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Business development strategies for Mexican honey with a 2032 perspective: The future of Mexican honey

Jatziri SORIA-ARELLANO[1], Nicolás CALLEJAS-JUÁREZ[2], Luis VELÁZQUEZ[3], Vianey GONZÁLEZ-HERNÁNDEZ[1], Humberto THOMÉ-ORTIZ[1], Nathaniel Alec ROGERS-MONTOYA[4], Francisco Ernesto MARTÍNEZ-CASTAÑEDA[1]*

Abstract

To identify market strategies for Mexico's apiculture sector, this study projects national honey production and the leading producing states through 2032. The states were considered strategic market units, with their positioning and growth stochastically projected over a 10-year period based on their honey production value. From 2023 to 2032, honey production volume is projected to decline. However, in the prospective scenario, the value of honey production is expected to rise, with Yucatán maintaining its position as the leading producer, followed by Chiapas, Jalisco, Campeche, and Oaxaca. Veracruz experienced a significant decline, while Yucatán positioned itself in the cash cow quadrant. Guerrero and Oaxaca showed growth and joined the question mark quadrant, where Quintana Roo remained. Meanwhile, Campeche and Veracruz were placed in the dog quadrant alongside Puebla, Jalisco, and Chiapas, even though Chiapas showed production growth. After analyzing their future performance, distinct market strategies were established for each state.

Keywords: market; prospective; public policy; rural development; sustainability.

Practical Application: This study provides implementable strategies to strengthen Mexico's apiculture sector. Each state's identified market position allows stakeholders to adopt targeted approaches, such as meliponiculture or product diversification, to enhance production and competitiveness. Policymakers can design strategies to regulate species mobility, encourage fair trade, and facilitate traceability systems. Producers can expand markets, forge industry partnerships, and capitalize on by-products for health and industrial sectors, thereby boosting local economies and improving rural livelihoods.

1 INTRODUCTION

Bees are pollinators that greatly contribute to human well-being and the survival of the planet's biodiversity (Sosenski & Dominguez, 2018), playing an essential role in preserving ecosystems and supporting agricultural activities (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019). Pollination, a key ecosystem service, sustains cultivation at both local and global scales (Requier et al., 2023).

By transporting pollen from flower to flower, bees enhance the genetic diversity of fruits and seeds while improving their variety and quality (Krishnan et al., 2020). Pollination can occur through solitary and native bees, as well as assisted pollination with Apis mellifera, a method proven to enhance crop production (Hernández & López Morales, 2016). According to the Ministry of Agriculture and Rural Development of Mexico (Secretaría de Agricultura y Desarrollo Rural [SADER], 2017), 87% of the world's 352,000 flowering plant species depend on bee pollination, and 94% of these species thrive in tropical climates (García García et al., 2016). Additionally, 80% of wild plants and nearly 75% of major food crops depend on animal pollinators, with bees being some of the most frequent crop visitors (Requier et al., 2023; Sosenski & Dominguez, 2018). Consequently, their decline would pose a serious threat to food security. The decline in bee populations has been primarily linked to climate change (Hernández & López Morales, 2016). Their health is also affected by diseases caused by Varroa destructor, small hive beetles, Nosema fungi, Africanization (Baena-Díaz et al., 2022), American foulbrood, and European foulbrood (Ramos Díaz & Pacheco López, 2016). Other key contributors include land use intensification, habitat degradation, biodiversity loss (García García et al., 2016), and exposure to herbicides and pesticides, all of which harm ecosystems and reduce biodiversity (Sosenski & Domínguez, 2018). In addition to their vital role in maintaining ecosystem stability (Food and Agriculture Organization of the United Nations [FAO], 2018), bees provide valuable social and economic benefits, including the production

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[1]*Universidad Autónoma del Estado de México, Instituto de Ciencias Agropecuarias y Rurales, Toluca, State of Mexico, Mexico.*
[2]*Universidad Autónoma de Chihuahua, Facultad de Zootecnia y Ecología, Chihuahua, Mexico.*
[3]*Universidad de Sonora, Departamento de Ingeniería Industrial, Hermosillo, Sonora, Mexico.*
[4]*Universidad Nacional Autónoma de México, Facultad de Medicina Veterinaria y Zootecnia, Mexico City, Mexico.*
*Corresponding author: femartinezc@uaemex.mx
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of honey, royal jelly, pollen, propolis, wax, and venom (Ramos Díaz & Pacheco López, 2016). By fulfilling both ecological and economic functions, they support biodiversity (Sosenski & Domínguez, 2018) and sustain rural livelihoods (Becerril García & Hernández Cuevas, 2020). Beekeeping is a sustainable, emission-free practice that directly supports several sustainable development goals (SDGs), including SDG 8: Decent Work and Economic Growth, SDG 12: Responsible Consumption and Production, and SDG 15: Life on Land (FAO, 2022). It also indirectly advances SDG 1: No Poverty and SDG 2: Zero Hunger. Mexican honey is highly valued in international markets for its unique organoleptic qualities, shaped by the country's diverse environments and providing a competitive advantage (Magaña Magaña et al., 2017). Its quality has positioned Mexico as the ninth-largest honey producer and tenth-largest exporter worldwide (SADER, 2022). According to SADER (2022), Mexico produced 63,362 tons of honey in 2021, marking a 17% increase over 2020. This output contributed $132 million in annual revenue to the livestock sector, as reported by the Agri-Food and Fisheries Information Service (Servicio de Información Agroalimentaria y Pesquera, [SIAP, 2023]). As a result, beekeeping is a vital livestock activity and a significant source of foreign exchange for the country. Given the social, economic, and ecological significance of beekeeping, this study adapted the Boston Consulting Group (BCG) matrix as a graphical analysis tool to guide strategic decision-making among leading honey and honey-based product producers in Mexico, thus optimizing the value of honey within the supply chain.

