Productive break-even point and marketing margins of the jalapeño peppers producer (*Capsicum annuum* 'jalapeño') in Mexico

Punto de equilibrio productivo y márgenes de comercialización del productor de chile jalapeño (*Capsicum annuum* 'jalapeño') en México

Ponto de equilíbrio produtivo e margens de comercialização do produtor de pimenta jalapeño (*Capsicum annuum* 'jalapeño') no México

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Abstract

Farmers in Mexico are increasingly interested in higher-value alternatives to commodity production. The direct sales channel is a potentially attractive marketing alternative as it offers higher net income to farmers. However, in Mexico, few farmers use direct sales. The objective of this study, was to estimate the productive breakeven point and the marketing margins of the jalapeño pepper production in order to obtain profitability for the producers of this vegetable in Quintana Roo, Mexico. A sampling for finite populations was carried out, and the sample size was 89 producers. Results showed that a minimum of 10,754.5 kg.ha^{-1} is required with a rural sale price no less than 5.6 \$.kg^{-1} of jalapeño pepper (equivalent to \$0.20), to maintain a profitable and sustainable commercial supply of the crop. Producers sold most of their jalapeño production to wholesalers (58.4%), despite results showed the fact, that direct markets are the most profitable marketing channel for farmers of the area. The gross marketing margin was 74.5%, which indicated that, by each peso paid for jalapeño consumers, 74 cents corresponded to the intermediation process, and 25 cents to the producer. The organization of producers is crucial to increase the quality of the product and for a greater presence in the marketing chain.

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Resumen

Los agricultores en México están cada vez más interesados en alternativas de mayor valor para la producción de productos básicos. El canal de venta directa es una alternativa de marketing potencialmente atractiva, ya que ofrece mayores ingresos netos a los agricultores. Sin embargo, en México son pocos los agricultores que utilizan la venta directa. El objetivo de este estudio, consistió en estimar el punto de equilibrio productivo y los márgenes de comercialización de la producción de chile jalapeño con la finalidad de obtener rentabilidad por parte de los productores de esta hortaliza en Quintana Roo, México. Se realizó un muestreo para poblaciones finitas y el tamaño de la muestra fue de 89 productores. Los resultados mostraron que para que el cultivo mantenga una oferta comercial rentable y sostenible, se requiere como mínimo 10.754,5 kg.ha^{-1} a un precio rural de venta no menor a los 5,6 $. kg^{-1} de chile jalapeño (equivalente a 0,20 USD). Los productores vendieron la mayor parte de la producción de jalapeño a los mayoristas (58,4%), a pesar de que los resultados mostraron que los mercados directos son el canal de marketing más rentable para agricultores de la zona. El margen bruto de comercialización se ubicó en 74,5 %, lo que indicó que, por cada peso pagado por los consumidores de jalapeño, 74 centavos correspondieron al proceso de intermediación, y 25 centavos fueron para el productor. Es crucial la organización de los productores para incrementar la calidad del producto y tener mayor presencia en la cadena de comercialización.

Palabras clave: Marketing directo, hortalizas, margen bruto, comercialización.

Resumo

Os agricultores no México estão cada vez mais interessados em alternativas de maior valor para a produção de commodities. O canal de venda direta é uma alternativa de comercialização potencialmente atrativa, pois oferece maior renda líquida aos agricultores. No entanto, no México poucos agricultores usam vendas diretas. O objetivo foi estimar o ponto de equilíbrio produtivo e as margens de comercialização da produção de pimenta jalapeño a fim de obter rentabilidade para os produtores desta hortaliça em Quintana Roo, México. Foi realizada uma amostragem para populações finitas e o tamanho amostral foi de 89 produtores. Os resultados mostraram que para que a cultura mantenha uma oferta comercial rentável e sustentável, é necessário um mínimo de 10.754,5 kg.ha^{-1} a um preço de venda rural não inferior a 5,6 $. kg^{-1} de pimenta jalapeño (equivalente a $0,20). Os produtores venderam a maior parte de sua produção de jalapeño para atacadistas (58,4%), apesar de os resultados mostrarem que os mercados diretos são o canal de comercialização mais lucrativo para os agricultores da região. A margem bruta de comercialização foi de 74,5%, o que indica que, para cada peso pago pelos consumidores de jalapeño, 74 centavos correspondiam ao processo de intermediação e 25 centavos ao produtor. A organização dos produtores é fundamental para aumentar a qualidade do produto e ter maior presença na cadeia de comercialização.

