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L. Mashine

Ph.D. Research Scholar,
 Department of Vegetable and
 Spice Crops, Faculty of
 Horticulture, Uttar Banga
 Krishi Viswavidyalaya,
 Pundibari, Cooch Behar,
 West Bengal, India

Jome Rime

Ph.D. Research Scholar,
 Department of Fruit Science,
 College of Horticulture and
 Forestry, CAU, Pasighat,
 Arunachal Pradesh, India

Suchand Datta

Professor, Department of
 Vegetable and Spice Crops,
 Faculty of Horticulture, Uttar
 Banga Krishi Viswavidyalaya,
 Pundibari, West Bengal, India

Sanasam Angousana

Ph.D. Research Scholar,
 Department of Pomology and
 Post Harvest Technology,
 Faculty of Horticulture, Uttar
 Banga Krishi Viswavidyalaya,
 Pundibari, West Bengal, India

Ajoy Guragai

Ph.D. Research Scholar,
 Department of Plantation crops
 and Processing, Faculty of
 Horticulture, Uttar Banga
 Krishi Viswavidyalaya,
 Pundibari, West Bengal, India

Ps. Mariam Anal

Assistant Professor, Department
 of Horticulture, College of
 Agriculture, CAU, Imphal,
 Manipur, India

Corresponding Author:

L Mashine

Ph.D. Research Scholar,
 Department of Vegetable and
 Spice Crops, Faculty of
 Horticulture, Uttar Banga
 Krishi Viswavidyalaya,
 Pundibari, Cooch Behar,
 West Bengal, India

A review on chayote (*Sechium edule* (Jacq.) Swartz): the viviparous cucurbit

L. Mashine, Jome Rime, Suchand Datta, Sanasam Angousana, Ajoy Guragai and Ps. Mariam Anal

Abstract

Sechium edule (Jacq.) Swartz is an underutilized crop under the family of cucurbits. Unlike the other members of the family, it is viviparous in nature which is its unique feature. From immature fruits to young leaves, shoots and tuberous roots almost all the different parts of the crop is consumed. Different dishes are prepared according to the regions and the ethnic groups, and also it is utilized in the food industry especially for the preparation of baby food due to its neutral taste. It is a highly nutritious crop with different bioactive compounds. Some ethnobotanical uses of the crop have been reported by different indigenous groups. For its production, it is traditionally produced in the backyard and empty patches, market gardens and in plantations with the use of seeds or the fruits. And the crop can withstand low temperature; however, the crop will be killed upon prolonged exposure to hard and frost climate.

Keywords: *Sechium edule*, viviparous, nutritional composition, ethnobotanical use

Introduction

The Cucurbitaceae family, predominantly found in the tropics has about 120 genera and 800 species, with few members adapted in the temperate climate. It is one of the largest families among vegetables and fruits, with broad life spectrum, utilized for culinary as well as medicinal since ancient times (Teppner, 2004; Mukherjee *et al.*, 2022) [27, 18]. *Sechium edule* (Jacq.) Swartz is an herbaceous perennial climbing vine under the family of Cucurbitaceae (Fu *et al.*, 2021) [12]. It is a species of cucurbit often neglected and underutilized. Commonly known as chayote, derived from the Aztec word "chayotl" which means "with thorns" (Aung, 1990; Cook, 1901) [2, 8]. Almost all part of the plant is consumed from the immature fruits, young leaves and shoots, tuberous roots. The crop is cultivated in tropical as well as in sub tropical climates (Veigas *et al.*, 2020) [29]. Although, it can withstand cold to some extent prolonged hard and frost climate eventually kill the plants (Cook, 1901) [8].

Botany of Chayote

Chayote is a monoecious, perennial and climbing vine. Unlike other members of the cucurbits family which bears many seeds, chayote bears a single seed per fruit. The crop is also viviparous in nature which is an important characteristic or its unique feature. On emergence of the shoots from the sprouted fruit, it grows for the first few metres quickly, then gradually its growth rate decline. Chayote stem are hollow glabrous and angular-grooved. When the stems are young they are green in colour, upon maturation they turned brownish gray, with a leaf at each knot (Valverde and Saenz 1985; Cook, 1901; Cadena-Iñiguez *et al.*, 2007; Veigas *et al.*, 2020) [28, 8, 6, 29]. The leaves are membranous in texture, palmately three-lobed or angled shape, cordate at the base, and apiculate at the apex. Around 2-5 branched tendrils rise from the points opposite to the leaves along the stem and helps the vine, like almost all cucurbits in climbing (Qui and Liu 2022; Cook, 1901) [23, 8]. Flowers are unisexual and staminate, small in size and yellowish to pale green in colour with inferior ovary (Qiu and Liu, 2022; Vieira *et al.*, 2019; Veigas *et al.*, 2020) [23, 30, 29]. The fruit is a one seeded pepo, greenish to ivory white, roughly pear shaped or globose, with length ranging from 10 to 20 cm. The fruits are fleshy with fleshy-fibrous with a bland taste (Qiu and Liu, 2022; Veigas *et al.*, 2020) [23, 29].

