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POTENTIALITIES OF THE KIWUANO (*CUCUMIS METULIFERUS* E.MEY), FOR SUSTAINABLE FOOD PRODUCTION IN CUBA

POTENCIALIDADES DEL KIWUANO (*CUCUMIS METULIFERUS* E.MEY), PARA LA PRODUCCIÓN SOSTENIBLE DE ALIMENTOS EN CUBA

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Summary

The research was carried out on the La Ceiba farm located in the La Lisa municipality, Havana province. With the objective of studying the productive behavior of Kiwuano (*Cucumis metuliferus* E.Mey) in winter and spring during two seasons (2021 to 2022). For the study, four plots of 60 m2 were used in both campaigns (cold and spring), the planting distance used was (1.50 m x 1m), for a density of 6666 plants per hectare, 10 plants per plot were marked for the evaluations. . The sowing was done on October 15 (cold campaign and spring June 6), the positions were produced in seedbeds and were transplanted after 30 days when they reached a height of 9 to 12cm and 2 to 3 true leaves. The variables studied were (number of fruits per plant, equatorial diameter of the fruits, length of the fruits, fruit mass and yield in tons per hectare), in addition the quality of the fruit was evaluated. The results show that spring sowing increases yields by 68% compared to winter sowing. The physical - chemical evaluations are in correspondence with the sensory analyzes with the overall quality being good, the fruit was evaluated by consumers as the last link in the productive chain, the values of mass loss due to physiological activity were low and the fruits maintained their firmness. showing good quality during shelf life.

Keywords: Production, sustainable, Kiwuan

Resumen

La investigación se realizó en la finca La Ceiba ubicada en el municipio La Lisa, provincia La Habana. Con el objetivo de estudiar el comportamiento productivo del Kiwuano (*Cucumis metuliferus* E.Mey) en época de invierno y primavera durante dos campaña (2021 a 2022). Para el estudio se utilizaron cuatro parcelas de 60 m^2 en ambas campañas (frio y primavera), la distancia de plantación empleada fue de (1.50 m x 1m), para una densidad de 6666 plantas por hectárea, se marcaron 10 plantas por parcelas para las evaluaciones. Las siembras se realizaron el 15 de octubre (campaña de frio y 6 de junio primavera), las posturas se produjeron en semilleros y fueron trasplantadas a los 30 días cuando alcanzaron una altura de 9 a 12cm y de 2 a 3 hojas verdaderas. Las variables estudiadas fueron (número de frutos por plantas, diámetro ecuatorial de los frutos, longitud de los frutos, masa del fruto y rendimiento en toneladas por hectárea), además se evaluó la calidad del fruto. Los resultados muestran que la siembra en primavera incrementa los rendimientos en un 68% con relación a la de invierno. Las evaluaciones físico - química están en correspondencia con los análisis sensoriales siendo la calidad global buena, la fruta fue evaluada por los consumidores como último eslabón de la cadena productiva, los valores de pérdida de masa por actividad fisiológica fueron bajos así los frutos mantuvieron la firmeza mostrando buena calidad durante la vida de anaquel.

Palabras clave: producción, sostenible, kiwuano

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Introduction

Cucumis metuliferus is found naturally throughout sub-Saharan tropical and subtropical regions of Africa, from Senegal to Somalia and South Africa, with some sources considering the Kalahari Desert as the specific area of origin. The first commercial plantations were established in New Zealand, where it was baptized with the name "kiwano". This country is the largest producer in the world.

The horned melon as it is also known is a warm season product in tropical and subtropical regions and does not tolerate cold conditions, growing at altitudes from near sea level to 1800 m. In southern Africa, seeds germinate with summer rains when night temperatures exceed 12°C. A semi-arid climate with a warm-season rainfall regime appears to improve the fruit ripening stage, allowing fruits to develop all its flavor, the optimal temperatures for its growth and development are between 20 0C and 35 0C.

