Colegio de Postgraduados

The importance of blackberry (*Rubus* spp.) production in Mexico

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ABSTRACT

Objective: To carry out a bibliographic review about the current situation of the commercial production and the generation of blackberry varieties in Mexico.

Approach: Based on the existent databases, a bibliographic review about the current blackberry production, production indicators, and generation of new varieties in Mexico was carried out. Berries have been produced in Mexico since the 19th century. The exportation of this product was a response to the North American market windows and generated new varieties adapted to the Mexican weather conditions. The USA market demands berries mainly in autumn, winter, and spring. During this period, prices are very attractive due to the lack of domestic American production. This situation causes a production increase in the berries sector, where innovative practices have been developed. In Mexico, the first commercial blackberry plantation was established in 1983, in Tetela del Volcán, Morelos. The Boysenberry (a raspberry-blackberry hybrid) was the chosen variety. The Brazos variety was the first blackberry variety that was planted and, in 1998, it was replaced by the Tupi variety, which has an excellent quality and shelf lifespan.

Conclusions: The blackberry productive chain is a source of direct and indirect employment during its production and commercialization. Mexico is one of the main blackberry exporters worldwide. Additionally, blackberry consumption has health benefits, because it prevents the development of several diseases.

Keywords: blackberry, production, varieties.

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INTRODUCTION

Blackberry general characteristics

The species of the genus *Rubus* can adapt to a wide range of environments: from the artic to the tropics, from lower to higher altitudes, from acid to alkaline soils, from dry to humid weather, and from shaded to sunny places (Clark and Finn, 2011; Ibarra-Morales *et al*., 2013). However, they require low temperatures (below 7 °C) to produce shoots, flowers, and fruits (Warmund and Byers, 2002). Blackberries are characterized by their

high morphologic diversity (Clark *et al.*, 2007) which includes creeping, semi-erect, and erect growth species (Clark and Finn, 2008). Their reproduction varies from apomictic reproduction to sexually fertile reproduction. Blackberry species are mostly infertile and the different species intercross; consequently, their taxonomic classification is very difficult or even impossible to carry out (Evans *et al.*, 2007; Marulanda *et al.*, 2010). This situation is mainly the result of the polyploidy, agamospermy, and the frequent inter-species hybridization (Alice, 2002). The flowers and fruits have a panicle or bunch shape (Hummer and Janick, 2007). The flower receptacle has several ovaries, styles and stigmas, and pink or white petals. Flowers with double petals are not common. From the botanical point of view, the blackberry fruits are made up of several drupelets surrounding the receptacle (Clark & Finn, 2011).

Blackberry taxonomy

Blackberries can be taxonomically classified in genus *Rubus*, subgenus *Eubatus*, and family Rosaceae (Thompson, 1997). This family includes approximately 750 species worldwide. *Rubus* is the genus with the highest number of species within the family Rosaceae (Potter *et al.*, 2007; Juinn-Yih and Jer-Ming, 2009). The genus *Rubus* has 12 subgenuses. The raspberry species (*Rubus idaeus* L.) belong to the subgenus *Idaeobatus* and the blackberries (*Rubus* spp.) to the subgenus *Eubatus* (Jennings, 1998). According to Rzedowsky and Calderón de Rzedowsky (2005), 61 species of the genus *Rubus* are distributed in Mexico. Rodríguez-Bautista *et al.* (2021) studied the distribution of 45 wild species of *Rubus* (subgenus *Eubatus*) in Mexico and they also described their ecoclimatic characterization.

Raspberry and blackberry have different morphologic features. The criteria commonly used to classify them consists of cutting the ripe fruits from the plant during harvest. The raspberry fruit is an aggregate of small drupelets that are separated from the receptacle. Meanwhile, the drupelets of the blackberry are attached to the receptacle, which is an edible part of the fruit (Clark and Finn, 2011).

