Article

The market for cape gooseberry in Mexico

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Abstract

The cape gooseberry (*Physalis peruviana* L.) is a crop adaptable to adverse climates and prolonged production of fruits with high economic potential. In Mexico, cape gooseberry is not yet cultivated for commercial purposes, due to ignorance of its consumption and profitability. The objective was to analyze the profitability of the cultivation of cape gooseberry in greenhouse and hydroponics and its consumption in Mexico City, to know its commercial potential. Cape gooseberry plants were grown in a greenhouse measuring 10 x 30 m, the inputs and activities of the production and harvesting process were recorded in an Excel spreadsheet (2010), quantified and extrapolated to 1 ha. The production costs and the profitability of the crop were determined based on the internal rate of return (IRR), the net present value (NPV) and the benefit/cost ratio (B/C). The breakeven point in sales was estimated with the total costs and the initial investment. Demand was estimated based on information from 150 surveys conducted in the named markets. El 100 and Medellin, in Mexico City. Tasting tests were carried out on the respondents, considering the taste, smell and color of commercially ripe fruits. The estimated yield was 52.65 Mg ha^{-1} of fresh fruit with calyx, with an investment of $3 664 551 at a sale price of 30.00 $ kg^{-1}, with NPV of $633 071, IRR of 17.24%, and B/C ratio of 1.1. The demand was determined by the price of the fruit, the income and the level of studies of the respondents. Most of that surveyed showed willingness to buy this fruit and recommended its consumption.

Keywords: demand, cape gooseberry, production costs, supply.

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Introduction

In Mexico, per capita fruit consumption is 98 kg per year (López and Alarcón, 2018), so fruit production throughout the year is essential, both for domestic consumption and for exports. According to the Agrifood and Fisheries Information Service (SIAP) (2018), the fruits and vegetables that Mexico exported the most in 2018 were: avocado (48.3%), tomato (24.1%), asparagus (23.9%), cauliflower and broccoli (18%), pepper (17.2%), cucumber (15.6%) and berries (strawberry, blackberry, raspberry and cranberry) (10.6%).

In this sense, the production of fruits and vegetables constitutes an economically viable alternative for family agricultural production systems, above all, of emerging crops such as cape gooseberry (*Physalis peruviana* L.) (Moreno-Miranda *et al*., 2019), the which is a plant of Andean origin and currently cultivated in America, Europe and Asia (Blendlin *et al*., 2015), being the largest producers in the world, Colombia, Perú, Ecuador, Chile and Brazil, where the cape gooseberry occupies an important place in the levels of fruit exports from these countries, which is why they have focused on increasing the area destined for said cultivation (Kretzschmar *et al*., 2012; Fischer *et al*., 2014; Barboza-Arias *et al*., 2018).

In other countries, cape gooseberry has been gradually incorporated to learn about its cultivation and agronomic management, because the plant is characterized by being a shrub, perennial, rustic and widespread, with a production cycle from germination to the first harvest of approximately five months (Lima *et al*., 2009).

Cape gooseberry fruits are round, bright yellow berries with many seeds (150 to 300 seeds per fruit), which take 60 to 80 days to ripen (Fischer *et al*., 2011). These fruits are consumed fresh in sweet and salty salads, or they can be transformed into frozen, dehydrated fruits, puree, pulp, jams, preserves, jellies, sauces, juices and ice creams (Kretzschmar *et al*., 2012; Moreno-Miranda *et al*., 2019).

Several medicinal properties are attributed to its roots, stems and leaves, which is why they are used in the pharmacological industry (Kretzschmar *et al*., 2012; Muniz *et al*., 2014), which has caused an increase in production due to the great interest in its nutritional and industrial properties, becoming an important source for the processing of new functional foods and beverages (Ramadan, 2011).

The cultivation of cape gooseberry adapts easily to various climatic conditions and its production can last for several years (Muniz *et al*., 2011), because its cultivation is perennial in the absence of frost (Singh *et al*., 2012).

