

Ecological and socioeconomic aspects of meliponiculture in the Yucatan Peninsula, Mexico

Martínez-Puc Jesús F.^{1,2}; Cetzal-Ix, William^{1*}; Magaña-Magaña Miguel A.²; López-Castilla Héctor MJ.¹, Noguera-Savelli Eliana³

¹ Tecnológico Nacional de México, Instituto Tecnológico de Chiná, Calle 11 entre 22 y 28, Colonia Centro, Chiná, Campeche, C.P. 24520, México.

² Tecnológico Nacional de México, Instituto Tecnológico de Conkal, Avenida Tecnológico S/N, Conkal, Yucatán, México.

³ Consejo Nacional de Ciencia y Tecnología, Colegio de Postgraduados Campus Campeche, Champotón, Campeche, México. C.P. 24450.

* Correspondence: rolito22@hotmail.com

ABSTRACT

Objective: To describe the main economic and ecological characteristics in the production of native stingless bees (NSBs) in the Yucatan Peninsula (YP), Mexico.

Design/Methodology/Approach: Through the snowball method, an exhaustive search for references about meliponiculture was conducted, using keywords individually or combined, such as meliponiculture, Melipona, native stingless bees, Mayan meliponiculture, Yucatan Peninsula, etc.

Results: In Campeche and Yucatán there is a total of N=216 producers who own a total of 3,362 “jobones” destined to meliponiculture. However, economic and ecological studies are scarce and do not allow deeply understanding the benefits of NSBs in the YP; that is, information about production costs and economic benefits that would be obtained with the conservation of NSBs.

Study Limitations/Implications: This study describes the socioeconomic and ecological aspects of native stingless bees in the Yucatan Peninsula.

Findings/Conclusions: Meliponiculture is an important activity from the cultural aspect, therefore, its rescue and conservation is urgent; on the other hand, the sale cost of Melipona honey is higher compared to honey from the *Apis mellifera* L. bee, representing an economic alternative for the producers of rural communities.

Keywords: Melipona, Plebeia, Trigona, Scaptotrigona.

Citation: Martínez-Puc, J. F., Cetzal-Ix, W., Magaña-Magaña, M. A., López-Castilla, H. MJ., & Noguera-Savelli E. (2022). Ecological and socioeconomic aspects of meliponiculture in the Yucatan Peninsula, Mexico. *Agro Productividad*. <https://doi.org/10.32854/agrop.v15i2.2108>

Editor in Chief: Dr. Jorge Cadena Iniguez

Received: August 3, 2021.

Accepted: January 19, 2022.

Published on-line: February 28, 2022.

Agro Productividad, 15(2). February. 2022. pp: 57-65.

This work is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International license.



INTRODUCTION

Apiculture refers to breeding and exploitation of honey bees (*Apis mellifera* L.), and meliponiculture to breeding and production of native stingless bees (NSBs) or Melipona bees (Tribe: Meliponini), which do not have a sting (Crane, 1992). According to archaeological vestiges from the Proto-classic period found in Mesoamerica (Crane, 1992; Calkins, 1973), meliponiculture is a cultural, economic and social activity that Mayan communities developed before the arrival of the Europeans.

The concept of meliponiculture was implemented by Paulo Nogueira Neto to define the activity of the people who are devoted to breeding and caring for NSBs, which is practiced in tropical and subtropical regions of America, Africa, Asia and Australia (Viene, 2017). Honey bees are originally from the old world, while NSBs are native to America, Africa, Asia and Australia; some indigenous cultures have maintained a close relationship with them because they are an important resource to obtain honey, cerumen (mixture of wax and resins), larvae, pollen, and they are also part of their worldview (Rosso *et al.*, 2001).

Meliponiculture in Mexico, in the Mayan regions of the Yucatan Peninsula (Campeche, Quintana Roo and Yucatán), is an important activity because interesting management processes have developed; the nests are housed inside logs and desiccated squash fruits (*Cucurbita* sp.) (Rosso *et al.*, 2001). However, indigenous groups in Puebla and Veracruz practice it to a lesser scale (Pererira-Nieto, 2005). Until before the “discovery” of the American Continent, native stingless bee breeding was part of the sociocultural, dietary, medicinal, ritual and commercial customs of many indigenous peoples (Ballivián, 2008; Quezada-Euan, 2005; Carrillo-Magaña, 2004).