Palavras chave*:* Marketing direto, hortaliças, margem bruta, marketing.

Introduction

In Mexico, the volume of fruit and vegetable production went from 19 million tons per year in 1994 to 37 million tons in 2017 (FAOSTAT, 2018). The main vegetables produced in Mexico in 2020 were red tomato, avocado, white onion, jalapeño pepper, green tomato and pumpkin (SIAP, 2021).

Quintana Roo contributed more than 94,000 tons of diverse agricultural products to the consumption of other states, including corn, sugar cane, grain sorghum, beans, corn, pumpkin, lemon and soybeans (SIAP, 2021).

The state showed a strong tradition for jalapeño peppers cultivation, which means almost 40 years of production (Solis *et al.*, 2007). In 1992, was registered its historical maximum with 26,287 tons of jalapeño pepper in 5,331 hectares. More than 2,000 families in rural areas depend on this crop, generating more than 500,000 wages/crop cycle, positioning itself as the crop with the greatest economic participation in Quintana Roo. However, despite the productive vocation of the state to this vegetable cultivation, at the beginning of 2000, it began to experience a decrease in the planted area and the consequent reduction in production. In 2020, the production of jalapeño in Quintana Roo was 2,174.35 tons, with a yield of 8.82 t.ha^{-1} and a production value of $20,869.83 (SIAP, 2021).

In this sense, it is relevant to consider that both, the reduction of costs and the improvement of production and marketing, among other factors, are vital to maintain the profitability of agricultural operations (Ashby *et al*., 2009). At the same time, the constant changes in the quality of the product demanded by the market have had a considerable impact on the technological and productive gap between the southern producing regions (tropical and seasonal climate) and the central and northern regions of Mexico (temperate climate and irrigation). This last two regions mentioned, have set the quality trends in the current market for jalapeños and other types of chili produced in the country due to their remarkable adaptation to changes, technological level and high competitiveness.

Hence, the challenge for producers in the state of Quintana Roo is to remain competitive in the jalapeño pepper market, then it is key to know the balance point in production and choose the correct channel for the product distribution. In this regard, Espinoza *et al*. (2005) warn about the deficient organization in family production systems, since the producers stop receiving part of the income from the sale by not taking charge of its commercialization. In addition, it implies that low prices are generated at the producer level and high prices for the consumer (Viteri and Zambrano, 2016).

A correct strategy and a marketing channel management can mean the success of a company, regardless of the market in which it operates. However, in Quintana Roo there is a lack of knowledge of the jalapeño marketing systems, specifically the marketing margins and the break-even point.

Caldentey (1992) defines agricultural marketing as the process that takes products from the farm to the consumer; while the market refers to the physical place where transactions between sellers and buyers are carried out. However, to bring products to markets, certain utilities are required (utility of possession, place, time or form) in the marketing process (McCarthy and Perreault, 1994). Intermediaries participate in this process. Intermediation in an economy is necessary so that various goods, after being produced, more easily reach the hands of those who wish to consume them (Belleflamme and Peitz,

2010). Thus, intermediation leads to the participation of agents or actors, and therefore an addition of value to the product.

Recent studies on the process of marketing efficiency between traditional and modern fruit and vegetable supply chains point out, that traditional chains include a longer supply chain, physical losses and lack of integration between producers make them more inefficient than traditional short commercialization chains (Bisen *et al*., 2018). The foregoing is in agreement with a study carried out in California with organic producers, where it was found that a direct sales channel provides producers with greater advantages in relation to the investments made in specific assets (Scalco and Baker, 2019). Similarly, Indhumathi *et al*. (2021) point out, that the cost of marketing is lower in the channel has not market intermediaries; in pepper farms, intermediaries were the main problem that reduced the net income of farmers.