There are antecedents that the growth of this species in the greenhouse is more accelerated with respect to its cultivation in the field, caused by the high temperatures that occur within these structures, which favors greater accumulation of biomass in all organs and therefore the increase of the weight of the fruits (Angulo, 2005), said increase allows to achieve competitive advantages in the market (Moreno-Miranda *et al*., 2019), which indicates that the cultivation of cape gooseberry represents an important production alternative with high nutritional value and economic potential (Muniz *et al*., 2014).

However, in Mexico the cultivation of cape gooseberry is little known and there are no intensive or extensive production areas (Aguilar, 2018), it has only begun to cultivate this species for experimental purposes to know the agronomic behavior of some varieties of this crop greenhouse (Mora *et al*., 2006), to study its growth and productive response to different concentrations of nutrient solution (Gastelum *et al*., 2013; Aguilar *et al*., 2018) and to fertilization with ammonium and nitrate in plants obtained by regrowth and seed (Castañeda *et al*., 2013; Antúnez *et al*., 2014; Antúnez *et al*., 2016).

It has also been cultivated with the purpose of knowing its phenology and productive behavior on different sowing dates and potassium and boron supply (Sabino *et al*., 2016; Sabino *et al*., 2018), and to carry out studies aimed at genetic improvement through mutagenesis (Antúnez *et al*., 2017). However, in Mexico there are still no commercialization and profitability studies for this crop.

Although the cape gooseberry is an exotic fruit with a growing international market, commercialization and marketing are the most important problems that the producer faces, governed by market supply and demand (Coral *et al*., 2012), in addition to that it is also essential that producers carry out financial practices, to objectively guide the production and commercialization processes of this crop and be competitive in the market, given current economic trends, challenges and opportunities that arise (Núnez and Monsave, 2012).

Where price variations, disposable income, tastes and preferences of potential consumers are considered (Tomek and Kaiser, 2014), this implies the study of the demand and supply of the cape gooseberry fruit, determined by the factors of the production, reflected in the financial statements and in the parameters of the economic evaluation, such as the net present value (NPV), which indicates the net profit generated by the investment, resulting from subtracting the sum of the discounted flows from the initial investment and whose value must be positive, the internal rate of return (IRR).

What is the discount rate that considers the investment cost with its projected income, if the IRR is less than the discount rate (commercial bank rate) of the project, this is not economically viable, the benefit/cost ratio (B/C), which indicates the net profit generated by each monetary unit invested, whose value must be greater than one (Lima *et al*., 2009; Baca, 2010). The objective of this study was to analyze the profitability of cape gooseberry cultivation in greenhouse and hydroponics and its consumption in Mexico City, to know its commercial potential.

Materials and methods

The cultivation of cape gooseberry genotype Colombia was established in a zenith type greenhouse on July 19, 2013, with an average temperature of 21.6 °C and relative humidity of 72.9%, located in the Postgraduate College, Montecillo, Texcoco, Mexico (Figure 1) (Sabino-Lopez *et al*., 2016). The sowing and agronomic management of the crop, as well as the harvest and the quantification of fruits were carried out based on the methodology described by Sabino-López *et al*. (2018).

Figure 1. Agronomic management of the cape gooseberry (*Physalis peruvinana* L.) crop in a greenhouse, in Montecillo, Texcoco, Mexico.

Then, according to Lima *et al*. (2009); Baca (2010), the total production costs were recorded and determined considering the administration and sales expenses of the production, the inputs and the labor required in each of the activities, from the planting of seedlings, transplantation, irrigation, fertilization, pruning, tutoring, pest and disease control and harvest, previously recorded in an Excel spreadsheet (2010).

The yield of fresh fruit of cape gooseberry (kg ha^{-1}) and the estimated production costs were extrapolated to one hectare. Next, the economic feasibility of the crop was determined, based on the internal rate of return (IRR), the net present value (NPV) and the benefit/cost ratio (B/C), for this the minimum price was considered and maximum sales obtained by 150 surveys carried out in 2015, in the markets called El 100 and Medellin, in Colonia Roma Sur, Cuauhtémoc Delegation, Mexico City, Mexico.

Next, three scenarios were proposed, two of price (minimum and maximum price) and one of production costs. The breakeven point in sales was estimated with the total costs and the initial investment, considering the amortization and depreciation of the goods. With the monthly cash flow, the working capital and the projection of expenses and income from the crop were determined for five years.