MATERIALS AND METHODS

The “snowball” method was used for the study, which is based on randomly following the literature cited by an author, until completing a number of main authors about the themes of a particular area; the search concludes when the cited authors are found again, causing the decrease in references, which indicates a maximum number of studies (Bernard, 2006). The search for keywords was done through digital search engines, using keywords such as meliponiculture, Melipona, native stingless bees, Mayan meliponiculture, Yucatan Peninsula. The sample size was not defined because it acted as a final census.

Taxonomy of native stingless bees (NSBs)

Melipona are found in the tropical and subtropical regions of Africa, Asia, Australia and America, and in this last region they are distributed from Mexico to Argentina (Quezada-Euan, 2005). The highest diversity of meliponines is found in America, with more than 400 species described, followed by the Indo-Australian region with close to 90 species and Africa with close to 30 (Arnold *et al.*, 2018). In Mexico, a total of 46 species have been identified in 11 genera of NSBs (Ayala, 1999); in the Yucatan Peninsula there are 17 species (Ayala, 1999; Ayala, 1992; Quezada-Euan, 2005; Figure 1, Table 1). The NSBs belong to the Meliponini tribe, Apinae subfamily and Apidae family (Michener, 2000).

The NSBs are characterized by the absence of a functional sting compared to other tribes of the Apidae family. In addition, they present a great reduction in venation of the anterior wings, simple non-bifurcated nails, and a line of comb-like thick hair in the internal distal margin of the posterior tibiae called penicillium (Ayala, 1999). The atrophied sting in the NSBs has allowed their easy management compared to European bees (Figure 1); however, their defense mechanism consists in biting with the mandibles, rolling up in the hair, or placing propolis on their enemies (De Matos and Fernandes, 2007).



Figure 1. *Melipona beecheii* in the Yucatan Peninsula, Mexico. A. Management of a colony. B. Honeycomb. C. Lateral view of *M. beecheii*. D. Front view of *M. beecheii*. Photos: W. Cetzal-Ix

Table 1. Native stingless bee species present in the Yucatan Peninsula, Mexico (modified from González-Acereto, 2012).

Taxa	Economic and ecological uses	Reference
<i>Cephalotrigona zexmeniae</i> Cockerell	Natural and commercial pollination	Grajales-Conesa <i>et al.</i> (2013)
<i>Lestrimelitta niitkib</i> Ayala	Natural pollination	Grajales-Conesa <i>et al.</i> (2013)
<i>Frieseomelitta nigra</i> Cresson	Natural and commercial pollination	Quezada-Euán (2005)
<i>Melipona beecheii</i> Bennett	Honey production, natural and commercial pollination	Crane (1992); Quezada-Euán (2005)
<i>Melipona yucatanica</i> Camargo, Moure & Roubik	Honey production, natural and commercial pollination	Quezada-Euán (2005)
<i>Nannotrigona perilampoides</i> Cresson	Natural and commercial pollination	Macias <i>et al.</i> (2001); Cauich <i>et al.</i> (2006)
<i>Partamona bilineata</i> Say	Natural and commercial pollination	Cerna Chávez <i>et al.</i> (2015)
<i>Plebeia frontalis</i> Friese	Natural and commercial pollination	Vandame (2012)
<i>Plebeia moureana</i> Ayala	Natural and commercial pollination	Vandame (2012)
<i>Plebeia parkeri</i> Ayala	Natural pollination	Vit <i>et al.</i> (2013)
<i>Plebeia pulchra</i> Ayala	Natural pollination	Vit <i>et al.</i> (2013)
<i>Scaptotrigona pectoralis</i> Dalla Torre	Honey production, natural and commercial pollination	Quezada-Euán (2005)
<i>Trigona fulviventris</i> Guérin-Ménéville	Natural pollination	Vit <i>et al.</i> (2013)
<i>Trigona fuscipennis</i> Friese	Natural and commercial pollination	Vandame (2012)
<i>Trigona corvina</i> Cockerell	Natural pollination	Vit <i>et al.</i> (2013)
<i>Trigonisca maya</i> Ayala	Natural pollination	Vit <i>et al.</i> (2013)
<i>Trigonisca pipioli</i> Ayala	Natural pollination	Vit <i>et al.</i> (2013)