Taxonomical Classification of *Sechium edule* (Veigas *et al.*, 2020) [29]

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida
 Order: Violales
 Family: Cucurbitaceae
 Genus: *Sechium*
 Species: *edule*



Fig 1: Backyard cultivation of Chayote



Fig 2: Shoot of Chayote



Fig 3: Leaf of Chayote



Fig 4: Flowers of Chayote



Fig 5: Chayote fruit

Food use of Chayote

Almost all parts of the plant are reported to be consumed. However, style of preparations varies and they are region specific and according to the taste of a particular ethnic group (Cook, 1901; Coronel *et al.*, 2017) [8, 9]. Tender shoots of the chayote are prepared and eaten like asparagus in Mexico (Cook, 1901) [8]. The fruits are also boiled, baked, stuffed, mashed, fried, scalloped, or pickled, although consumption as a broth is the most common both in the Mexican and Latin American households and restaurants (Booth *et al.*, 1992; Lim, 2012; Coronel *et al.*, 2017) [4, 16, 9]. In Southeastern Asia, the shoots are utilized in the preparation of soups as green vegetable. Chayote fruits with peel after removing the seeds are cut into longitudinal pieces batter dipped and fried. According to the chef creativity, different dishes are prepared to suit the palates of the consumers (Cook, 1901) [8]. In India, different plant parts are cook and use as common vegetables in regions of Eastern Himalayas, Darjeeling district and Tarai and Doars regions of West Bengal, India (Bandyopadhyay *et al.*, 2021) [3]. Matured fruits are consumed with salt and pepper after halving and boiling in Jamaica and also the seeds are fried and roasted and eaten. In Puerto Rico, the halved fruits are parboiled and the flesh is removed, blended and mixed

with different seasonings such as garlic and onion along with meat and vegetables and baked (Cook, 1901) [8]. It is preserved like dill pickles in New Zealand. Meanwhile, in France; fruit is used as artichoke hearts substitute. The roots of the plant are also consumed as tuber and considered as a delicacy in Mexico, Costa Rica and Indonesia. The root tubers are very nutritive, and the tuber starch is easily digestible therefore recommended for infants and paralyzed patients (Coronel *et al.*, 2017) [9].

Chayote is also used in the baby food industry for its neutral taste in the preparation of purees, juices, sauces, pasta dishes and jams. For making stews and desserts, Chayote fruit also served as an alternative ingredient (Coronel *et al.*, 2017; Gajar and Badrie, 2002) [9, 13].

Nutritional composition and ethnobotanical use of Chayote

Schedium edule is a highly nutritive crop including dietary

fiber, essential minerals, vitamins and amino acids, however the nutritional composition is influenced by different factors such as the prevalent climate, geographical region, the plant age and the different processing method used (Vieira *et al.*, 2019, Sakung *et al.*, 2021) [30, 24]. High calorie and carbohydrate content have been reported in the young shoots, root and seeds, along with adequate contents of macro and micronutrient in fruits of chayote. Presence of different bioactive compounds such as flavonoids, and carotenoids such as lutein and β -carotene etc., have been reported (Sood and Rana, 2017; Chang *et al.*, 2021) [25, 7]. The nutritional composition of shoots, leaf and fruits is given in Table 1 along with some bioactive compounds. Traditional use of the crop as herbal remedy has been reported by some communities in some countries (Mexico, Philippines, Indonesia and Brazil). Ethnobotanical use of the crops is given in Table 2.

Table 1: Nutritional composition of Chayote (Booth *et al.*, 1992; Lira-Saade, 1996; Leterme *et al.*, 2006; Sriwachi *et al.*, 2016 and Chang *et al.*, 2021) [4, 17, 15, 26, 7]