An analysis of relative frequencies of the profile of the respondents and of the perception of the fruit was also carried out through tasting tests, based on the taste, smell and color of commercially ripe gooseberry fruits (Figure 2), based on the proposed methodology by Morales (2011). It is worth mentioning that the yield estimate was obtained by adding the accumulated weight of the fruit with calyx, determined with a scale.

To determine the production costs and financial analysis of the cape gooseberry crop, the information obtained from the crop production cycle established in 2013 was used, then the costs and financial analysis were updated to 2019 and extrapolated to 1 ha.

Figure 2. Commercially mature fruit of cape gooseberry (*Physalis peruvinana* L.).

After the evaluation of the crop, the care of it inside the greenhouse and the harvest of fruits lasted until 2015. Finally, the demand estimate was made; through a linear regression model in Excel (2010), considering the information from the surveys and through the study of dependence between dependent and independent variables (Gujarati and Porter, 2010).

Results and discussion

The results obtained in this study indicate that an investment of $3 664 551.00 MXN is required to establish 1 ha of cape gooseberry cultivation, where 86% corresponds to fixed assets, 1% to deferred assets and 13% to working capital, highlighting that the largest item in deferred assets was the cost of the greenhouse, which represented 82% of the initial investment (Table 1).

Table 1. Investment required for one hectare of greenhouse cultivation of cape gooseberry.

Fixed assets	$3 144 500.00
Pumping equipment	$15 000.00
Sprinkler-sprayer	9 500.00
Electrical and hydraulic installations	50 000.00
Greenhouse (irrigation system, ground cover)	3 000 000.00
Well drilling	50 000.00
Computer equipment	15 000.00
Office furniture	5 000.00
Deferred assets	49 000.00
Water analysis	3 000.00
Company constitution	16 000.00

Market study	15 000.00
Development of the project	15 000.00
Working capital	471 051.00
Total	3 664 551.00

Prepared with market information in Mexico as of 2019.

Total costs and income

The results of the surveys indicate that the sale price ranged from $30.00 to $120.00 MXN per kg of fresh fruit, values that are relatively low compared to the prices that this product reaches in the markets of the United States of America (18.51 dollars per kg of fresh fruit) and Europeans (14.27 euros per kg of fresh fruit) (Arias *et al*., 2015), even in Brazil, with R $35.00 ($162.40 MXN) (Lima *et al*., 2009).

On the other hand, of the total operating costs, the fixed costs represented 26.81% and the variables 73.19% (Table 2), the latter decrease in the second year, because from the second year of production the plant is pruned to obtain regrowth plants, taking advantage of the fact that cape gooseberry is a perennial shrub with indeterminate growth (Fisher *et al*., 2014), which favors capital savings in the purchase of seeds, sowing and transplantation in 71.46%, prolonging the crop life for more than 20 years when grown in a greenhouse (Muniz *et al*., 2014).

Table 2. Projection of expenses and income for five years.

Years	Income ($)	Costs ($)		
		of operation	fixed	variables
1	1 579 500.00	857 835.00	230 000.00	627 835.00
2	1 579 500.00	747 835.00	230 000.00	517 835.00
3	1 579 500.00	747 835.00	230 000.00	517 835.00
4	1 579 500.00	747 835.00	230 000.00	517 835.00
5	1 579 500.00	747 835.00	230 000.00	517 835.00

Prepared with data from the production of the greenhouse cape gooseberry crop in Mexico.

In the same context, the production costs calculated in this study, they exceeded by 97.37% the production costs reported by Lima *et al*. (2009) for the establishment of 1 ha of cape gooseberry in the field, in Brazil, with an investment of R 18 114.00 $ ha^{-1} ($98 217.16 MXN). While in Colombia the average production costs amount to 17 848.975 $ ha^{-1} ($99 954.26 MXN) (Coral *et al*., 2012).