Brief history of meliponiculture in Mexico

The NSBs have their roots as honey producers since the times of the Mayan civilization, which can be corroborated in ancient codices and references in sacred texts (Echazarreta *et al.*, 1997). Indigenous communities in Mexico use preferably two species (*Melipona beecheii* and *Scaptotrigona mexicana*) for the production of honey and wax. Breeding of both species was very intense in the past, since honey was highly appreciated as an element to trade between Mesoamerican civilizations, in such a way that there were guardian gods and protectors of these bees such as Ah-Mucen-cab among the Mayan, whose image can still be appreciated in the buildings of Tulum and others (Sayil), as well as in scenes of the Matritense Codex (Quezada-Euán, 2011). Both species are still being managed; however, they have been widely displaced by honey bees, which have higher honey production and a market positioned in Europe (Quezada-Euán and Ayala-Barajas, 2010).

Meliponiculture in times of peninsular Maya people reached a high level of production, because this ethnic group developed the activity at a similar level of management as with honey bees, like in medieval times in Europe, with densities of up to 500 colonies (Quezada-Euán *et al.*, 2001). The honey and wax produced by the Maya people were traded from the border between Campeche and Tabasco to Guatemala and Honduras; however, during the Spanish conquest, Yucatec honey was one of the main products offered in the Tenochtitlan market (currently Mexico City) (Pereira-Nieto, 2005). After the Spanish conquest, the Yucatan Peninsula paid tributes with honey and wax from the NSBs, and more than 35,000 kg of the so-called “Campeche wax” was exported to Europe (Reyes, 2011). The products derived from the domestication of NSBs had diverse uses, such as food, for ceremonies and traditional medicine (Carrillo-Magaña, 2004). Between the 3rd and 10th centuries, the period when the Mayan culture was at its maximum height, honey and wax were two of the most abundant products traded in ancient times, as were salt, dry fish, henequen, muslin, and copal (Carrillo-Magaña, 2004). However, the displacement of meliponiculture had several factors, beginning with the arrival of the Spanish to the YP in the 15th century, when the Mayan production system suffered gradual changes as the workforce of the traditional processes was moved towards new activities.

The introduction of extensive livestock production also caused a gradual process of disappearance of rainforests, which increased with the establishment of the henequen monocrop; with the disappearance of the rainforest, the spaces for nesting and sources of food for NSBs were scarce (Quezada-Euán, 2011), affecting the populations. In parallel, the introduction of sugarcane (*Saccharum* spp.) and its generalized consumption contributed even more to the abandonment of this activity (Pereira-Nieto, 2005).

The beginning of the abandonment of meliponiculture in the YP marked the introduction of European bees (*A. mellifera*) for the beekeeping activity, which took place at the beginning of the 20th century. The presence of European bees in the YP is recent when compared to other regions of the American continent, where honey bees were introduced with the arrival of the Spanish conquistadores; the first apiaries were established in Yucatán in 1911, with honey bees imported from the United States to Yucatán (Echazarreta *et al.*, 1997). This was because honey bees produced a higher amount of honey in comparison to the *Melipona* bees, which also had an effect in the reduction of the meliponiculture

activity. In the year 2020, the honey production from honey bees was 54165 t annually (SIAP, 2020), and there are no records of stingless bee honey production.

