

# An introduction to Pepino (*Solanum muricatum* Aiton): Review

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**Abstract**— During the past few decades there has been renewed interest in pepino cultivation both in the Andean region and in several other countries, as the pepino is considered a crop with potential for diversification of horticultural production.

It a species of evergreen shrub and vegetative propagated by stem cuttings and esteemed for its edible fruit. Fruits are juicy, scented, mild sweet and colour may be white, cream, yellow, maroon, or purplish, sometimes with purple stripes at maturity, whilst the shape may be spherical, conical, heart-shaped or horn-shaped. Apart from its attractive morphological features, the pepino fruit has been attributed antioxidant, antidiabetic, anti-inflammatory and antitumoral activities. Fruits have been used traditionally as remedy of mellitus diabetic, hypertension and sprue. It has many health benefits including curing diabetes, stroke, high blood pressure, heartburn (indigestion), cancer, kidney, constipation, and haemorrhoids. Pepino represents fruit having high values for antioxidant capacity and may make a significant contribution to antioxidant intake in the diet. Though, an impressive variation of cultivars and cultivated types exists for pepino but its evergreen and easy stem cuttings propagation habits give good scope for its introduction in different suitable parts of the world.

**Keywords**— *Pepino, antioxidant, propagation*

## I. INTRODUCTION

The pepino (*Solanum muricatum* Aiton) is a well-known cultigen of the Andes, with Southern Colombia/Northern Ecuador as the main centre of diversity; this region has been suggested as the centre of origin of the crop (Blanca *et al.*, 2007). Pepinos are described by early Spanish chroniclers as being cultivated on the coast; the Moche Valley in Peru was particularly famous for them. They were a popular decorative motif in Moche art. Its cultivation was important during pre Columbian times, but since the decline of the Inca Empire it increasingly became a neglected crop. However, during the past few decades there has been renewed interest in pepino cultivation both in the Andean region and in several other countries of Central

America, Morocco, Spain, Israel and the highlands of Kenya, as the pepino is considered a crop with potential for diversification of horticultural production (Munoz *et al.*, 2014). In the United States the fruit is known to have been grown in San Diego before 1889 and in Santa Barbara by 1897 but now a days, several hundred hectares of the fruit are grown on a small scale in Hawaii and California. The plant is grown primarily in Chile, New Zealand and Western Australia. In Chile, more than 400 hectares are planted in the Longotoma Valley with an increasing proportion of the harvest being exported. Recently, the pepino has been common in markets in Colombia, Ecuador, Bolivia, Peru and Chile and grown commercially in Ecuador, Peru, and Chile, primarily for export to the USA and Europe. Commercial production has also been attempted in New Zealand, with most exports reaching the Japanese market (Prohens *et al.*, 1996).



Fig.1: Plant of Pepino

The cultivated crop *S. muricatum* Aiton, known as *cachum* or *pepino dulce* ("sweet cucumber" in English), as well as a

dozen or so wild relatives, belong in this section (Child and Lester, 2001). Pepino has been known by its different common names in different languages viz. cachuma in Aymara, xiang gua quie in Chinese; pepino and melonpaere in Danish; pepino, appelmeloen, meloen peer and peermeloen in Dutch; pepino, pepino dulce, melon pear, melon shrub, pear melon, peruvian pepino, tree melon, sweet cucumber, sweet pepino and mellow fruit in English; pepino, melon poire and poire melon in French; pepino and melonenbirne in German; pepino and pera-melone in Italian; pepino in Japanese; pepino doce, pera melao and tomateiro frances in Portuguese; cachum in Quechua and pepino dulce, mataserrano, melon pera, pepino amarillo, pepino de agua, pepino de chupar, pepino de fruta, pepino mango, pepino morado, pepino redondo and pera melon in Spanish.



Fig. 2: Fruits of *S. muricatum*

The pepino fruit resembles a melon (*Cucumis melo*) in color and its flavor recalls a succulent mixture of honeydew and cucumber, thus it is also sometimes called pepino melon or melon pear but pepinos are only very distantly related to melons and pears. It is a ground cover and trailing plant. This species is, however, a close relative of other nightshades cultivated for their fruit, including the tomato and the eggplant, which its own fruit closely resembles.

It a species of evergreen shrub (Fig. 1) and vegetatively propagated by stem cuttings and esteemed for its edible fruit. Fruits are juicy, scented, mild sweet, and colour may be white, cream, yellow, maroon, or purplish, sometimes with purple stripes at maturity, whilst the shape may be spherical, conical, heart-shaped or horn-shaped (Fig. 2). The fruits may be variable in fruit size, shape, and colour (Herrai *et al.*, 2015), but they generally weigh between 80

and 250 g, are round to elongated in shape and have a yellow skin with purple (when immature or ripe) or brown (when fully ripe) longitudinal stripes that cover a variable part of the fruit surface (Levy *et al.*, 2006). The pepino fruits are considered very refreshing, as they have a high moisture content (typically above 90%), and are very aromatic (Rodriguez-Burruezo *et al.*, 2011). An impressive variation of cultivars and cultivated types exists for pepino and contrary to other domesticates, this variation is also matched by a high variation at the molecular level, as demonstrated in studies with DNA markers (Anderson *et al.*, 1996 and Rodriguez-Burruezo *et al.*, 2003).

