Description of cultivar

Ch'ujuk: clonal variety of 'stevia' as an alternative to the mass cultivation of Morita II for the Tropic of Mexico

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Abstract

The demand for natural sweeteners is increasing in the world, mainly due to the side effects produced by synthetic sweeteners, which has caused several countries to ban their consumption. An example is Japan, which banned the use of synthetic sweeteners since the 1970s and replaced half of its consumption of cane sugar with *Stevia rebaudiana* (Bertoni) Bertoni crystals. Due to the current relevance of *S. rebaudiana*, having materials adapted to the conditions of Mexico is an urgent need for the cultivation to increase in the country. Since 2010, CIRSE-INIFAP has been working with the technological development of this crop and, from 2012, the project to promote innovation with Morita II plots began. Subsequently, INIFAP acquired genetic material from Paraguay, which strengthened its source of genetic variability. This variability has made it possible to establish plots and make an individual selection of those materials that show better agronomic behavior, in such a way that at present there is a new varieagronomic widely superior to creole materials and to the Morita II variety, it has large leaves abundant, and highly branched stem. It blooms evenly, which facilitates cutting at the most opportune moment (when the first flower buds appear). The average yield is 7 to 9 t ha^{-1} $year^{-1}$ with 60 000 plants ha^{-1}.

Keywords: agronomic characterization, Ch'ujuk variety, clone, industrial.

Reception date: November 2020
Acceptance date: December 2020

The genus *Stevia* has more than 250 species in the American continent (Villagómez-Flores *et al*., 2018), from where it originates, but *Stevia rebaudiana* (Bertoni) Bertoni, is the only species with sweetening principles in the leaves (Flores and Lita, 2011). Sweeteners are used as sugar substitutes in treatments against overweight and diabetes, diseases that can lead to the development of multiple diseases, especially of the chronic degenerative type (Velasco and Echavarría, 2011). Due to its content of sweeteners of *S. rebaudiana*, there has been an interest in generating new varieties for commercial planting, many of which have as parents the creole materials of Paraguay, currently it is considered that there are more than 200 varieties of Stevia in the world, but to date none generated in Mexico.

The sowing of 'stevia' in Mexico began with the Morita II variety, a material that was generated in Japan (Martínez-Cruz, 2015), which presents some agronomic problems for its commercial development in the tropics, such as: one stem, with limitations for regrowth so it is only feasible to sustain it for a year, susceptible to camping and difficulty in rejuvenation, in addition to being very susceptible to *Fusarium*, causing the loss of between 20 to 30% of the population planted with 'stevia', in addition to presenting a greater demand for nutrients than native materials (Jarma, 2008).

On the other hand, according to the 2016 National Catalog of Plant Varieties published by SNICS, at that date there was no recommended variety of 'stevia' and according to the Official Gazette of Plant Variety Breeders' Rights published in 2016 by the SNICS, only had a breeder's title granted in 'stevia' to the material AKH L1, which was requested by a North American company (country of origin United States of America) in September 2015 and granted as of April 2016 with the number 1522.

Mexico currently does not have registered 'stevia' materials and it is urgent to have varieties better adapted to their conditions for domestic producers, thereby reducing their production cost and avoiding dependence on abroad, also with the possibility of improving yield and increasing the cultivation area

Origin

Stevia rebaudiana for research purposes was introduced in Mexico in 2010, the work mainly focused on determining the adaptation of the crop when realizing the productive potential of *S. rebaudiana* under irrigation conditions and validating some technological components such as: population densities, weed and disease control, in addition to determining the concentration of glycosides in leaves (Ramírez-Jaramillo *et al*., 2011a).

The selection work began on the variety in 2012, the year in which we worked with genetic materials of 'stevia', in the project to promote innovation we worked on the production of 'stevia' seedlings in 2015 and 2016 the material continued to be evaluated in the project for the genetic improvement of the *S. rebaudiana* crop to obtain Mexican clonal varieties and in 2017, in the project for characterization of genetic materials of *S. rebaudiana*, the last agronomic tests of the variety were carried out.

The first varieties tested at an experimental level in Mexico were Morita II due to its high content of Rebaudioside-A and its tolerance to Septoria and the creole material from Paraguay, due to its variability and greater availability of Stevioside. The studies carried out indicated that the content of Rebaudioside-A in Morita II presented concentrations that were from 7 to 13% of Rebaudioside-A and of Stevioside from 1.2 to 5%, in the case of creole materials in addition to presenting a great variability, the content of Stevioside was higher than that of Rebaudioside A, therefore, with a less sweet taste (Ramírez *et al*., 2011b).

Due to these results, selection works were carried out among the creole materials and currently the CIRSE has a group of outstanding clonal materials of *S. rebaudiana*. Of a total of 20 materials, two of them have phenological advantages suitable for the region such as: better plant height, leaves larger than Morita II, multi-stem, possibility of harvesting up to 6 times against the three or four of Morita II, being the best of the clonal varieties, the Ch'ujuk.

Plant height

Ch'ujuk is a clonal variety with an intermediate cycle (80 to 100 days), whose plant is semi-decumbent; that is, from 10 to 70% of the stems are in contact with the ground, with respect to the height present an average of 60 cm and the Morita II of 45 cm (Figure 1). Regarding its resistance to lodging, it shows resistance above all because it is multi stem and with abundant roots in relation to Morita II, which is one stem and with scarce root development, which makes it more susceptible to lodging and to the damage of fungi present in the soil.