Polyploidy has been fundamental for the species evolution of the genus *Rubus*. Regarding blackberries, the ploidy varies from diploid (2n=14) to dodecaploid (2n=126), including uneven ploidy and aneuploids (Thompson, 1997; Meng and Finn, 1999). Meanwhile, most of the raspberry species are diploid plants (Moore and Skirvin, 1990). The chromosome of blackberries is 1-3 μm long and the DNA content of the diploid species ranges from 0.56 to 0.59 pg (Meng and Finn, 2002).

Origin of the blackberries

Blackberries have been part of the human diet since ancient times (Clark *et al.*, 2007). Already in the 4th century BC, blackberries were eaten as fresh fruit and drank in traditional beverages in Rome. Blackberry leaves were also prepared as tea with medicinal purposes (Patel *et al.*, 2004). Blackberries were domesticated in the 17th century and the first varieties were developed in the 19th and 20th centuries (Galleta and Violette, 1989).

Blackberry varieties grown around the world come from the *Rubus occidentalis* Focke species or from hybrids created from *Rubus idaeus* (Ryabova, 2007). For instance, *Rubus* *parviflorus* Nutt. and *Rubus odoratus* L. (Graham and Jennings, 2009) and *Rubus idaeus*, and *Rubus crataegifolius* Bunge (Briggs *et al*., 1982) are used as source of resistance against pests. *R. crataegifolius* Bunge, *R. palmatus* Thunb, and *R. lambertianus* Hemsley are used to increase the polyphenol content and the antioxidant activity in raspberry varieties (Shigyo *et al*., 2013). Other significant species for genetic improvement include: *Rubus allegheniensis* Porter, *R. arguti* Weber, *R. caesius* L., *R. canadensis* L., *R. flagellaris* Willd, *R. ursini* Cham, *R. vera-crucis* Rydb, *R. idaeobatus*, and *R. lampobatus* (Clark *et al*., 2007; Finn, 2008).

Some wild blackberry species are used as commercial crops in different areas of the world: *Rubus glaucus* Benth (South America) (Cancino *et al*., 2012); *R. armeniacus* Focke (Europe and the Americas); *R. phoenicolasius* Max, *R. coreanus* Miq, and *R. parvifolius* L. (Asia); and *R. chamaemorus* L. and *R. arcticu* L. (North America) (Finn, 2008). In Mexico, the first commercial blackberry plantation was established in 1983, in Tetela del Volcán, Morelos. The Boysenberry (a raspberry-blackberry hybrid) was the chosen variety. The Brazos variety was the first blackberry variety that was planted and, in 1998, it was replaced by the Tupi variety, which has an excellent quality and shelf lifespan (Clark and Finn, 2011).

Nutritional importance of blackberries

Blackberries are eaten fresh and they are also used to prepare fruit juices and concentrates (Siriwoharn *et al*., 2005). The industrial residues of this products (skin, pulp, and seeds) constitute 4.4-12.2% of the waste resulting from the extraction of the juice. Nevertheless, these residues still have flavonoids, coloring, pectin, and organic acids (Badjakov, 2008; Laroze *et al*., 2010).