The foregoing causes uncertainty regarding the profitability generated by this activity for each of the agents that participate in the commercialization process. Therefore, the objectives of this research were to estimate the productive breakeven point and analyze the marketing margins of jalapeño pepper production, in order to promote the profitability of producers of this vegetable in Quintana Roo, Mexico.

Materials y methods

Study area Location

The state of Quintana Roo is located in the southwest of the Mexican Republic (19°36'00″N 87°55'00″W) and represents 2.26% of the country's Surface, with a population of 1,501,562 inhabitants. 88% live in urban areas and 12% in rural areas (INEGI, 2019).

Sample selection

The research was carried out between March and December 2020 using the direct survey technique of the agents participating in the commercialization of jalapeño pepper (producer, retailer and wholesaler) with a transverse temporal dimension, that is, data was collected at a single cut in time (Torres *et al.,* 2014).

To determine the sample size of the farmers, it was taken as a basis, the total number of jalapeño pepper producers registered in the records of the State Plant Health Committee (N = 115), then a simple random sampling for finite populations was carried out, resulting in a sample size of 89 producers. This implies a sampling error of 5%, with a confidence level of 95%. (Sánchez-Toledano *et al*., 2013).

The structured questionnaire contained 30 closed-type questions with dichotomous, multiple, and scale responses (Malhotra, 2008). The questions made to the producers allowed to collect information regarding the production process, participating agents, production costs, volumes and current prices. Later it were determine, the marketing margins and the characterization of the production. As part of the activities, prior to the survey application, a pilot tests were carried out to ensure the clarity of the questions and minimize errors (n = 10).

Likewise, to identify the commercialization channels it was followed the direct method, that is, the jalapeño pepper commercialization channel was monitored from the exit of the fresh product from the plot, to the final consumer. This activity was carried out during the sales season, which made it possible to identify the number of participating agents, prices and costs at each stage and the level of commercialization, giving certainty and veracity regardles to the collected information (González *et al*., 2014).

Sixty intermediaries were identified but only 35 were willing to participate in the research. The intermediaries came from different establishments of the supply centers of Quintana Roo, Puebla and the State of Mexico. The validated questionnaire contained the following questions: number of producers to whom purchase jalapeño pepper, frequency of visits to the producer, volume of jalapeño pepper acquired, expenses incurred, distribution of the product, means of conservation and other services provided to producers.

Consumer prices were obtained through direct observation, using convenience sampling, which is used in exploratory studies to have an approximation of the object of study (Grande and Abascal, 2014). Linear tours were carried out in commercial establishments such as supermarkets, medium-sized stores and wheels markets in the state of Quintana Roo, where a total of 41 establishments were visited.

Information analysis

Productive break-even point

First, the production costs were estimated at prices observed in 2020 agricultural year. Based on Ayala *et al.* (2014), the costs were divided into: a) Variable costs (payment for chemical and organic fertilizers, pesticides, fungicides, herbicides, payment for mechanized and manual labor, and harvest) and; b) Fixed costs (general expenses for payment of services and depreciation).

Considering r as the number of jalapeño pepper producers that use i inputs in their production process, the production cost paid by producer r can be calculated as follows:

$$TC_r = \sum_{i=1}^{I} [p_{ri} \times x_{ri}] \quad (1)$$

Where: *TC* is the total cost of production paid by the producer r; p_{ri} is the price of input i paid by producer r; x_{ri} is the amount of input i that producer r buys and uses.

To estimate the income per hectare, the jalapeño sale price in 2020 and the average yield reported by the producers were used, that is,

$$TI_r = p_r \times y_r \quad (2)$$

Where: *TI* is the total income obtained by producer r; p_r is the sale price received by the producer r; and y_r is the yield obtained by producer r.