Nutritional Constituent	Shoot	Fruit	Leaf
Dry matter	-	9.2%	11.9±0.6 g/100 g
Calorie (kcal)	320/100 g dw	26.0 - 31.0/100 g	-
Carbohydrate	36.60 g/100 g dw	3.5-7.7%	2.1 (raw) g/100 g fw 2.4 (cooked) g/100 g fw
Fibre	19.18±0.49 g/100 g dw	0.4-1.0%	1.1 (raw) g/100 g fw 0.9 (cooked) g/100 g fw
Protein	30.27±0.24 g/100 g dw	0.9-1.1%	3 (raw) g/100 g fw 2.8 (cooked) g/100 g fw
Pectin	-	-	0.4±0.1 g/100 g
Lutein	-	-	7.4±0.6 mg/100 g
β -Carotene	-	-	4.4±0.1 mg/100 g
Retinol Equivalent	-	-	0.32±0.10 mg/100 g
Fat	1.50±0.042 g/100 g dw	0.4-0.6%	0.4 (raw) g/100 g fw 0.4 (Cooked) g/100 g fw
Ash	12.45±0.33 g/100 g dw	776 mg/100 g	1.1 (raw) g/100 g fw 0.4 (Cooked) g/100 g fw
Calcium	438.32±1.15 mg /100 g dw	18 mg/100 g	30 (raw) mg/100 g fw 41 (Cooked) mg/100 g fw
Iron	11.92±0.69 mg/100 g dw	0.33 mg/100 g	2 (raw) mg/100 g fw 1 (Cooked) mg/100 g fw
Phosphorus	-	36 mg/100 g	70 (raw) mg/100 g fw 45 (Cooked) mg/100 g fw
Potassium	-	203 mg/100 g	316 (raw) mg/100 g fw 81 (Cooked) mg/100 g fw
Magnesium	-	21 mg/100 g	26 (raw) mg/100 g fw 16 (Cooked) mg/100 g fw

Note: fw-fresh weight, dw-dry weight

Table 2: Ethnobotanical use of Chayote

Country	Vernacular name	Part use	Used against	Preparation	Administration	References
México	-	Fruit	Diabetics and Kidney problems	Infusion	Oral	Andrade-Cetto, 2009 [1]
Philippines	Sayoti	Fruit	Hypertension and blood vomiting	The skin is removed, sliced and then blended	Drink the juice as needed	Olowa and Demayo, 2015 [20]
Indonesia	Jipang	Leaf	High blood pressure	Cooked	-	Nahdi <i>et al.</i> , 2016 [19]
Mexico	Chayote	fruit	Cholesterol	Decoction	-	Lara Reimers <i>et al.</i> , 2019 [14]
Brazil	Chuchu	Bud and fruits	Hypertension, as sedative	Decoction	-	Di Stasi <i>et al.</i> , 2002 [10]
Mexico	Chayote	Leaves	Cardiovascular	Boiled	Oral	Orozco-Martínez <i>et al.</i> , 2020 [21]

Production of Chayote

Chayote is cultivated traditionally in backyards, empty patches, market gardens and in plantations (Cadena-Iñiguez *et al.*, 2007; Lira-Saade, 1996) ^[6, 17]. The crop can be grown at an altitude ranging from 300 to 2000 m asl. It requires annual precipitation of at least 1500-2000 mm and relative humidity of 80-85% (Lira-Saade, 1996) ^[17]. Temperature between 20 to 25 °C is suitable for its growth. The soil should be well drained, rich in humus and can be grown at soil pH ranging from 4.5 to 6.5 (Cadena-Iñiguez *et al.*, 2007) ^[6]. Propagation is done mostly by use of seeds or the fruits (viviparous) (Veigas *et al.*, 2020) ^[29]. In traditionally producing areas, planting side is prepared by digging a large hole, to allow the roots to grown to their full extent and is usually filled with organic manure. For the plant to climb, frame of branches, wood or some other kind of material is often made nearby. Intensive care is require in the initial weeks of the plant development, and throughout its life cycle proper attention should be given to the roots to avoid any damage (Lira-Saade, 1996) ^[17]. In Mexico, monthly fertilization of macronutrients relations from N170, P46, and K120 to N220, P46 and K240 were applied in acid to slightly acid soils (Cadena-Iñiguez *et al.*, 2007) ^[6]. Harvesting of the fruits can be done 18±2 days after anthesis (Cadena-Iñiguez *et al.*, 2006; Cadena-Iñiguez *et al.*, 2007) ^[6, 7]. It can also be harvested at 45 days after pollination (Piatto, 2002) ^[22]. Fruits are recommended to harvest early in the morning for the tissue to remain turgid at low temperature (Cadena-Iñiguez *et al.*, 2007) ^[6]. More than 300 fruits can be obtained from one plant per year with commercial plantations yielding 22-28 t/ha (Engels and Jeffrey, 1993; Lira-Saade, 1996) ^[11, 17].

Conclusion

Amongst the members of the cucurbitaceae family, chayote (*Schedium edule*) is an undervalued crop. Almost all parts are consumed and the crop ability to withstand low temperature to some extent is important advantage as comparing to other cucurbits. It is prepared by using different methods, it is boiled, baked, stuffed, mashed, fried, scalloped, or pickled etc, or as green vegetable in preparation of soups. It is a highly nutritive crop, which is utilized in the food industry particularly for its bland taste. Ethnobotanical use of the crop as herbal remedy is also reported although as not extensive as those of other different medicinal crops. It has good potential as the crop has not being properly exploited commercially and could be a good source of income to farmers.

Conflict of interest: The Authors declared no conflict of interest.

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