1.1 Relevance of the work

This research proposes strategic pathways to enhance Mexico's apiculture sector through scenario projections and market analyses. By identifying growth opportunities for each major honey-producing state, it was possible to design tailored strategies that maximize profitability, ecosystem services, and rural development. The findings inform stakeholders, emphasizing the importance of sustainable beekeeping practices to protect biodiversity and boost local economies. Ultimately, this study highlights the critical role of apiculture in achieving food security and sustainable development goals, offering strategies for producers and policymakers to strengthen Mexico's honey supply chain.

2 MATERIALS AND METHODS

2.1 Study area

The study focused on Mexico as the unit of analysis and selected states with significant honey production: Campeche, Chiapas, Guerrero, Jalisco, Oaxaca, Puebla, Quintana Roo, Veracruz, and Yucatán. Collectively, these states accounted for 73.4% of national honey production in 2022.

2.2 Data collection

Data on production volume, average rural price, and honey production value for the country and selected states were obtained from SIACON-NR (2022).

2.3 Data analysis

The selected states were treated as strategic market units (SMUs) to adapt the BCG matrix, using its original axes of production value and market growth. This approach positioned states within quadrants aligned with the product life cycle, providing a graphical framework for developing targeted growth strategies. For the BCG matrix analysis, production value from 2020 to 2022 was used to evaluate the growth potential of each SMU, considering expansion capacity, repositioning, and strategic redirection (Kotler & Keller, 2012). In the BCG matrix, an SMU in the Star quadrant has high growth and strong market share. A Question Mark SMU shows low market share but has potential for rapid growth. A Cash Cow SMU has high market share coupled with slow growth, ensuring steady profitability. By contrast, a Dog SMU displays low market share and slow growth, often yielding minimal or negative returns. Based on the results, an Ansoff matrix was created to develop growth strategies for the SMUs in line with their honey production volume. To project future production, a stochastic estimation of the production value for 2023–2032 was carried out (Wooldridge, 2010) to determine the SMUs' prospective market positions. An empirical distribution was applied for the analysis, designating Yucatán as the leading SMU in honey production for comparative purposes. The Box-Jenkins method was applied to a univariate time series, with statistical testing, model estimation, and forecasting conducted using Simetar© software from Texas A&M University. The time series was plotted to examine trends, seasonality, cyclic patterns, and irregularities, and stationarity was evaluated. The trend was estimated using the equation $P = a + bD\_(1,t)$. The time series was stabilized through first differencing: $D\_(1,t) = D(t + 1) - D\_t$. The regression model was then estimated as $D\_(1,t) = a + bD\_(2,t)$. The estimated model was an AR (number of differences, number of lags), where the number of lags was determined using the Schwarz Information Criterion. The regression model was specified as: $D\_1,t = a + bD\_(t-1)$. Deterministic forecasting for 2023–2032 was performed using this model, while risk simulation was conducted with an empirical distribution.

3 RESULTS

The projected national honey production volume for 2032 exhibited a downward trend beginning in 2022 (Figure 1), with an average annual growth rate (AAGR) of −0.77% from 2022 to 2032.

Figure 2 presents the BCG matrix results, showing that most SMUs are positioned in the right sector. Campeche, Quintana Roo, and Veracruz fall within the question mark quadrant, where the strategic focus is on market expansion. In contrast, Chiapas, Guerrero, Jalisco, Oaxaca, and Puebla are located in the dog quadrant, indicating a need for restructuring or potential divestment. Yucatán stands out as the leading SMU, followed by Quintana Roo and Campeche.

Table 1 summarizes the growth and market share coefficients of the SMUs, with Yucatán emerging as the leader in both.

In the projected honey production scenario, Yucatán—the leading producer—shows continued growth, followed by

Chiapas, Jalisco, Campeche, and Oaxaca, while Veracruz experiences a significant decline. Yucatán was positioned in the cash cow quadrant. Guerrero and Oaxaca showed growth and entered the question mark quadrant, where Quintana Roo remained. Meanwhile, Campeche and Veracruz were placed in the dog quadrant, along with Puebla, Jalisco, and Chiapas, although Chiapas showed an upward trend in production (Figure 3). Veracruz experienced a significant decline in market share (0.006), falling below the quadrant threshold of 0.1. Nevertheless, its honey continues to be exported to the European Union (EU), valued for its distinctive qualities linked to its coffee-producing origin.