For his part, Altamirano (2010) mentioned that in Ecuador the production costs for this crop ranged from 3 000 to 7 000 dollars ha^{-1}, these costs are low with respect to those estimated in the present investigation, due to the cost of the greenhouse, irrigation system and drilling of the well for irrigation water. However, the investment obtained is offset by the production volume and the fresh fruit yield per unit area, which yielded an estimated yield of 52 650 Mg ha^{-1} (Sabino *et al*., 2018),

exceeding that reported in field (14.5 Mg ha^{-1}) in Colombia (Fisher *et al*., 2014), the main world producer, this allows to have a favorable equilibrium point, which indicates that by selling 51.48% of the production during the first year and 42.76% in subsequent years of production projection, the producer recovers his initial investment in four years.

In this regard, Bendlin *et al*. (2015) mentioned that the establishment of the cultivation of cape gooseberry is highly profitable, due to the prices that this fruit can reach, in such a way that with the sales of the first year the investment costs are covered, of which, the costs of operation and maintenance of the crop are the activities that require the most capital. Likewise, it is evident that production costs vary according to the level of technology adopted and the availability of different resources (natural, economic and human) for the establishment of this crop (Lima *et al*., 2009).

Economic evaluation

When proposing the scenarios with the minimum ($30.00 MXN) and maximum ($120.00 MXN) sale price and with the changes in production costs due to inflation (Banco de Mexico, 2019), it was observed that as the price increased, the NPV, the IRR and the B/C ratio also increased (Table 3).

Table 3. Five-year financial indicators under different scenarios of price and production costs per kg of fresh gooseberry fruit.

Projections	Production	IRR	NPV	Price	B/C
	(Mg ha^{-1})	(%)	$		
Scenario with minimum price	52 650	17.24	633 071.00	30.00	1.1
Scenario with maximum price	52 650	88.9	8 646 919.64	120.00	1.61
Production cost increase (4.93%)	52 650	16.1	495 327.00	30.00	1.08

Elaboration with crop production data, surveys and inflation (3.59%) for the year 2019.

The results obtained with the minimum price scenario ($30.00 MXN) were lower than that mentioned by Bendlin *et al*. (2015) for the cultivation of cape gooseberry, who obtained a NPV of R$484 556 ($2 627 344.00 MXN), the IRR of 96.89% and the B/C ratio of 1.68, because these authors made the 10-year projection. However, despite the difference in time, both studies were cost-effective.

Additionally, when considering the higher sale price and comparing it with the minimum price scenario, an increase was observed in all financial indicators. In the same sense, the increase in production costs reflected a decrease in financial indicators with respect to the minimum price scenario. This trend is similar to what happens with these indicators under different scenarios of price or production costs reported in the cultivation of cape gooseberry, in the field, in the country of Chile (Ministerio de Agricultura de Chile, 2010).

Even with price increases and production costs, the project is viable, which confirms the high economic potential of the cape gooseberry cultivation with a marginal profit of up to 95% (Barirega, 2014), influenced by the great adaptability of this crop under very adverse environmental conditions, so it is to be expected that in regions of Mexico with favorable temperature and humidity conditions, high yields and fruit quality can be achieved (Mora *et al*., 2006), coupled with the fact that its production in the same place can last for several years and even more in protected agriculture conditions (Muniz *et al*., 2014).

The foregoing confirms that cape gooseberry presents economic indicators similar to those of other exotic crops in Mexico such as strawberry (*Fragaria sativa*), whose macro-tunnel cultivation presented an IRR of 18%, initial investment of $325 290.00 MXN and the cost benefit ratio of 1.6 (Olmos-Oropeza *et al*., 2015). While the open pit cranberry cultivation has shown better financial indicators, with NPV of 134 321 dollars ($2 686 420.00 MXN), IRR of 25.54% and an initial investment of 47 902 dollars ha^{-1} ($958 040.00 MXN) (Benavides, 2015).

Despite the above, the cultivation of cape gooseberry could be more competitive because it adapts to any climate for its production and on the other hand, when the price in the Mexican markets increases, even more so when the price is $120.00 MXN per kg of fresh fruit; however, its sale will depend on the places where it is marketed and the consumer's demands (Almanza and Fischer, 1993).