Subsequently, the break-even point (*B.P.*) was determined, which defines the level where profits equal costs. The equations used to calculate the indicators were the following:

$$B.P.(SL) = \frac{FC}{1} = \left(\frac{VC}{TI}\right) \quad (3)$$

$$Peq = B.P.(SL) / \left(\frac{TI}{US}\right) \quad (4)$$

Where: *B.P.* (*SL*)= Break-even point in sales value; *Peq*= Equilibrium production (t.ha^{-1}); *FC* = Fixed production cost ($.ha^{-1}); *VC* = Variable production cost; *TI* = Total income ($.ha^{-1}); *US* = Units sold (t.ha^{-1}).

Marketing margin

To obtain the absolute (a) and relative (r) marketing margins, it were taken into account, the average purchase and sale prices

of jalapeño pepper from the sample of producers, based on the methodology set forth by Mendoza (1991).

The marketing margins and the direct participation of the producer were estimated as follows:

$$GMM(a) = PC - PP \quad (5)$$

$$GMM(r) = \left(\frac{GMM(a)}{PC}\right) * 100 \quad (6)$$

Where: GMM is gross marketing margin, PC is price paid by the consumer, PP is the producer price.

The direct participation of the producer (DPP) was established as follows:

$$DPP(a) = PC - GMM \quad (7)$$

$$DPP(r) = \left(\frac{DPP(a)}{PC}\right) * 100 \quad (8)$$

Analysis of marketing agents through statistical techniques

The Kolmogorov-Smirnov test was applied, which is a non-parametric test that allows verifying whether or not the sample scores follow a normal distribution (Wayne, 2017). The existence of differences between the means was verified using the Kruskal-Wallis statistic and the next step was to determine where these differences were found, so the Games-Howell test was implemented. The general information was analyzed whith Excel Microsoft 2016 and IBM SPSS 20 softwares.

Results and discussion

Break-even point of jalapeño pepper at Quintana Roo state

The highest proportion of the production costs of jalapeño pepper in Quintana Roo was caused in the harvest process (31.9%), followed by the cost of weed control (23.5%) and fertilization (8.17%) (table 1).

Fixed costs grouped equipment depreciation expenses and service payments. The analysis did not consider the expense of land rent since 73% of the farmers had private property. Given this, the Instituted Trusts in Relation to Agriculture (FIRA, 2007) point out that the rent of land in other crops generated an expense of 49% of the total cost in production units under temporary conditions.

Table 1. Breakdown of average production costs per hectare of jalapeño pepper in Quintana Roo, México, 2020 (n=89).

Variables costs		Fixed costs	
Soil preparation	$2,900.00 ± 353.55	Depreciation	$3,130.00 ± 282.84
Sowing	$3,600.00 ± 282.84	Services	$2,570.00 ± 212.13
Fertilization	$9,400.00 ± 141.42	Total fixed costs	$5,700.00 ± 494.97
Weed control	$13,000.00 ± 282.84		
Control of pests and diseases	$8,605.00 ± 212.13		
Harvest	$17,616.67 ± 70.71		
Total variable costs	$55,121.67 ± 141.42		
Total production costs		$60,821.67 ± 777.81	

Source: own elaboration (2020).

Once the production costs of jalapeño pepper were obtained from the interviewed producers, the productive balance point was determined in 10,754.5 kg.ha^{-1} as the minimum production to maintain a profitable, sustainable commercial offer and benefit to the state producer of jalapeño pepper. The rural sale price must be no less than $5.6 kg, equivalent to 0.28 USD, considering an exchange rate of 19.87 pesos (Banxico, 2020). However, 15.3% of the jalapeño producers in the state sold below that price in the first harvest cut, while in the second and third cut they were 21.1% and 19.2% of the producers, respectively.