Most of the cultivated pepino is represented by endangered local cultivars, although there are some modern cultivars, such as 37-A, Valencia, 'El Camino', 'Toma', 'Kawi', 'Sweet Long', 'Sweet Round' or 'Puzol', that have been produced through breeding programmes (Dawes *et al.*, 1984; Ruiz *et al.*, 1997 and Prohens *et al.*, 2002). Unfortunately, Pepino is a new fruit crop for Asian countries and still now there is very limited literature available regarding various aspects that could be useful for different farmers' communities, scientists and students. Therefore, in this review, an attempt has been made to collect and execute some informations regarding this wonderful fruit called Pepino.

## II. DIVERSITY OF PEPINO

William Aiton described the *Solanum muricatum* but pepino as *S. furcatum* was also called by Bertero based on Dunal. Taxonomically, pepino is placed within *Solanum* subgenus *Potatoe* section *Basarthrum* (Correll, 1962; Anderson and Bernardello, 1991 and Anderson *et al.*, 1996). This section, characterized by the basal pedicel articulation (i.e. flowers fall off with pedicels attached, leaving only scars on the inflorescence axis), includes 11 species, the cultivated pepino and 10 wild species distributed through Central and South America. The wild species are characterized by green fruits, 1 to 5 cm in length and typically ovate or round (Fig. 3). Species from *Solanum* section *Basarthrum* are distributed among four series: series *Muricata*, of which pepino (*Solanum muricatum*) is the only member; series *Caripensia*, which includes eight species (*Solanum basendopogon* Bitter, *Solanum caripense* Humb. & Bonpl. ex Dunal, *Solanum cochoae* G. J. Anderson & Bernardello; *Solanum filiforme* Ruiz Lopez & Pavon; *Solanum fraxinifolium* Dunal in DC; *Solanum heiseri* G. J. Anderson; *Solanum tabanoense* Correll and *Solanum trachycarpum* Bitter & Sodiro); series *Suaveolentia*, whose only member is *Solanum suaveolens* Kunth and Bouche;

and series *Canensa*, also with a single species, *Solanum canense* Rydb.



Fig.3: Fruits diversity of Pepino in England

There is no clearly defined wild ancestral form of the pepino (Heiser and Anderson, 1999). However, at least one Andean wild relative of *S. muricatum* is known to be edible, the *cimbalo*, *S. caripense* Dunal, which has edible fruits with an acid-sweet taste (Nuez *et al.*, 1999). The two other wild relatives *S. basendopogon* Bitter and *S. tabanoense* Correll, both of Peru, may also be picked from the wild and consumed. Wild species from *Solanum* section *Basarthurum* represent invaluable genetic resources for pepino breeding. In particular, fertile hybrids with several species of section *Caripensia* are easily obtained and the introgression of genes into the pepino for high sugar content has been carried out via the backcross method. Furthermore, because interspecific somatic hybrids between tomato and pepino have been obtained (Sakamoto and Taguchi, 1991), the genetic resources of the pepino also represent genetic resources that can be useful to improve tomatoes.

### III. HEALTH BENEFITS OF PEPINO

Apart from its attractive morphological features, the pepino fruit has been attributed antioxidant, antidiabetic, anti-inflammatory, and antitumoral activities (Shathish, and Guruvayoorappan, 2014 and Sudha *et al.*, 2011). Fruits have been used traditionally as remedy of mellitus diabetic, hypertension and sprue (Ahmad *et al.*, 2014). It has many health benefits including curing diabetes, stroke, high blood pressure, heartburn (indigestion), cancer, kidney, constipation, and haemorrhoids (Anonim, 2007). Pepino represents fruit having high values for antioxidant capacity