Profile of respondents

On the other hand, the age of the respondents ranged from 21 to 78 years old and with various occupations (Figure 3A), whether in the private or public sector, own business and housewives; with various levels of study (Figure 3B), highlighting that the majority have undergraduate studies (58.3%) and few with primary (0.7%).

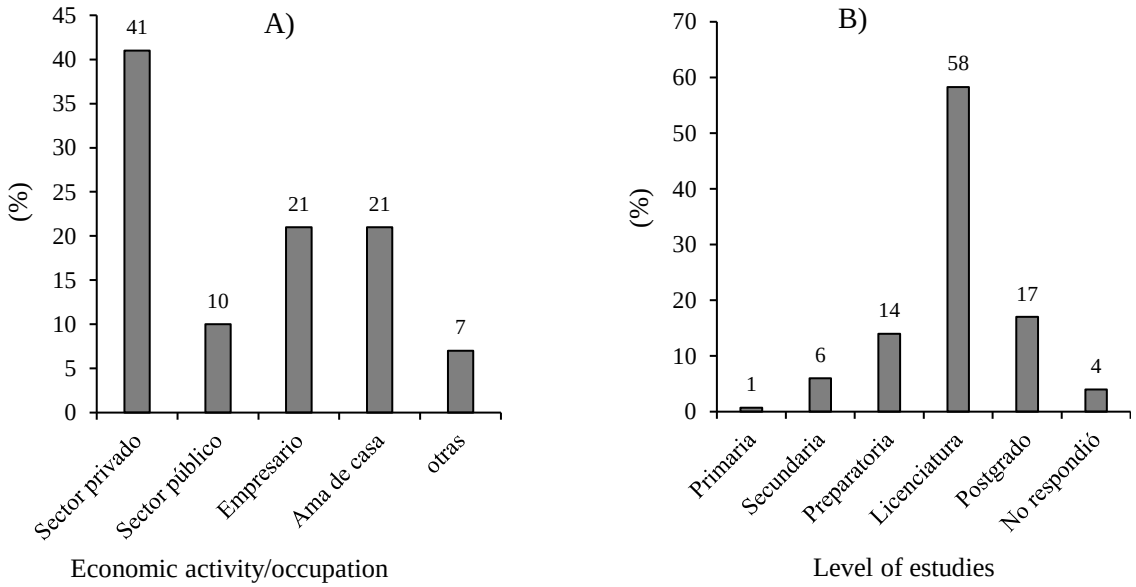

Figure 3. Economic activity/occupation (A) and level of studies (B) of the respondents and possible consumers of cape gooseberry in Mexico City.

In addition to the above, income ranged from $5 000.00 to more than $20 000.00 MXN per month, highlighting that 26% had an income between $5 000.00 and $10 000.00 MXN (Figure 4A). Which shows that in this studied area the purchasing power is moderate, considering that the minimum wage at the date of this study was $88.36 ($2 650.00 per month), this affects the majority of consumers (67.3%) making their shopping in markets or flea markets near their homes (Figure 4B), places where 100% of those surveyed mentioned buying fresh seasonal fruits, highlighting bananas, apples, oranges, papaya, melons, mangoes and grapes and berries, of the latter the most consumed in order of importance were strawberry, cranberry, blackberry and raspberry.