Kiwano is a fruit especially rich in water, so it is a food with cleansing and diuretic benefits, helping to counteract fluid retention and also eliminate toxins from our body (https://www.blogichef.com/kiwano-properties-and-benefits-of-the-fruit-of-paradise/,2021).

It is also a fruit low in calories and fat, making it ideal for diets. It is also very rich in potassium and sodium, which is why it is recommended for people who suffer from high blood pressure, heart problems, blood vessel conditions and diabetes. It is considered an ornamental fruit, ideal for fruit bowls. Keeping it in a place at room temperature of 16 to 20 °C lasts 6 to 9 months. It also meets all the conditions for export in ventilated containers at controlled temperatures. (https://www.blogichef.com/kiwano-propiedades-y-beneficios-de-la-fruta-del-paraiso/,2021).

Materials and Methods

Field experiments were carried out at the La Ceiba Farm owned by the producer Enerledis Fito Duvergel belonging to the Orlando López CCS of the La Lisa Municipality, Havana province, supported on a Red Ferralitic soil - Typical eutric (Hernández et al., 2015), with the purpose of studying the productive behavior of Kiwuano (*Cucumis metuliferus* E.Mey) in winter and spring during two seasons (2021 to 2022).

Four plots of 60 m2 were used in both campaigns (cold and spring), the planting distance used was (1.50 m x 1m), for a density of 6666 plants per hectare, 10 plants per plot were marked for evaluations. For sowing, the seedlings were produced one month in advance in seedbeds using plastic cups. After 30 days, the seedlings were transplanted, having a height of 9 to 12 cm and 2 to 3 true leaves. The sowing was carried out on the 15th. October (cold campaign and June 6 spring) during the two years of study.

The behavior of the climatic variables during the development of the experiments is shown in table 1.

The following variables were studied:

- Number of fruits per plant (the four harvests per experiment were averaged)
- Equatorial diameter (cm): measurements were made at the time of harvest, a Vernier caliper (vernier caliper) was used. The value of the selected fruits was recorded (20 fruits per harvest).
- Fruit length (cm) The value of the selected fruits was recorded (20 fruits per harvest).
- Fruit mass in (g): a SARTORIUS digital scale was used at the time of harvesting.

TABLE 1. Behavior of the climatic variables during the experiment.

Months	Year- 2021			Year -2022		
	Temperatures Average (ºC)	Precipitation (mm)	H R (%)	Temperatures Average (ºC)	Precipitation (mm)	H R (%)
1	21,3	21,6	77	21,2	11	76
2	23,7	1,3	68	23,1	81,5	73
3	23,8	59,4	69	24,1	105,2	72
4	25,5	121,5	72	25	233,5	79
5	26,6	661,8	83	25,7	406,8	84
6	26,2	176,9	81	25,9	203,3	82
7	27,2	244,3	81	27,1	398,7	83
8	27,1	283,5	83	26,7	408,3	86
9	26,3	179,3	83	26,2	14,3	80
10	25,7	25,2	81	24,7	95,1	83
11	22,8	30,1	79	25	18,2	78
12	23,1	63,3	78	22,7	1,2	74

Archive Data (ISMET, 2023).

- Performance in t. ha-1: (average of the four crops).

A sample was sent to the IIH laboratory "Liliana Dimitrova", located in the municipality of Quivican in the south of the Mayabeque province, they were benefited by carrying out the following evaluations

1. Postharvest Quality

- Fruit mass (g): Fruit mass was measured on a Sartorius BP 4100 digital scale (Edgwood, NY); from the beginning of the experiment each fruit was weighed separately.
- Firmness (Kg). It was determined with a penetrometer (BERTUZZI model), with a cylindrical prop, placed horizontally and with a penetration of 8 mm, the action was carried out in the equatorial zone of the fruit. The values obtained are presented as the force in kg necessary to penetrate the tissue. IIHLD (2020)
- Fruit length (cm): Measurements were made with the help of a graduated ruler and the values were expressed in centimeters.
- Width of the fruit (cm): The measurements were made with the help of a caliper and the values were expressed in centimeters.