4 DISCUSSION

From 1980 through the projected period of 2032, Mexico's honey production volume has fluctuated, revealing two distinct phases. The first is characterized by sharp peaks that stabilize around 1988. The second, spanning from 1988 to 2032 (including projections), shows an AAGR of 0.07%. Research indicates that honey production is highly vulnerable to climate change, extreme weather events, agrochemical use, pollinator population declines, and natural resource depletion. Before the Africanization process began in 1986, both honey production and hive numbers were on the rise. A subsequent decline followed that year, yet honey yield per hive increased, suggesting potential enhancements in production methods or efficiency. The distribution and dynamics of Apis mellifera populations in Mexico reveal growth in the southern and southeastern regions, as well as in Sonora and Baja California, while populations in the north and central areas have declined or remained stable (Baena-Díaz et al., 2022). Worldwide, bee populations and honey production have shown a declining trend. Bioclimatic and environmental

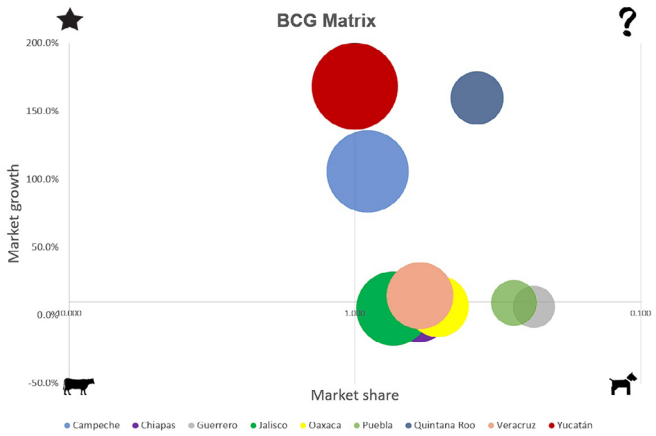

Figure 2. Boston Consulting Group matrix of honey production value for 2021–2022.

Table 1. Market share and growth rate of honey strategic market units for 2021–2022.

SMU	Market share	Market growth rate
Campeche	0.902	106.0%
Chiapas	0.598	4.8%
Guerrero	0.237	6.4%
Jalisco	0.734	5.0%
Oaxaca	0.512	6.7%
Puebla	0.278	9.3%
Quintana Roo	0.374	159.8%
Veracruz	0.592	14.4%
Yucatán	1.000	168.5%

SMU: strategic market unit.

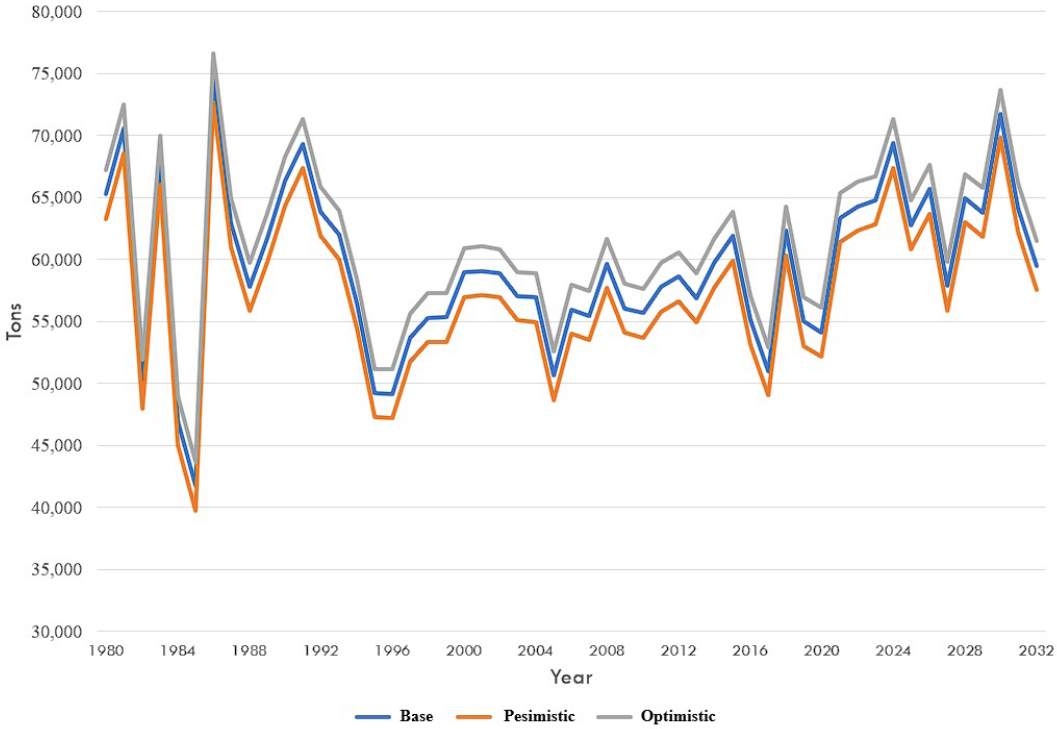

Figure 1. Projected honey production volume to 2032.