Additionally, blackberries have phenolic compounds (*e.g*., anthocyanin, flavonols, chlorogenic acid, and procyanidins), which can provide benefits to human health (Moure *et al*., 2001). Phenols are compounds with potent antioxidant properties and they also remove free radicals protecting major biomolecules against oxidative damage (Who and Consultation, 2003). Several studies have evaluated these compounds in berries (*Rubus*) of different species and varieties (*R*. sp. hyb Marion, *R. laciniatus* Evergreen, *R*. spp. Tupy, and *R. fruticosus*), both as a whole fruit and only its pulp or seeds. These studies have also evaluated several extraction technologies (supercritical carbon oxide extraction, ultrasound-assisted extraction, extraction with pressurized liquids, etc.) in order to retrieve phenols, anthocyanins, fat acids, phytosterols, and tocopherols. These compounds are responsible for antioxidant activity (Siriwoharn and Wrolstad, 2004; Wajs-Bonikowska, 2017). There are less studies about the evaluation of antioxidants in the husks or residues generated by the processing of the berries (Reátegui *et al*., 2014; Da Fonseca-Machado *et al*., 2017; Da Fonseca-Machado *et al*., 2015). Phenolic compounds and dietary fiber are usually studied separately, perhaps as a result of their different chemical structure, physicochemical and biological properties, and metabolic pathways (Saura-Calixto, 2011). However, both are part of vegetable food and are associated with many health benefits. Additionally, they reduce the risk of developing cancer and some chronic diseases (Hooper and Cassidy, 2006; Jaganathan *et al*., 2014). Dietary fiber plays an essential role in intestinal health and it also seems to have a significative association with cholesterolemia and the modification of the glycemic response (Anderson *et al.*, 2009).

Genetic improvement of blackberries in Mexico

Currently, there are 99 varieties registered in the Official Gazette of Plant Breeder's Rights of the Servicio Nacional de Inspección y Certificación de Semillas (2023) in Mexico. Out of this total, 48 varieties come from American companies, followed by 40 varieties from Mexico, 6 from Spain, 2 from Chile, 2 from the UK, and 1 from the Netherlands (SNICS, 2022) (Figure 1).

Importance of blackberry cultivation

The profitability and the interest in consuming food with nutraceutical properties, as well as the potential exportation, have been important factors for the fast growth of the worldwide production and commercialization of berries, including blueberry 8 (*Vaccinum corybosum*), strawberry (*Fragaria*×*anannasa* Duch), raspberry (*Rubus idaeus* L.), and blackberry (*Rubus* spp.) (Carvalho *et al.*, 2010).

Mexico and Papua New Guinea were the two main producers of 2019. The former produced 298,024 t in a 12,900-ha sowing area, obtaining an average yield of 23.1 t per ha; the latter produced 107,642 t in a 21,429-ha sowing area, obtaining an average yield of 5 t per ha. Meanwhile, the USA ranked 8th, with a 28,164-t production sown in 3,439 ha (FAOSTAT, 2022). Guatemala, Colombia, and Mexico produce blackberries from September to December. Therefore, this is an opportunity to supply the American demand for this product, because its domestic production decreases during those months as a result of weather conditions. This situation means that the production could be profitable (Muñoz and Juárez, 1997). The great advantage of Mexico is its production window from November to June. This is a very important period during which most of the producer countries cannot meet the demand. Guatemala is the exception, because its productive window lasts from November to August (Ibarra-Morales *et al.*, 2013).

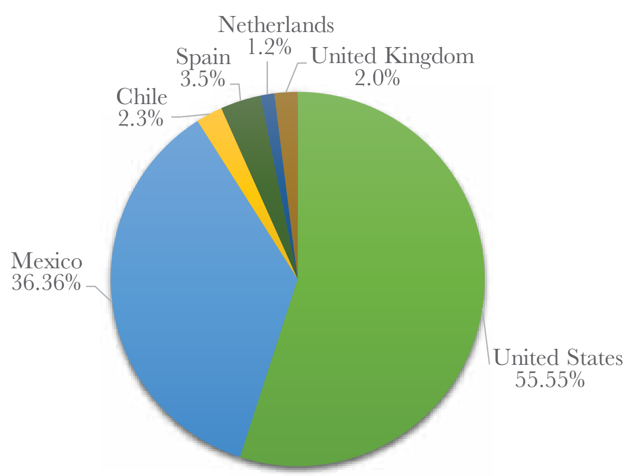

Figure 1. Percentage of participation of the blackberry producer countries in the Official Gazette of Plant Breeder's Right of the Servicio Nacional de Inspección y Certificación de Semillas (2022).