2. Bromatological analysis

To carry out the bromatological studies, a sample of five fruits was taken, which were homogenized in a blender for five minutes, performing the following evaluations:

- Determination of SS °Brix: It was carried out by refractometry, according to NC ISO (ISO 2173: 1978. IDT) 2001, placing one or two drops of the sample in the prism of the refractometer and then reading the temperature at the one in which it was carried out. The results were expressed as °Brix.
- Total soluble solids (°Brix.) = Reading + correction for temperature.
- pH index: The pH was determined with a pH meter, previously calibrated, according to NC ISO 1842: 2001 with precision 0.1 and subsequently pH values were read expressed as hydrogen ions.

3. Shelf life

The fruits were preserved at temperatures between 18.6°C - 25.5°C, relative humidity of 59.6% - 83.8% and CO2 621ppm, the evaluations were carried out at the beginning, 4, 7, 13 and 18 days of shelf life.

The mass loss due to physiological activity was determined as the ratio of mass loss as a function of the initial mass of the fruits and was expressed as a percentage (IIHLD 2001c). A Sartorius BP 4100 digital scale (Edgwood, NY) was used.

The calculations were carried out using the following equation:

$$PMAF = [(Mi - Mf)]/Mi \times 100$$

Where:

PMAF: Mass loss due to physiological activity (%)

Mi: Initial mass of the fruit at the time of harvest (g).

Mf: Final mass of the fruit (corresponding to the mass in each evaluation) (g).

4. Sensory evaluation

The sensory analyzes were carried out taking into account the quality from the consumer, for this purpose untrained tasters were used who evaluated the sensory quality of the samples using the general impression method (Duarte, 2013) describing the following characteristics: external and internal appearance, firmness to the touch, smell, acidity and flavor issuing a global quality opinion on a 5-point scale: 5-excellent, 4-good, 3-acceptable, 2-insufficient, 1-terrible (Duarte, 2013).

For the statistical processing of the information, analysis of Simple classification variance. The means were compared using the Tukey test at 5% probability where necessary.

Results and Discussion

As can be seen in table number one, the highest values in the yield components occurred in the spring season (planting in June) with values of 23.5 fruits x plants; average mass of the fruits 202 g, length of the fruits 9.60cm and 6.82cm in diameter. These values resulted in yields increasing by 68% in the spring campaign in relation to the winter campaign.

These results are given because in that period the behavior of the temperatures was (26 to 270c), being more favorable for the growth and development of the African or horned cucumber plants, also helped by more numerous rains combining a warm humid period which which is ideal for the Kiwuan.

These results confirm the hypothesis that the horned melon as it is also known is a warm season product in tropical and subtropical regions and does not tolerate cold conditions, growing at altitudes from near sea level to 1800 m. In southern Africa, seeds germinate with summer rains when night temperatures exceed 12°C. A semi-arid climate with a warm-season rainfall regime appears to improve the fruit ripening stage, allowing fruits to develop all its flavor, the optimal temperatures for its growth and development are between 20 0C and 35 0C (Kiwuano technical guide, 2021).

Table 2 shows the results of the characterization of the Kiwuano fruits. In relation to their weight, adequate values of 203.77g were reached, which corresponds to what is stated in the literature, which ranges between 160-200 grams. The fruits showed good firmness 12.8 kg,

TABLE 1. Productive behavior of the Kiwuan in the different planting seasons (average of 2 years 2021-2022).

Treatments	Fruits x plant	Fruit mass (g)	Fruit length (cm)	Fruit diameter (cm)	Yield t.ha^{-1}
October 15	16.76 b	152 b	6.3 b	4.24 b	19 b
June 6	23.5 a	202 a	9.60 a	6.82 a	31.95 a
C.V %	2.12	5. 45	3.24	2.17	6.37

which is a characteristic attribute of this type of fruit, it has a length of 9.88 cm and 6.14 cm wide, similar in length and greater in width than what was reported. in the literature where it is stated that the fruit has a length of about 10-12 cm by about 6 cm wide.