These findings show that, throughout the harvest, producers gradually lose the ability to recover the equilibrium price. This reflects the low bargaining power and profitability of state chili production. In this way, if the pertinent measures are not taken, in the long term it can lead to a detriment or abandonment of the activity (Cruz-Bermúdez *et al*., 2021; Iñiguez-Iñiguez *et al*., 2018).

Marketing agents of jalapeño pepper in Quintana Roo

The previous results made it possible to distinguish that the low profitability of the producers is largely associated with the price at which they market their product. However, there are other factors that also affect producers, such as the lack of knowledge about marketing channels, the low value added in the products, incipient organization and limited sales strategies. These elements, either individually or together, have caused the producer to choose to deliver his merchandise to the best bidder; as a consequence, competition increases and prices stabilize, in an agreement between large buyers (Sánchez *et al.,* 2017).

From an economic point of view, these relations are not very favorable for the producers, however the intermediaries have the responsibility of transporting, storing, processing and selling products (Ellis, 1996).

The agents involved in the commercialization process of jalapeño pepper in Quintana Roo are indicated in figure 1. The producers sold most of the jalapeño production to wholesalers (58.4%) and according to the sample, only 10 % of farmers sold directly to consumers.

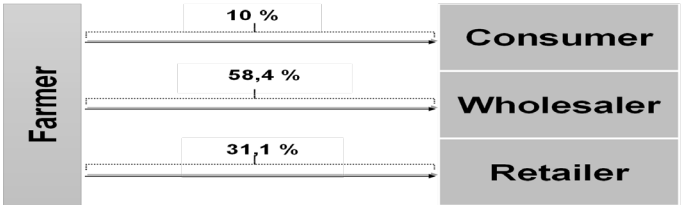

Figure 1. Marketing agents of jalapeño pepper in Quintana Roo.

The majority of the production of jalapeño pepper from Quintana Roo (51.4%) was destined for local and state supply, 30.7% was destined for the state of Puebla and 1.9% was sent to the State of Mexico market. However, it is important to point out that 16% of the producers didn't know that the buyers of the final destination of their products came from the state of the Mexican Republic. This makes it clear that the farmers sold to the buyer who gave the best price without showing any interest in additional information. However, to ensure the sustainability of agriculture in commercial terms, the key lies in making decisions regarding the place where producers by themselves could sell their products if they didn't have any intermediary.

Marketing margin of jalapeño pepper in Quintana Roo

Based on the information collected from the different agents of the agri-food chain, the gross marketing margin was calculated at 74.5%, which indicated that, each peso paid by jalapeño consumers,

74 cents corresponded to the intermediation process, and 25 cents went to the producer; that is, the intermediation process obtains 74% of the final price of the product paid by the consumer, which is equivalent to $31.8 per kg (1.60 USD) (table 2). This value is considerably high in relation to the price paid to the producer, who bears the greatest risk and all production costs.

The direct participation of the jalapeño producer was 25.5% of the price paid by the consumer, which meant that the producer received the equivalent of $8.1 per kg (0.41 USD) from a total of $31.8 per kg, (table 2). The estimated data of the producer's participation in the final price, agrees to a certain extent with reported by the Agrifood and Fisheries Information Service -SIAP (2021) which was 33.1% in Quintana Roo. In general, considering the national territory, the participation of producers in the final price of jalapeño pepper is heterogeneous and can go from 10.3% to 71.4% (SIAP, 2021) depending on the place of production and final destination.

Table 2. Marketing margins (absolute and relative) and producer participation in the final price of jalapeño pepper.

Item	Value ($/kg)	
Producer price	8.1	
Wholeseller price	22.0	
Consumer price	31.8	
	Absolute ($/kg)	*Relative (%)*
Gross sales margin	23.7	74.5
Producer share	8.1	25.5

Source: own elaboration (2020)

Agricultural benefits through different marketing channels

According to the Kolmogorov-Smirnov test, with the Lilliefors significance correction, the asymptotic significance of 0.00, 0.020 and 0.00 was obtained for the price, yield and profit variables, respectively. The Kruskal and Wallis test was applied and it was concluded that there are differences in at least one type of agent (table 3).