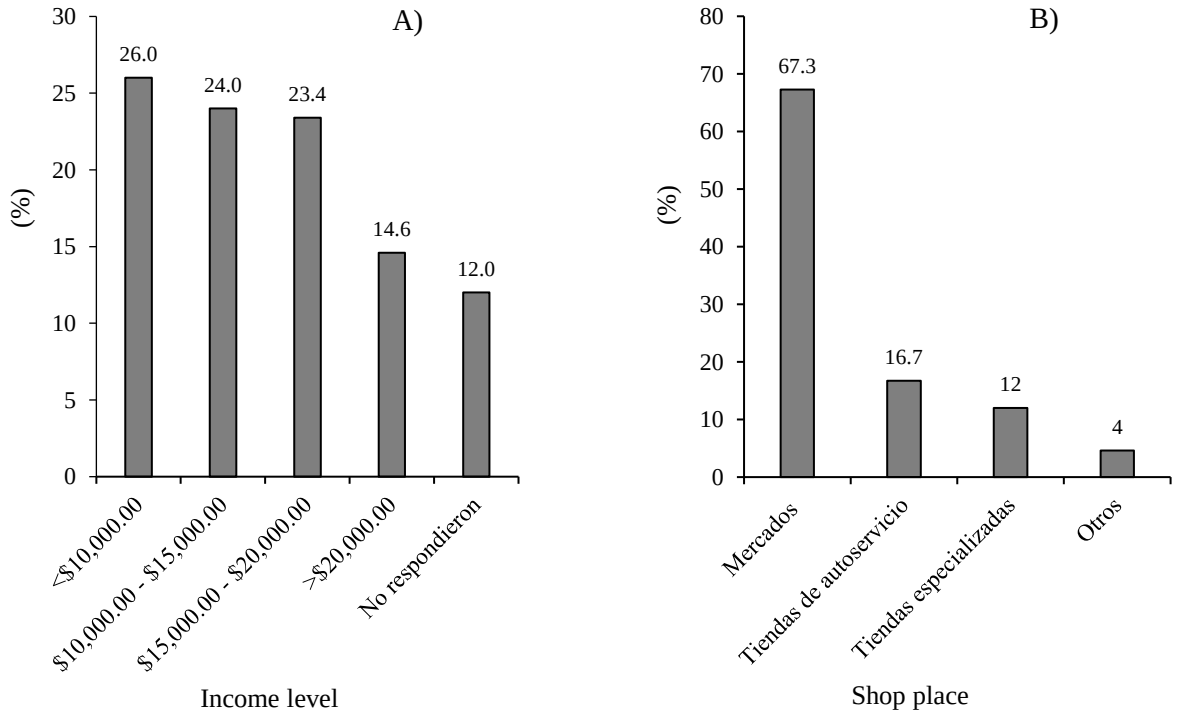

Figure 4. Monthly income (A) and place of purchase (B) of the respondents and possible consumers of gooseberry fruit in Mexico City.

The main reasons the aforementioned fruits are consumed were availability, taste, health, and price. 87% of those surveyed were willing to purchase the cape gooseberry fruit, at a price that ranged from $30.00 to $120.00 MXN, per kg of fresh fruit with calyx, which shows that in Mexico there is a potential demand for this fruit, as has been observed when exploring other markets as reported by Barirega (2014), in a study of the introduction of cape gooseberry in Uganda, where 67% of respondents were interested in the consumption of cape gooseberry, despite being a unknown fruit.

Additionally, it was identified in this study that the marketing channel for the cape gooseberry fruit is the distribution among the 1 420 local markets or tianguis of Mexico City (Secretaria de Desarrollo Economico del Distrito Federal, 2015) and on the other hand , through wholesalers and retailers of commercial stores in the same city, where samples of the product are offered for tasting to customers, with the idea of highlighting the healthy properties due to their content of vitamins and medicinal benefits (Coral *et al*., 2012).

Similar to what happens with other exotic fruits, the introduction of the gooseberry fruit has to do with the commercial strategy that is decided to implement, if it is not associated from the beginning to a defined commercial chain, the sales opportunity is conditioned to the market fluctuations (Ministerio de Agricultura de Chile, 2010).

In addition to this, the possibility of using the fruit as a raw material for the bakery, confectionery, frozen food, packaging, international and specialty food restaurant industries and in the pharmacological industry can be considered (Ramadan, 2011; Muniz *et al*., 2014).

Tasting tests

On the other hand, the tasting tests of the fruit showed that 18% considered it a sweet fruit, 41% sweet and acid, 18% acid and the rest (23%) tasteless. Regarding the smell of the fruit, 35.2% considered it acceptable and 64.8% considered it a pleasant-smelling fruit. In addition, 71% of the interviewees answered that the fruit of the cape gooseberry has a pleasant and striking color.