The soluble solids content is 4.72. O Brix and pH 4.64, although the values obtained could be in correspondence with the characteristic flavor of the fruits as Alarcón (2018) points out, the TSS act as an index of the amount of sugars and increase with the ripening of the same ones. According to Chacón et al, (2020) they state that the percentage of total soluble solids varies in cucumber cultivation between 3.00 and 4.08 °Brix for medium cucumber and between 2.5 and 5.0 °Brix for small cucumber. The results obtained in this research were located within these ranges, taking into account that they are from the same cucurbitaceae family.

The electrical conductivity test indirectly evaluates the degree of structuring of cell membranes, by determining the amount of ions leached in the imbibition solution. The leached ions are inversely proportional to the integrity of the cell membranes. In the evaluation carried out, values of 4.78 were reached.

In the literature, no results were found for electrical conductivity in the crop, however it has been proven that this electrical parameter constitutes an index of maturity in avocado and a "conductivity threshold" has been defined that establishes the limit of the optimal period of conservation at temperatures above the critical one in pear, these results indicate that electrical conductivity is an index of maturity. Lirola (2021), so studies in this sense should continue in the cultivation of kiwuano.

Table 3 shows the results obtained in the study of mass loss due to physiological activity during shelf life in kiwano fruits, increasing as the storage time passes. Logical behavior, since the fruits, once harvested, continue to live, breathe, and various changes occur that determine the decline of internal and external quality, because they only depend on their reserves (Salgado et al., 2017).

The losses were not so high considering that the fruits had been on the shelf for 78 days. According to the literature, they are fruits that can last up to six months of conservation as long as the outer bark is not beaten or damaged and there are no humid environments.

Table 4 shows the results of the sensory evaluation of kiwano fruits, which were accepted by consumers as the last link in the production chain, with an overall evaluation of good, which corresponds to the values determined in the physical evaluations. - chemical described above.

Color is one of the most attractive characteristics of the fruit, since it is the first contact that exists between the consumer and the fruit. Consumers judge their food primarily by appearance, then by texture and flavor.

The refreshing flavor with certain hints of cucumber, melon, perhaps due to the potassium and somewhat acidic content, makes this exotic fruit very little known in our country.

Firmness is the second most important characteristic and is commonly used to indicate the degree of maturity, since the lower the firmness, the greater the maturity and vice versa. (INTAGRI, 2017)

TABLE 2. Postharvest characterization of the kiwano crop produced by the biointensive cultivation method

Weight (g)	Firmness (Kg)	Fruit length (cm)	Fruit width (cm)	ºBrix	pH	CE (*mS*)
203. 77	12.8	9.88	6.14	4.72	4.64	4,78

TABLE 3. Mass loss due to physiological activity during shelf life in kiwano cultivation.

	Days of shelf life			
ESx	4	7	13	18
	1.13^{c}	2.04 ^{c}	4.98^{b}	8.24^{a}
		0.66*		

TABLE 4. Sensory evaluation of kiwano fruits

Attributes	Kiwano
External appearance	Fruit with greenish orange thorn
Internal Appearance	Greenish gelatinous with seeds
Firmness to the touch	Firm
Smell	Cucumber- melon
Acidity	slightly acidic
Flavor	66% Cucumber-melon 33% tasteless
Global Quality	Good

FIGURA 1. External appearance of kiwano fruits and their juice.

Conclusions

Sowing in spring increases yields by 68% compared to winter sowing

The kiwano fruits were characterized by having a length of 9.88 cm and a width of 6.14 cm. The physical-chemical evaluations correspond to the sensory analyzes with the overall quality being good, evaluated by consumers as the last link in the production chain.

The values of mass loss due to physiological activity were low and the fruits maintained their firmness, showing good quality during shelf life.

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