In the first sixteen years of the 21st-century, blackberry production in Mexico had an important and continuous growth: from 1,911.90 ha sowing area in 2000 to 13,081.89 ha in 2016. However, the sowing area decreased to 9,585.16 ha in 2021, obtaining a 212,316-t production and a yield of 22.94 t per ha (Figure 1). Subsequently, the sowing area increased again in 2022 to 222,623.05 t, obtaining an average yield of 23.1 t per ha (SIAP, 2023). The increase in the blackberry Mexican production is mainly the result of the modification of production practices and the introduction of new varieties, whose development does not require cold temperatures (Clark and Finn, 2011). Figure 2 shows an increase in the development of new varieties in Mexico. The domestic production is mainly distributed in the following states: Michoacán, (205,066 t), Jalisco (12,456.11 t), Colima (1,532.58 t), and Baja California (2,462.59 t) (SIAP, 2023).

Exportation and importation

Blackberry cultivation is an important economic source, as a result of the direct and indirect employment generated by its production and commercialization. During the last decade, Mexico was classified as the main worldwide exporter of berries (Sánchez, 2008). In 2014, Mexico exported 123 t of berries, with a value of US$659 million. The main destinations of Mexican berries include: USA, the Netherlands, United Kingdom, Italy, Belgium, France, Canada, Germany, and Chile. Mexico mainly imports frozen fruits (<1,000 t), with an average value of US$3 million (FND, 2015). In 2020, Mexico held the second place (19%) in the blackberry exportation market, only surpassed by Spain (22.54%). Meanwhile, the USA, Canada, and Germany imported 45.85%, 9.66%, and 9.33%, respectively, of the Mexican production (FAOSTAT, 2022).

On the one hand, these two markets (USA and Canada) are potential sale markets for Mexican producers. Their proximity to Mexico and the already established commercial relationship with both countries will facilitate the transportation of the product. On the other hand, factors such as perishable fruit with a short shelf lifespan and the geographic

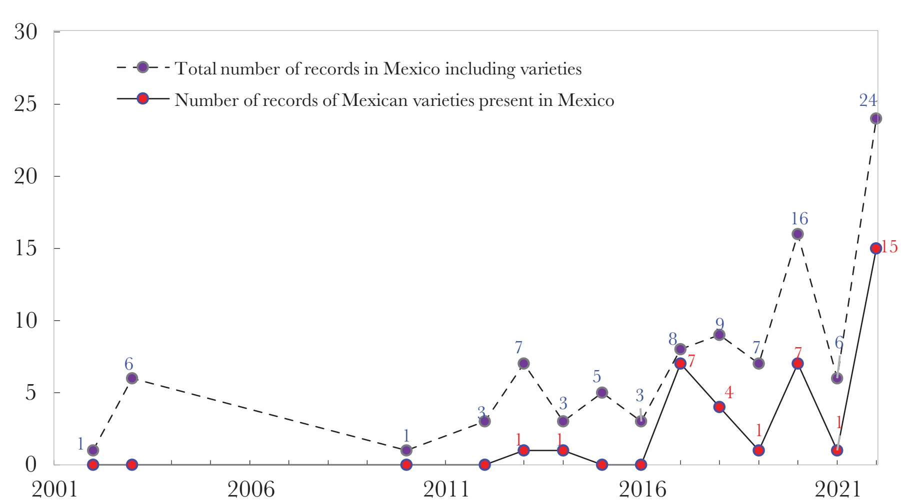

Figure 2. Number of registrations of blackberry varieties in the SNICS per year.

and weather conditions means that Mexican producers play a significant role in the commercialization for these two markets (Ibarra-Morales *et al.*, 2013).

CONCLUSIONS

Blackberry cultivation is an important economic source, as a result of the direct and indirect employment generated by its production and commercialization. Additionally, Mexico is one of the main exporters of blackberry worldwide. Finally, blackberry consumption provides health benefits and prevents the development of metabolic diseases.

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