Architecture of the nest

The NSBs build their nests exposed or in pre-existing cavities such as tree holes, termite nests, or underground, using cerumen (wax mixed with resins), clay and other materials. The breeding honeycombs are arranged horizontally or in clusters and store the honey and the pollen in ellipsoidal jars (Nates-Parra and Rosso, 2013). The indigenous peoples housed them in hollow trunks known regionally as “jobones”, which are arranged horizontally, the stingless bee breeder extracts honey from the ends (Figure 2, Table 2; Quezada-Euán, 2011). The most representative hive consists in an artificially hollowed trunk, with



Figura 2. Meliponary established in the locality of Tankunché, Calkiní, Campeche, Mexico. Photos: J.F. Martínez-Puc.

Table 2. Main structures that make up a nest of Meliponini bees.

Structure name	Function
Access tube	It allows to control the humidity and temperature, as well as the defense of the nest
Entrance	Main cavity for nest access
Tunnel	Made of cerumen, it is tube-shaped and leads to the breeding chamber
Batumen	Lines the nest cavity and its ends, and allows ventilation
Food pots	Spherical structures made of soft cerumen lie outside the involucre and are used to store pollen and honey separately.
Involve	Series of cerumen sheets that surround the brood chamber to maintain the thermoregulation of the nest and thus protect the queen from being attacked by enemies.
Pillars and connectives	Both structures keep the nests fixed. The pillars are vertical and the connectives are horizontal.
Honeycombs and brood chamber	Cells built with cerumen, when the new bee emerges the cell is destroyed and the material is recycled inside the hive
Scutellum	Structure composed of colony debris, is located in the lower part of the nest
Waste	Place where bees transport waste out of the colony. A group of bees is in charge of removing the garbage from the hive

approximately 55 cm length and 18 cm diameter, thickness between 4 and 8 cm, and in the middle part it includes an orifice of 1.0 cm (which serves for bee entry and exit), while the ends of the trunk are closed with wood plugs (González-Acereto and De Araujo, 2005).

Meliponiculture today

Melipona bees used currently in Mexico for honey production or for medicinal uses in the YP, Tabasco, Chiapas and Veracruz (*M. beecheii*), in Chiapas and Guerrero (*M. fasciata*), in the Sierra Norte of Puebla, and the Papantla Region in Veracruz (*S. mexicana*) (González-Acereto and De Araujo, 2005). The Maya people from the YP and some Nahua groups from Puebla and Veracruz continue practicing meliponiculture, although due to its limited economic importance is at risk. There is not a process of generational succession that favors continuity, since most of the stingless bee breeders are men of advanced age and when they abandon the activity, the Melipona colonies are lost. In Yucatán it is estimated that there are less than 500 Melipona breeders, with average holdings of ten colonies (Quezada-Euán *et al.*, 2001).

In the YP, honey from stingless honey bees is still being used as part of traditional medicine, and important healing properties are attributed to it, particularly for respiratory diseases and ocular illnesses such as cataracts (González-Acereto, 2012). In rural communities, honey is also used for the diet of women who have given birth (González-Acereto, 2012). Recent studies show that honey from Melopona bees have antimicrobial and scar-healing properties, which is why they can be used in the treatment of wounds and some throat diseases (Quezada-Euán, 2001).

Authors such as Márquez (1994) point out that meliponiculture has weaknesses, such as: 1) *lack of awareness of the destination of production*, 2) *no producers' organizations or interest in forming them*, 3) *many management techniques have been lost, such as division of the colony*, 4) *it is an activity that is scarcely practiced*, 5) *scarce production and therefore it generates limited income*, 6) *lack of dissemination and promotion of it*, 7) *lack of current and potential markets for its products*, 8) *there is no trust from producers regarding technological innovations, such as "rational boxes"*, 9) *lack of government support*, and 10) *no connection between producers and researchers*.

The authors, Guzmán *et al.* (2011), indicated that there are advantages of this production practice, since: 1) it has been possible to conserve it because of its traditional rootedness in the Maya culture, 2) it requires low capital and workforce investment, 3) its products can be traded at a higher price than those of *A. mellifera*, 4) it is easy to work with the bees, given their docility and lack of sting, 5) it is distributed primarily in the tropical and subtropical regions of the world, 6) the bees stand out for being excellent pollinators of native and cultivated flora in the ecosystems which they inhabit.