variables are key determinants of bee survival, with the most critical factors being the minimum temperature of the coldest month, annual mean temperature, precipitation of the wettest month, and radiation during the warmest trimester (Hu et al., 2021). Projections for certain agroclimatic regions indicate moderate growth in land suitable for bee development. In China, for instance, highly, moderately, and marginally suitable areas account for 1.48% (141,858 km²), 1.95% (186,198 km²), and 2.72% (259,878 km²) of the total land area, respectively (Hu et al., 2021). Nonetheless, these trends point to a decrease in the availability of optimal land for honey production. Vandame and Palacio (2010) hypothesized that the primary factors affecting bee populations in Latin America are beekeeping practices, land use changes, and agricultural practices. Over the past four decades, agricultural areas in Mexico have expanded, leading to notable alterations in the configuration of native natural resources. Statistical data indicate a significant rise in the use of neurotoxins, pesticides, and agrochemicals, all of which adversely affect bee health and behavior (Blot et al., 2019; Boff et al., 2022; Conradie et al., 2024). Concurrently, observations of increased heterozygosity suggest a rise in inbreeding within species previously considered stable, along with a measurable decline in allelic richness over time. Notably, this genetic decline commenced at least 30 years prior to the observed decreases in bee species abundance (Rhode et al., 2024). For instance, the use of glyphosate in maize and soybean crops in Mexico increased between 1996 and 2010 (Consejo Nacional de Ciencia y Tecnología [CONACYT], 2020).

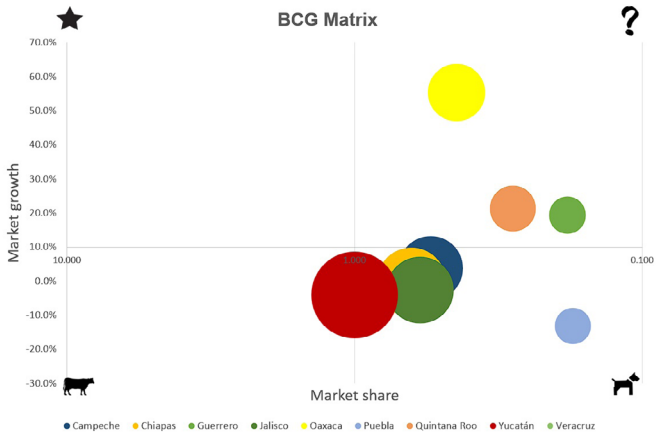

Figure 3. Boston Consulting Group matrix of honey production value projection (2031–2032).

Analysis of the SMUs positioning and growth for 2021–2022 reveals that, overall, their placement in the right quadrant signifies that they follow the market leader while retaining a substantial market share. Campeche is positioned closest to the leading producer, followed by Jalisco, Chiapas, Veracruz, and Oaxaca—all of which exhibit values above 0.5, highlighting their competitiveness. In contrast, Quintana Roo, Puebla, and Guerrero fall below this threshold. In terms of a company's market share compared to its primary competitor, a value exceeding 1.0 signifies that it surpasses the market leader, whereas a value below 0.5 indicates that the company is at least half the size of the leader (Kotler & Keller, 2012). Echazarreta et al. (1997) identified several key factors contributing to the success of beekeeping in Yucatán up to the 1990s: abundant and diverse nectar-producing vegetation, a high density of bee colonies, efficient honey marketing systems, and the use of accessible, low-cost technology. However, Yucatán beekeepers now face challenges similar to those in other Latin American regions, and likely elsewhere, as bee diseases become increasingly prevalent.

The BCG matrix supports strategic decision-making, improves competitiveness, and optimizes market positioning of products. Castro Fajardo et al. (2022) similarly applied the BCG matrix to analyze the international market for honey, identifying high-potential markets for developing differentiated and focused value propositions. In addition, Valdivieso-Apolo et al. (2023) employed the matrix to devise competitive strategies that enhanced the export of non-traditional products in Ecuador during periods of international crisis.

Utilizing the Ansoff matrix, it was possible to identify the investment areas necessary to boost honey production. For the SMUs positioned in the question mark quadrant, the recommended strategy is market penetration, growing by increasing sales of existing products within current market segments (Kotler & Armstrong, 2013). Table 2 provides an overview of the strategies to be implemented for each SMU.

The states of Campeche, Quintana Roo, and Veracruz have the potential to improve and reach the star quadrant. On the other hand, the SMUs in the dog quadrant require strict restructuring focused on reducing production costs to improve their profitability.

Table 2. Ansoff matrix strategies for the question mark strategic market units in honey production (2021–2022 scenario).

	Current products	New products
Existing markets	Market penetration -Increase in market share (Veracruz, Quintana Roo, and Campeche)	Product development -New products within the same market Bee Venom Wax Production Royal Jelly (Yucatán)
New markets	Market development -Expand the market for the current SMUs	Diversification Vertical integration (forward, backward)

SMUs: strategic market units.