Table 3. Test of means differences by Kruskal-Wallis.

	Test statistics[b]		
	Price	Yield	Profit
Kruskal-Wallis H	39.118	16.545	27.884
df	2	2	2
Asymptotic significance	0.00	0.00	0.00

[b]Grouping Variable: Agent Type

Given that, it was accepted that there were differences between means for at least one agent, it were proceeded to verify which groups were found the differences. The Games-Howell post hoc test was chosen, not assuming equal variances to find out which specific means differ from others (table 4).

The results of the Games-Howell post hoc test showed that there are significant differences in all the agents for price variable. Usually, producers sales prices are higher when they sell directly to the consumer, particularly is observed a lower average in the wholesalers. Comparing the prices offered between retailers and wholesalers, it is also observed that they are higher in retailers. Regarding yield, there are no differences between producers who sell to wholesalers and those who sell to retailers. In other words, those producers with lower average returns tend to sell to wholesalers and retailers.

Table 4. Games-Howell Post Hoc test of the variables price, yield and profit for different agents of jalapeño pepper.

Dependent variable	(I) Agent	(J) Agent	Averages differences (I-J)	Estándar desviation	Sig.
Price	Wholeseller	Retailer	-2.22167*	0.21924	0.00
		Consumer	-6.29667*	0.27242	0.00
	Retailer	Wholeseller	2.22167*	0.21924	0.00
		Consumer	-4.07500*	0.25489	0.00
	Consumer	Wholeseller	6.29667*	0.27242	0.00
		Retailer	4.07500*	0.25489	0.00
Yield	Wholeseller	Retailer	-838.333	787.971	0.542
		Consumer	-4430.000*	706.621	0.00
	Retailer	Wholeseller	838.333	787.971	0.542
		Consumer	-3591.667*	659.483	0.00
	Consumer	Wholeseller	4430.000*	706.621	0.00
		Retailer	3591.667*	659.483	0.00
Profit	Wholeseller	Retailer	-12141	5272.666	0.074
		Consumidor	-80089,333*	6185.067	0.00
	Retailer	Wholeseller	12141	5272.666	0.074
		Consumer	-67948.333*	6712.801	0.00
	Consumer	Wholeseller	80089.333*	6185.067	0.00
		Retailer	67948,333*	6712,801	0.00

* The mean difference is significant (P≤0,05).

Regarding the profit variable, there is no statistical difference between producers who sell to wholesalers or retailers. As explained, the price is higher in those producers who sell directly to the consumer, so it was expected that they obtain higher profits on average compared to those who sell to retailers and wholesalers. These results agree with different studies (Pei-An *et al.,* 2017), however, in some farms in Taiwan even though the government promoted direct marketing, wholesale markets were found to be the most profitable marketing channel (Lee *et al*., 2020).

Conclusions

The offer price of the jalapeño pepper must be $5.6 per kg and the economic optimum is reached with a yield of 10,754.5 kg. ha^{-1}. Such amount would make possible to recover the total costs and obtain the maximum profit, but the producers are gradually losing the capacity to recover the equilibrium price since, throughout the harvest up to 21.1% of them sold below that price.

The marketing channel used to bring the product from the production unit is: producer, wholesaler and final consumer. There is a total rupture between the producer and the final consumer, since the proportion of producers that sells directly to consumers is very low. The connection between both agents is the responsibility of the intermediaries. In this way, the producers are subject to the conditions imposed by the marketing agents; that is, they sell to the buyer who offers the best price without additional information such as the final destination of the vegetable.

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The power of the marketing agents is such that three quarters of the final price of the product remains in the intermediary, despite the fact that the producer is the one who assumes the greatest risk and all the production costs. The organization of the producers is crucial to increase the quality of the product and improved the presence in the marketing chain.

The margins found in this research, show the goodness of this activity, however, there is a low bargaining power on the part of the producers, which will prevail as long as production costs do not decrease and they generate market strategies to place the product through different routes or agents.

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