and may make a significant contribution to antioxidant intake in the diet (Chun *et al.*, 2005). It is known that pepino fruits contain significant amounts of vitamin C, as well as carotenoids, which give the yellow colour to the flesh (Hsu *et al.*, 2011). Fruits and leaves of pepino contain alkaloids, flavonoids, and tannins (Saptarini *et al.*, 2011). Phenol and flavonoid are compounds that can counteract the free radicals. The human body has several defence mechanisms against free radicals. The important defence is the enzyme system; called superoxide dismutase (SOD), catalase and glutathione peroxidase (Langseth, 1995). However, the human body requires antioxidant intake to help prevent free radical overload. The highest antioxidant activity of various extracts of fruit in a row is 70% ethanol, 22.11 g / m ethyl acetate, 23.81 mg / ml water, 28.31 ug / ml chloroform, 30, 06 ug / ml petroleum ether and hexane, 38.92 ug / ml (Husnah, 2009). It has been found that the phenolics content of the pepino fruit is much higher than that of vitamin C (Di Scala *et al.*, 2011), indicating that they may have an important role in the pepino's bioactive properties. Regarding the phenolics profile, Hsu *et al.* (2011) using HPLC separation detected some phenolic acids (chlorogenic acid, isomers caffeoylquinic acid, caffeoyl-sinapoyl-quinic acid and 3-caffeoyl-quinic acid) and four flavonoids (myricetin, naringenin, quercetin and rutin) while Wu *et al.* (2013) using LC-TOF-MS methods detected eight hydroxycinnamic acid derivatives (major phenolic compounds) and one flavonoid (isoquercitrin) in the pepino fruit. It has a total phenolic contents 24.68 mg GAE / g and the total flavonoid contents 53.60 mg RE / g, with IC<sub>50</sub> of 0.44 mg / ml (Sudha, *et al.*, 2011a).

### IV. AGRO TECHNIQUES FOR PRODUCTION OF PEPINO

Pepino is a cultivated edible species, while its' wild species called *S. caripense* is occasionally harvested from the wild for its sweet fruits (Rodriguez-Burruezo *et al.*, 2011). The pepino is evolutionarily linked to the tomato (Spooner *et al.*, 1993) and the growing techniques commonly used for tomato can be used for pepino cultivation.

Cultivation of this fruit is possible in temperate conditions (Samuels, 2013) as long as winter protection is provided, or the crop is grown as an annual but pepino needs more time to mature than other widely known Solanaceae vegetable crops, such as the tomato, pepper and eggplant, and in many seasonal climates the summer season is not long enough for this crop; as a consequence, in many cases, pepinos are grown as a greenhouse crop. It is relatively hardy and in its' native range, it grows at altitudes ranging from close to sea

level up to 3,000 m (10,000 ft.). However, it performs best in a warm, relatively frost-free climate. The plant can survive a low temperature of  $-2.5^{\circ}\text{C}$  ( $27$  to  $28^{\circ}\text{F}$ ) if the freeze is not prolonged, though it may drop many of its leaves. The species is a perennial, but its sensitivity to chilling, pests, and diseases force the growers to replant the crop every year. The crop also adapts well to greenhouse cultivation, training the plants up to 2 m tall, and obtaining yields that are 2-3 times larger than those obtained outdoors.

Pepinos' seeds are fertile and produce vigorous offspring which are highly heterozygous and do not breed true but it has to be vegetatively reproduced, either primarily by cuttings (Heiser, 1964 and Anderson, 1979) taken from healthy mother plants or by *in vitro* micro propagation techniques as a consequence, its genetic structure could be different from that of seed-propagated crops. Its' cuttings can establish easily without rooting hormones. It is grown in a manner similar to its relatives such as the tomato, though it grows naturally upright by habit and can thus be cultivated as a free-standing bush, though it is sometimes pruned on trellises. Additionally, supports are sometimes used to keep the weight of the fruit from pulling the plant down. It has luxurious vegetative growth, which may compete with fruit set; it is thus advantageous, especially for greenhouse cultivation, to either prune the plants by removing the lateral side-shoots and training them in a one to several leaders system, or to trellis them between double horizontal wires in a hedge like manner; also, nitrogen fertilization should be limited to avoid excessive vegetative growth. It has a fast growth rate and bears fruit within 4 to 6 months after planting. It is a perennial, but is usually cultivated as an annual. Seedlings are intolerant of weeds, but it can later easily compete with low growing weeds. Like their relatives tomatoes, eggplants, tomatillos and tamarillos, pepinos are extremely attractive to beetles, aphids, white flies and spider mites. Pepinos are tolerant of most soil types, but require constant moisture for good fruit production. Established bushes show some tolerance to drought stress, but this typically affects yield. The plants are parthenocarpic, meaning it needs no pollination to set fruit, though pollination will encourage fruiting. Fruit quality, and especially sugar concentration, is greatly influenced by temperature during ripening; that is, when maximum temperatures during ripening exceed  $30^{\circ}\text{C}$ , a considerable reduction in the sugar content takes place; as a consequence, if premium organoleptic fruit quality is desired, growing cycles for pepinos, either outdoors or in

greenhouses, should be planned to avoid high temperatures during ripening.

## V. CONCLUSION

Fruits have been used traditionally as remedy and has many health benefits including curing various diseases. Moreover, it represents fruit having high values for antioxidant capacity, and contains significant amounts of vitamin C, as well as carotenoids that may make a significant contribution to their intake in the diet. Though, an impressive variation of cultivars and cultivated types exists for pepino but its evergreen and easy stem cuttings propagation habits give good scope for its introduction in different suitable regions of the world.

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