Social factors affecting the competitiveness and profitability of apicultural systems have also been identified. Martínez-González et al. (2018) assessed the overall impact of technology adoption by beekeepers, reporting a significant 16.8% increase ($p < .01$) over 8 months. Moreover, significant differences ($p < .01$) were observed in key variables such as the location and setup of the apiary, apicultural health, harvesting, field personnel, and cleaning and hygiene programs, factors directly related to the productive performance of bees. Contreras-Escareño et al. (2013) found that beekeeping units where the activity is primary demonstrate higher productivity and economic performance than those in which it is secondary. Chan Chi et al. (2018) reported a cost-benefit ratio of two for small-scale beekeepers with limited training and innovation. Additionally, López Santiago et al. (2023) determined that the optimal economic inputs for producing one kilogram of honey in 2022 were approximately 1.045 kg of feed and 0.084 workdays. However, several factors limit the average production unit from achieving the optimal scale necessary to sustain the activity. Notably, inadequate management significantly undermines the decision-making process, especially when it does not rely on internal economic data, thereby directly affecting overall performance (Bragulat et al., 2018).

In the prospective scenario, the studied SMUs did not achieve favorable honey production values, highlighting the need to implement current strategies that enable their transformation into star SMUs in the future. Kotler (2001) stresses the importance of focusing on developing business and marketing competencies to enhance competitiveness and improve market positioning. Given the projected decline in honey production value in the analyzed states, it is imperative to adopt strategies that diversify production. Such an approach will facilitate market expansion and yield economic benefits for honey producers. Mexico's extensive biogeographic diversity results in variations in both the quantity and quality of honey produced, offering a significant opportunity to add value to the product (Baena-Díaz et al., 2022). Variables such as harvest seasonality, altitude, latitude, topography, temperature, and humidity affect the color, aroma, and flavor of the honey, giving it unique characteristics. These distinctive traits grant Mexican honey a competitive advantage in the international market, where it is highly valued (Magaña Magaña et al., 2017). Becerril García and Hernández Cuevas (2020) report that income from beekeeping has played a significant role in reducing poverty among rural families. Considering that Mexican honey possesses unique properties and serves as a vital driver of economic development for these communities, it is imperative to adopt strategies that enhance and optimize its production.

Based on the BCG matrix results for Mexico's leading honey-producing states, Chiapas, Guerrero, Jalisco, Oaxaca, and Puebla fall within the dog quadrant. Consequently, meliponiculture emerges as a viable strategy for these producers. Its success relies on ancestral knowledge, which is readily available in these communities, as well as careful site selection for apiaries, a thorough understanding of flowering periods, and optimal alignment among vegetation, nectar quality, and geographic location (Becerril García & Hernández Cuevas, 2020). Beekeeping, as a cultural ecosystem service, provides both economic benefits and essential ecological functions. Honey producers and farmers who rely on assisted pollination both benefit from these services (Becerril García & Hernández Cuevas, 2020). In addition, the National Union of Apiculturist Associations of Mexico notes that leasing a beehive for crop pollination over a 45-day period—despite cost variations—creates an extra source of income for beekeepers (Hernández & López Morales, 2016). Considering the importance of this ecosystem service, it is crucial to revisit national regulations on species mobility and to recognize beekeeping as a productive system that includes assisted pollination. For states in the dog quadrant, a practical strategy involves diversifying and promoting apicultural by-products for health and industrial applications. Key products include propolis, wax, pollen, royal jelly, and bee venom, used in alternative therapies. These by-products possess medicinal properties because of plant-derived compounds found in flower nectar, which exhibit unique biological activities (Ramos Díaz & Pacheco López, 2016). Campeche, Quintana Roo, and Veracruz, currently in the question mark quadrant, must diversify their honey production to advance into the star quadrant. These states hold significant potential for growth and could solidify their positions as leaders in the sector. A key strategy is to penetrate the market by boosting sales of honey by-products, primarily within the domestic market. In this context, the industry offers a viable avenue to enhance competitiveness and broaden commercial opportunities.

The food industry is the primary consumer of honey, utilizing it as a natural sweetener in baked goods, cereals, beverages, and more (Ramos Díaz & Pacheco López, 2016). Honey is also gaining prominence in the pharmaceutical sector, where its antimicrobial and antioxidant properties are applied in therapies for various conditions, including cancer, cardiovascular and respiratory diseases, burns, aging, wound healing, and gastrointestinal disorders. Furthermore, honey can be integrated into healing materials such as bandages, gauzes, and cleaning products (Ramos Díaz & Pacheco López, 2016). It has also been used in traditional medicine since ancient times, both topically and orally (Becerril García & Hernández Cuevas, 2020). In the cosmetic industry, honey is primarily utilized in the formulation of creams, shampoos, and soaps. Beyond industrial opportunities, honey production can be directed toward both industrial sales and alternative distribution channels, such as collection centers, interstate distribution, or local markets (Magaña Magaña et al., 2017). When choosing local commerce, it is crucial to implement effective packaging and distribution methods to maximize the product's added value and improve its market competitiveness. Finally, for Yucatán (positioning itself as a star product), a diversification strategy has been proposed that involves implementing a traceability system, a key requirement imposed by the EU for market access. This system is crucial for ensuring food safety standards are met and for enhancing the product's competitiveness in international trade (Ramos Díaz & Pacheco López, 2016).

