FAOSTAT, 2019). Native to Sudan and Egypt, it includes wild and cultivated forms (Paris, 2015) and is grown for its edible endocarp, rind, and seed oil. The colored flesh, though 93% water, contains significant amounts of carbohydrates, vitamin A, and lycopene (Wehner, 2008). It has been certified as a heart-healthy food by the American Heart Association because it is low in calories, sodium, cholesterol, and fat. In Tunisia, watermelon is largely consumed in summer as a fresh fruit.

Citrullus colocynthis, the colocynth, is considered a putative ancestral or progenitor species of watermelon (Levi et al., 2001a). Also known as bitter apple, it is cultivated for its numerous medicinal properties and the oil of its seeds (Hussain et al., 2014). It is also used as a potential rootstock for watermelon (Bigdelo et al., 2017). *C. colocynthis* is native to the deserts and semi-arid regions of northern Africa and southwestern and central Asia (Paris, 2015). In Tunisia, it grows wild in the arid regions and is used as a medicinal plant. Another wild species, *C. amarus* (previously known as *C. lanatus* var. *citroides*), also known as the citron watermelon or preserving melon, is neither sweet nor bitter. Its rind is used to make pickles and fruits that are fed to livestock (Dane and Liu, 2007) and is also used as a rootstock for watermelon (Thies et al., 2007).

A wide range of phenotypic characteristics, including fruit size, flesh color, rind pattern, and also disease resistance and flesh sweetness, are observed between cultivars. Each growing region has a unique set of cultivars that are widely grown and are suited for cultivation in the local environment (Wehner, 2008; Chikh-Rouhou et al., 2019). Despite considerable geographic and phenotypic diversity, the genetic variation of cultivated watermelon is limited (Levi et al., 2001b).

Watermelon has been cultivated and grown for many centuries in Northern Africa (Jensen et al., 2011). Landraces collected in Northern Africa, including Tunisia, could be a useful source of germplasm for breeding programs. Indeed, the strategic geographic location of Tunisia and the variability of its climate, which varies from humid in the north to arid in the south, have fostered the diversification of several cucurbit species (both landraces and wild genetic resources). In Tunisia, the watermelon collection at the Regional Research Centre on Horticulture and Organic Agriculture (CRRHAB, Tunisia) was initiated in 2017 (Figure 1). The accessions collected belong to *C. lanatus*, *C. amarus,* and *C. colocynthis* (Table 1). Several studies were initiated to characterize watermelon landraces using either morphological traits (Chikh-Rouhou et al., 2019), molecular markers (Elbekkay et al., 2021), or phytochemical traits (Tlili et al., 2011). However, watermelon genetic resources in Tunisia are, in general, poorly characterized and additional studies are needed to properly collect, classify and evaluate them. Unfortunatelly, most landraces have been abandoned and replaced by commercial imported hybrids, except on scattered family farms.

Very few studies have been conducted to characterize the local Tunisian germplasm. Tlili et al. (2011) evaluated antioxidant components and antioxidant activities of 6 watermelon cultivars and 2 selections (P503 and P403 obtained by the National Institute of Agricultural Research of Tunisia (INRAT) and found significant differences among accessions for lycopene, phenolics, flavonoids, ascorbic acid (AsA), dehydroascorbic acid (DHA) and total vitamin C (AsA + DHA) contents, as well as in antioxidant activity of their hydrophilic and lipophilic fractions. The results of that study indicated a wide range in the nutritional value of those watermelon accessions and emphasized the need to evaluate watermelon biodiversity for improving nutritional value. Chikh-Rouhou et al. (2019) found wide phenotypic diversity for fruit and seed traits among watermelon landraces collected from Center-East Tunisia. Elbekkay et al. (2021), using RAPD markers, found substantial genetic diversity among watermelon landraces collected from southern Tunisia.

Screening for resistance to *Fusarium oxysporum* f. sp *niveum* (FON), the pathogen causing Fusarium wilt in watermelon, is ongoing to identify germplasm sources useful for breeding programs. Some landraces with a potential source of resistance to FON were identified and are under trial-confirmation (Chikh-Rouhou et al., in preparation). In addition, the phenotyping of the root traits of these landraces is ongoing at CRRHAB. It is essential to phenotype the roots as they are an important component for productive plant performance (Katuuramu et al., 2020). Evaluation of root traits across *Citrullus* spp. is a promising means to identify superior genotypes useful for the improvement and development of elite watermelon cultivars.

We emphasize here the need to collect and evaluate watermelon diversity for more efficient management and utilization of landraces to facilitate sustainable conservation and enrichment of the *Citrullus* spp. germplasm in Tunisia.

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Figure 1. Diversity of some watermelon genetic resources collected in Center-East Tunisia (Photo H. Chikh-Rouhou)

Table 1. Details of *Citrullus* spp. landraces in the Research Centre on Horticulture and Organic Agriculture (CRRHAB), Tunisia, collection.

Code	*Species*	Flesh color	Weight (kg)	Total soluble solids (°Brix)
P1	*C. lanatus*	Dark red	8.60±1.2	10.10±0.5
P2	*C. lanatus*	Red	4.50±0.5	9.98±0.8
P3	*C. lanatus*	Pinkish-red	5.73±1.2	9.49±0.5
P4	*C. lanatus*	Red	4.63±0.5	9.25±0.3
P5	*C. lanatus*	Dark red	5.80±0.8	9.90±0.5
P6	*C. lanatus*	Dark red	5.70±0.5	8.50±0.4
P7	*C. lanatus*	Dark red	6.60±0.6	8.19±0.4
P8	*C. lanatus*	Red	10.00±1.0	9.50±0.5
P9	*C. lanatus*	Light red	4.70±0.6	9.55±0.4
P10	*C. lanatus*	Dark red	7.75±0.7	9.25±0.5
P11	*C. colocynthis*	White	0.50±0.1	3.00±0.1
P12	*C. lanatus*	Red	3.35±0.2	8.10±0.1
P13	*C. lanatus*	Dark red	4.56±0.3	8.50±0.3
P14	*C. amarus*	Light yellow	6.60±0.5	2.60±0.1
P15	*C. amarus*	Light yellow	5.80±0.5	1.54±0.1