These characteristics were important factors for 76% of the respondents to be willing to consume it and 88% of the respondents to recommend the consumption of the cape gooseberry fruit, because the appearance and freshness of the fruit is a crucial factor in the purchase decision (Barbosa-Arias, 2018), which is also linked to the presentation of the product, whether the fruit with calyx or without calyx, the latter in addition to providing conservation, gives it exclusivity, increasing consumer interest (Almanza and Fischer, 1993), this interest may increase as information related to the nutritional and medicinal value of this fruit is available, as well as knowledge about its processing for other forms of consumption, which could increase the promotion of its commercialization (Barbosa-Arias, 2018).

Demand for cape gooseberry fruit

The statistical analysis of the demand for cape gooseberry fruit in the present investigation agrees with the economic theory regarding the signs of the variables studied (Table 4). Based on the *t* statistic, the variable that most influenced the demand for cape gooseberry fruit in the markets of Mexico City was the price per kg of fresh fruit, which indicates that for each additional unit in the price of cape gooseberry, demand decreases 17%, *ceteris paribus*.

Table 4. Estimators of the regression model parameters for the demand for cape gooseberry fruit.

Estimators	Coefficients	Standard error	Statistical t
Interception	1.4534	0.0957	15.1873
Cape gooseberry price	-0.1794	0.0147	-12.1704
Occupation	-0.0389	0.0168	-2.31
Education	0.0018	0.0259	0.0713
Income	0.0022	0.0163	0.1402
Shop place	-0.0451	0.0283	-1.5918

However, it was also observed that as the educational level of the respondents increased, the acceptance of the cape gooseberry fruit, *ceteris paribus*, also increased. Likewise, even when the *t* statistic showed a weak relationship (0.07), there was a significant impact on demand, having, for each additional unit in the level of studies of the people surveyed, the demand increased 0.18%, *ceteris paribus*.

This is due to the fact that, in recent years the trend regarding the consumption of fresh fruits and functional foods has increased, this trend has been observed with the fruit of the cape gooseberry, which is becoming an important crop due to its adaptability and as functional food, thus representing an emerging market of growing economic importance (Ramadan, 2011).

However, it is evident that at the beginning the consumer will show resistance to a new product, but, as consumers are informed about the product, they will include it in their consumption habits (Brambila, 2011), coupled with the fact that the introduction of new products depends on the orientation of the market (Lukas and Fererell, 2000). Despite this, strategies should be explored so that the consumer identifies an additional valuation in the product, which motivates their demand (Coral *et al*., 2012).

It was also had that the income level of the respondents conditioned the decision to purchase the fruit, in such a way that, for each additional unit in income, the demand for cape gooseberry increased 0.22%, *ceteris paribus*, reaffirming that income is decisive in the consumption of a new product (Subin *et al*., 2003), due to the fact that high prices reduce their consumption to a market niche in which only people with greater purchasing power are included (Muniz *et al*., 2011).

In this sense, the potential consumers identified in this study are people who have an interest in nutraceutical foods and a curiosity for exotic and unknown products. In addition, they have the purchasing power to buy this type of fruit, considered as a luxury good and with greater demand in foreign markets with high purchasing power (Rodríguez *et al*., 2013).

However, for the introduction of this fruit in Mexico, a marketing plan is necessary to make it known and implement the desire to purchase in potential consumers (Díaz and del Valle, 2016), based on marketing programs that include tastings, recipes and promotion of scientific research on the benefits and their production process (Núñez and Monsalve, 2012).

In addition, the sale of this product at a minimum price ($30.00 MXN) at harvest peaks would make it more accessible to a wider range of consumers (Muniz *et al*., 2011). According to the regression model, an adjusted determination coefficient (R^2) of 56% was obtained, which meant that the behavior of demand was described with the behavior of the independent variables.

Despite the fact that R^2 is low, in dichotomous response models, R^2 has limited value, since in most practical applications its value is between 20% and 60% (Gujarati and Porter, 2010).

Conclusions

Although the fruit of the cape gooseberry is unknown in Mexico, 76% of those surveyed in the markets of Mexico City are willing to buy this fruit and 88% recommend its consumption, although the price is the determining factor in the purchase decision of this exotic fruit. The economic indicators are favorable for the establishment and production of the hydroponic and greenhouse cultivation of cape gooseberry in Mexico. So, the cape gooseberry represents a new alternative for the diversification of profitable crop production in Mexico.

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