Traceability is an essential prerequisite for entering the European market, as mandated by Regulation (EC) Nº 178/2002 of the European Parliament and the Council (European Union, 2002), which outlines the fundamental principles and general requirements of food law. This system assures consumers that the products offered are safe and fit for consumption, ensuring adherence to established food safety standards. Implementing an effective traceability system requires compliance with several

prerequisites. The apiary must be assigned a unique code and maintain a transformation record. Each bee batch should receive an identification number for tracking purposes. Furthermore, honey extraction must be officially documented through a process managed by the Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria. For beekeepers seeking organic certification, which is increasingly demanded in the international market, meeting specific environmental conditions that support bee foraging is essential (Baena-Díaz et al., 2022). The quality and nutritional composition of honey-derived products are critical, given that their content varies in both amount and structure. Rzetecka et al. (2024) documented the presence of 32 amino acids in pollen, 31 in royal jelly, and 28 in propolis. In the analyzed apicultural products, histidine was the most abundant essential amino acid in bee pollen (1.5 mg/g), lysine in royal jelly (2.05 mg/g), and valine in propolis (0.006 mg/g). These compounds are highly prized within the nutraceutical industry.

Continuing to leverage the provisions of the TLCUEM, signed in 2000, is vital—especially those involving preferential tariffs for Mexican honey and other agricultural goods. The agreement grants Mexico an annual export quota of 30,000 tons at a preferential tariff, an exclusive benefit not extended to any other country. This creates a strategic opportunity for both Mexican exporters and European importers (Cital Gómez & Bonales Valencia, 2023). Export-focused social enterprises have targeted strategic market niches to maximize their competitive advantages. Their key differentiators include producing organic honey and joining fair trade associations (Magaña Magaña et al., 2017). Fair trade is a viable approach to strengthening the honey production chain. Organizations following this model standardize global trade practices by creating marketing channels that enable direct purchases from producers, effectively removing intermediaries. As a result, producers benefit from better prices, and the fair price consistently surpasses the conventional market rate. Under fair trade regulations, pre-financing is recognized as a strategy to enhance producer competitiveness by eliminating the need for expensive credit. Additionally, this model encourages strategic alliances among organizations, promoting long-term commercial relationships (Vargas, 2004). Furthermore, establishing a comprehensive database with precise information on the number of hives in Mexico, the socioeconomic profiles of beekeepers across different regions, apiary management statistics, and identified threats in various contexts could lead to significant improvements (Baena-Díaz et al., 2022).

5 CONCLUSION

By identifying each state's prospective market position, tailored strategies were developed accordingly. This does not prevent the formulation of general strategies for all states, but rather ensures that each one is adapted to its specific projected outcome.

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REFERENCES

Baena-Díaz, F., Chévez, E., Ruiz de la Merced, F., & Porter-Bolland, L. (2022). Apis mellifera en México: Producción de miel, flora melífera y aspectos de polinización. Revisión. *Revista Mexicana de Ciencias Pecuarias*, *13*(2), 525–548. https://doi.org/10.22319/rmcp.v13i2.5960

Becerril García, J., & Hernández Cuevas, F. I. (2020). Apicultura: su contribución al ingreso de los hogares rurales del sur de Yucatán. *Península*, *15*(2), 9–29. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-57662020000200009#:~:text=Los%20hallazgos%20revelan%20el%20efecto,la%20condici%C3%B3n%20de%20pobreza%20alimentaria

Blot, N., Veillat, L., Rouzé, R., & Delatte, H. (2019). Glyphosate, but not its metabolite AMPA, alters the honeybee gut microbiota. *PLoS One, 14*(4), Article e0215466. https://doi.org/10.1371/journal.pone.0215466

Boff, S., Keller, A., Raizer, J., & Lupi, D. (2022). Decreased efficiency of pollen collection due to sulfoxaflor exposure leads to a reduction in the size of bumble bee workers in late European summer. *Frontiers in Ecology and Evolution*, *10*, Article 842563. https://doi.org/10.3389/fevo.2022.842563

Bragulat, T., Angón, E., García, A., Giorgis, A., Barba, C., & Perea, J. (2018). Influence of the apiarist managerial capacity on viability of beekeeping production units on the Pampa Argentina. *Revista Mexicana de Ciencias Pecuarias*, *9*(1), 32–47. http://doi.org/10.22319/rmcp.v9i1.4394

Castro Fajardo, H., Otálora Gómez, L. M., & Chavarro Miranda, F. (2022). Análisis y evaluación de mercados internacionales de la miel natural. *Apuntes del Cenes*, *41*(74), 201–240. https://doi.org/10.19053/01203053.v41.n74.2022.14129