Figure 1. The Ch'ujuk variety (left side), was up to 20 cm taller than Morita II (right side of the photo).

Stem type and its characteristics

It presented up to eight primary stems while Morita II only presented three, with regard to secondary stems, the Ch'ujuk clone is highly branched compared to Morita II, which presented little branched stems (Figure 2). The stem diameter was 15.9 mm compared to 8.39 in Morita II, in the case of the length of the internodes it is greater in Morita II with 8 cm against 7 cm of the clone.

Figure 2. Ch'ujuk variety has 6 cm long leaves, is multi-stemmed and with abundant roots.

Leaf type and its characteristics

An important factor in the performance of the 'stevia' crop is the leaves. The length of the leaf of the clonal variety Ch'ujuk is 6 cm, standing out in relation to Morita II with 4.5 cm. Regarding the width of the leaf, Ch'ujuk is 3 cm and Morita II is 1.5 cm, with petioles in both cases considered sessile, the margins of the leaves in the clonal variety Ch'ujuk are crenate, while in the case of Morita II it is serrated and the number of teeth in the margin of the blade is 12 and 18 respectively. The position of the leaves on the main stem is opposite in all three cases.

Color of the inflorescence of the clonal variety Ch'ujuk. The color of the inflorescence is white (Figure 3).

Figure 3. The color of the inflorescence in the clonal variety Ch'ujuk was white.

Crop cycle of the clonal variety Ch'ujuk

In the case of the cultivation cycle, the clonal variety has a short cycle (80 to 100 days), while Morita II has an intermediate cycle (100 to 130 days). The above allows up to six cuts per year to the clonal variety.

Sanitary behavior

In the case of the Ch'ujuk clone, it shows a moderate resistance to *Rhizoctonia solani*, *Fusarium* sp. and *Sclerotium rolfsii*, but not in the case of Morita II, which is moderately susceptible, as regards *Alternaria* sp., *Septoria* sp. and *Cercospora* sp.

Industrial aspects

The concentration of the main glycosides is 6.78 g 100 g^{-1} of Stevioside leaf dry, 7.46 g per 100 g of Rebaudioside-A leaf dry and Rebaudioside-C 2.14 g 100 g^{-1} of dry leaf, contrary to Morita II content, which has 3.97 g 100 g^{-1} of Stevioside leaf dry, 14.5 g 100 g^{-1} of Rebaudioside-A leaf dry and 2.24 g per 100 g of Rebaudioside-C leaf dry.

Yield

The potential yield evaluated was 9.67 t ha^{-1} $year^{-1}$ of dry leaf, which represents a content of Rebaudioside-A of 0.73 t, of Stevioside 0.65 t and Rebaudioside-C 0.2 t (Figure 4).

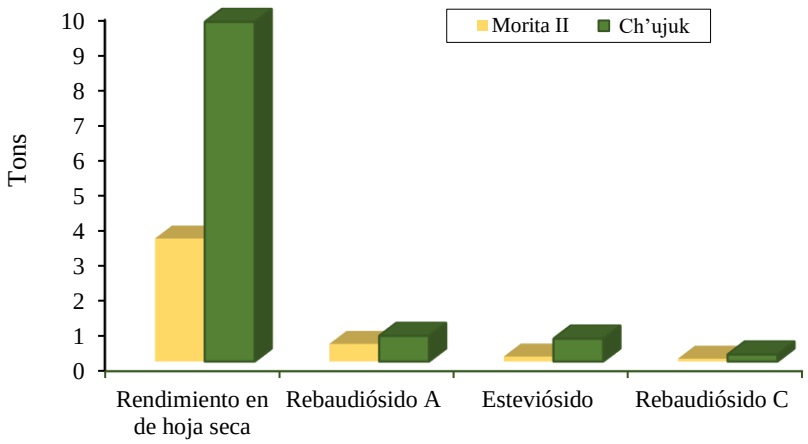

Figure 4. Yield in t ha^{-1} $year^{-1}$ of dry leaf and of three of the main steviol glycosides in Morita II and the clonal variety Ch'ujuk.

Conclusions

The clonal variety Ch'ujuk is a material that has a higher yield potential than Morita II, due to its more appropriate agronomic characteristics such as: plant height, number of stems, types of leaves and tolerance to diseases. The yield obtained was 9.67 t ha^{-1} $year^{-1}$, which was more than twice the recorded yield of Morita II (3.5 t ha^{-1} $year^{-1}$).

Regarding glycoside content, Morita II presented a high concentration of Rebaudioside A, which was expected; however, the clonal variety Ch'ujuk presented an adequate balance between the contents of Stevioside and Rebaudioside-A, making it attractive for the sweetener industry and for direct consumption for health purposes.

The new Ch'ujuk variety is recommended for the states of the Yucatán Península: Campeche, Quintana Roo and Yucatan, and potentially in other states of the Mexican tropics such as: Nayarit, Michoacán, Jalisco, Guerrero, Oaxaca, Chiapas, Veracruz, Tabasco, Campeche, Quintana Roo, Yucatan. The disposition of cuttings for commercial plantings of the clonal variety Ch'ujuk, can be acquired at the National Institute of Forestry, Agricultural and Livestock Research (INIFAP)-Campo Experimental Mococha.

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