Chan Chi, J. R., Caamal Cauich, I., Pat Fernández, V. G., Martínez Luis, D., & Pérez Fernández, A. (2018). Social and economic characterization of bee honey production in the north of the state of Campeche, Mexico. *Textual*, *72*, 103–124. https://doi.org/10.5154/r.textual.2017.72.007

Cital Gómez, P. V., & Bonales Valencia, J. (2023). Ventaja Competitiva Revelada de la Miel de Abeja de México en el mercado mundial, 2005-2020. Revista CIMEXUS, *XVIII*(2), 133–154. https://doi.org/10.33110/cimexus180207

Conradie, T. A., Lawson, K., Allsopp, M., & Jacobs, K. (2024). Exploring the impact of fungicide exposure and nutritional stress on the microbiota and immune response of the Cape honey bee (Apis mellifera capensis). *Microbiological Research*, *280*, Article 127587. https://doi.org/10.1016/j.micres.2023.127587

Consejo Nacional de Ciencia y Tecnología. (2020). *Expediente científico sobre el glifosato y los cultivos GM*. Retrieved March 8, 2024, from https://conahcyt.mx/wp-content/uploads/documentos/glifosato/Dossier_formato_glifosato.pdf

Contreras-Escareño, F., Pérez Armendáriz, B., Echazarreta, C. M., Cavazos Arroyo, J., Macías-Macías, J. O., & Tapia-González, J. M. (2013). Present situation and characterististics of beekeepers in the South and Southeastern regions of the State of Jalisco, Mexico. *Revista Mexicana de Ciencias Pecuarias*, *4*(3), 387–398. https://www.scielo.org.mx/scielo.php?pid=S2007-11242013000300009&script=sci_abstract&tlng=en

Echazarreta, C. M., Quezada-Euán, J. J. G., Medina, L. M., & Pasteur, K. L. (1997). Beekeeping in the Yucatan peninsula: Development and current status. *Bee World*, *78*(3), 115–127. https://doi.org/10.1080/0005772X.1997.11099346

European Union. (2002). *Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*. Official Journal of the European Union. http://data.europa.eu/eli/reg/2002/178/oj

Food and Agriculture Organization of the United Nations. (2018). *Why bees matter: The importance of bees and other pollinators for food and agriculture*. Retrieved January 19, 2024, from https://www.fao.org/3/I9527EN/i9527en.PDF

Food and Agriculture Organization of the United Nations. (2022). *Salvar a las abejas y apoyar la miel sostenible en Marruecos y Palestina*. Retrieved March 29, 2024, from https://unsdg.un.org/es/latest/stories/salvar-las-abejas-y-apoyar-la-miel-sostenible-en-marruecos-y-palestina

García García, M., Ríos Osorio, L., & Álvarez del Castillo, J. (2016). La polinización en los sistemas de producción agrícola: revisión sistemática de la literatura. *Idesia*, *34*(3), 51–66. http://doi.org/10.4067/S0718-34292016000300008

Hernández, E. T., & López Morales, C. A. (2016). La desaparición de abejas en el mundo: Polinización, ecología, economía y política. *Revista Ciencias*, *118–119*, 102–105. https://www.revistacienciasunam.com/es/201-revistas/revista-ciencias-118-119/1984-la-desaparici%C3%B3n-de-abejas-en-el-mundo-polinizaci%C3%B3n,-ecolog%C3%ADa,-econom%C3%ADa-y-pol%C3%ADtica.html

Hu, X., Liu J., Ding, G., Naeem, M., Li, J., Ma, F., Huang, J., & An, J. (2021). An evaluation of habitat uses and their implications for the conservation of the Chinese bumblebee Bombus pyrosoma (Hymenoptera: Apidae). *Frontiers in Ecology and Evolution*, *9*, Article 667949. https://doi.org/10.3389/fevo.2021.667949

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES secretariat. https://files.ipbes.net/ipbes-web-prod-public-files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf

Kotler, P. (2001). *Dirección de mercadotecnia: Análisis, planeación, implementación y control* (8th ed.). Pearson Education.

Kotler, P., & Keller, K. L. (2012). *Dirección de marketing* (15th ed.). Pearson Education.

Kotler, P., & Armstrong, G. (2013). *Fundamentos de marketing* (11th ed.). Pearson Educación.

Krishnan, S., Guerra, G. W., Bertrand, D., Wertz-Kanounnikoff, S., & Kettle, C. (2020). *The pollination services of forests: A review of forest and landscape interventions to enhance their cross-sectoral benefits*. Forestry Working Paper 15. Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/server/api/core/bitstreams/fd57ac5a-5c31-4379-968d-5866a3411f87/content

López Santiago, M. A., Zavala Beltrán, J. I., Valdivia, Alcalá, R., & Montiel Batalla, B. M. (2023). Función Cobb-Douglas de la producción de miel en Aguascalientes, México. *Revista Mexicana de Ciencias Pecuarias*, *14*(3), 735–744. https://doi.org/10.22319/rmcp.v14i3.6285

Magaña Magaña, M. A., Sanginés García, J. R., Lara y Lara, P. E., Salazar Barrientos, L. L., & Leyva Morales, C. E. (2017). Competitiveness and participation of Mexican honey in the world market. *Revista Mexicana de Ciencias Pecuarias*, *8*(1), 43–52. http://doi.org/10.22319/rmcp.v8i1.4304

Martínez-González, E. G., Arroyo-Pozos, H., Aguilar-Gallegos, N., Álvarez-Coque, J. M. G., Santoyo-Cortés, V. H., & Aguilar-Ávila, J. A. (2018). Dynamics of adoption of good practices in honey production in the Peninsula of Yucatán, Mexico. *Revista Mexicana de Ciencias Pecuarias*, *9*(1), 48–67. http://doi.org/10.22319/rmcp.v9i1.4366

Ramos Díaz, A. L., & Pacheco López, N. A. (Eds.). (2016). *Producción y comercialización de miel y sus derivados en México: Desafíos y oportunidades para la exportación*. Ciatej & Conacyt.

Requier, F., Pérez-Méndez, N., Andersson, G. K. S., Blareau, E., Merle, I., & Garibaldi, L. A. (2023). Bee and non-bee pollinator importance for local food security. *Trends in Ecology & Evolution*, *38*(2), 196–205. https://doi.org/10.1016/j.tree.2022.10.006

Rzetecka, N., Matuszewska, E., Plewa, S., Matysiak, J., & Klupczynska-Gabryszak, A. (2024). Bee products as valuable nutritional ingredients: Determination of broad free amino acid profiles in bee pollen, royal jelly, and propolis. *Journal of Food Composition and Analysis*, *126*, Article 105860. https://doi.org/10.1016/j.jfca.2023.105860

Rohde, A. T., Branstetter, M. G., Mock, K. E., Knoblett, J. N., Pilliod, D. S., Everett, J. G., Galpern, P., & Strange, J. P. (2024). Population genetics of museum specimens indicate decreasing genetic resiliency: The case of two bumble bees of conservation concern. *Biological Conservation*, *291*, Article 110453. https://doi.org/10.1016/j.biocon.2024.110453

Secretaría de Agricultura y Desarrollo Rural. (2017, Mayo 16). *¿Por qué son importantes las abejas para el medio ambiente?* Gobierno de Mexico. Retrieved February 12, 2024, from https://www.gob.mx/agricultura/es/articulos/por-que-son-importantes-las-abejas-para-el-medio-ambiente

Secretaría de Agricultura y Desarrollo Rural. (2022, February 3). *Crecen producción y exportaciones de miel en México al cierre del 2021: Agricultura*. Gobierno de Mexico. Retrieved January 15, 2024, from https://www.gob.mx/agricultura/prensa/crecen-produccion-y-exportaciones-de-miel-en-mexico-al-cierre-de-2021-agricultura-293944?idiom=es

Servicio de Información Agroalimentaria y Pesquera. (2023). *Exportaciones de bienes agropecuarios y pesqueros. Resultados Oportunos 2022*. Gobierno de Mexico. Recuperado el 10 de noviembre de 2023 de https://www.gob.mx/cms/uploads/attachment/file/800155/Exportaciones_agropecuarias_y_pesqueras_de_M_xico_Resultados_Oportunos_diciembre_2022_.pdf

Sistema de Informação Agroalimentaria de Consulta. (2022). *SADER*. Gobierno de Mexico. Retrieved November 10, 2023, from https://www.gob.mx/siap/documentos/siacon-ng-161430

Sosenski, P., & Domínguez, C. A. (2018). El valor de la polinización y los riesgos que enfrenta como servicio ecosistémico. *Revista Mexicana de Biodiversidad*, *89*(3), 961–970. https://doi.org/10.22201/ib.20078706e.2018.3.2168

Valdivieso-Apolo, A. V., Michay-Pinta, L. K., Pizarro-Romero, K. H., & Benítez-Luzuriaga, F. V. (2023). Matriz BCG para potenciar la competitividad del sector no tradicional durante períodos de crisis internacionales. *Economía y Negocios*, *14*(2), 132–147. https://doi.org/10.29019/eyn.v14i2.1203

Vandame, R., & Palacio, M. A. (2010). Preserved honey bee health in Latin America: A fragile equilibrium due to low-intensity agriculture and beekeeping? *Apidologie*, *41*(3), 243–255. https://doi.org/10.1051/apido/2010025

Vargas Gálvez, C. E. (2004, Noviembre 22–26). *El comercio justo y las perspectivas comerciales de la miel de abejas en este segmento de mercado*. [Symposium] Simposium Internacional Sobre Apicultura, XI Reunión Nacional de Investigación Pecuaria, Yucatán, Mexico.

Wooldridge, J. M. (2010). *Introducción a la econometría: Un enfoque moderno* (4th ed.). Cengage Learning.