On the other hand, the NSBs visit flowers to obtain nectar and pollen for their subsistence and they are a stabilizing element of the ecological environment through the pollination of plant communities (González-Acereto and De Araujo, 2005). Some species collect resins, mud or excrement that they use in the construction of their hives. The advantages of their products for the human diet and health are achieved in the national and international organic market, where they have their greatest market positioning. *Currently, the need to optimize and to increase the productivity is based on the development of*

different types of boxes, such as the Capel model, Isis model, Juliana model, Kerr model, Bayesian model and PNN model.

Economic aspects of meliponiculture

The economic aspect of meliponiculture in Mexico has not been generally evaluated yet, and only some evaluations have been conducted about pollination in tomato and chili crops, where an increase in production and quality of the product was observed (Quezada-Euán, 2005). However, there are few producers in the YP that use the benefits of these bees in production, especially in the management of crops under greenhouse conditions, since bumblebees are generally used for pollination (Tribe: Bombini). Likewise, there is scarce literature about the NSBs, with regards to detailed numerical reports and statistics about their favorable impact in production, which would represent a better management of these bees in the southern region of Mexico.

The amount of honey harvested from meliponines is relatively low compared to the harvest in apiaries, since 0.25 to 1 kg of honey can be harvested in meliponaries per year (Echazarreta *et al.*, 1997). Melipona honey (*M. beecheii*) presents many attributes that favor fixing high prices, such as the scarcity and the medicinal properties.

According to Pat-Fernández (2018), Melipona breeders in the Biosphere Reserve of Los Petenes in the state of Campeche sell on average 88.5% of the honey harvested, and the surplus is destined to family consumption. The honey is sold to local buyers and intermediaries in the region, the sale price in 2015 ranged between \$3.11 USD and \$49.81 USD. For the case of honey from *A. mellifera*, in 2017 it was traded in \$1.725 USD per kg, with an average price in the last ten years of \$1.42 USD per kg.

In Yucatán, it is estimated that there are 162 Melipona breeders with approximately 1,900 “jobones” (Quezada-Euán *et al.*, 2001), and in the Biosphere Reserve of Los Petenes in Campeche, a total of 54 Melipona breeders with a total of 1,462 “jobones” (Pat-Fernández, 2016). In this state, as in the national sphere, studies about the benefits of the NSBs in the pollination of crops under greenhouse conditions are also scarce; this system is used in the region for tomato and habanero chili production. Pollination with this bee species represents a great economic potential for the YP, due to the cost reduction when substituting non-native bumblebee colonies (*Bombus*), as well as the risk of importing diseases and exotic species (González-Acereto and De Araujo, 2005).

Based on the aforementioned, it can be stated that economic and ecological studies are required to allow evaluating further the benefits of the NSBs in the YP, that is, for information to be generated about the economic benefits that would be obtained with the conservation of NSBs and from using them as pollinators in agricultural crops, whose importance also transcends in the conservation of biodiversity. Therefore, it is necessary to raise awareness among producers, populations of rural communities and cities about managing NSBs and the conservation of their natural habitat.

CONCLUSIONS

The conclusion is that meliponiculture is an important activity from the biological, social and economic viewpoint. However, more studies are needed from the ecological

and socioeconomic point of view, since there is scarce information about the typology of producers, characterization of production systems, productive and value chains, and identification of market niches. It is important to foster the activity among young people, in order to rescue cultural and technical knowledge generated by traditional Melipona breeders, to ensure the conservation of the activity.

ACKNOWLEDGEMENTS

We thank the CONACyT project (FORDECyT-PRONACES, #304952) *Consolidación de la Unidad de Conservación de Flora Nativa de la Península de Yucatán: estrategia para integrar y promover el conocimiento etnobotánico con fines de investigación, formación de recursos humanos, conservación, uso y manejo sustentable* [Consolidation of the Native Flora Conservation Unit in the Yucatan Peninsula: strategy to integrate and promote ethnobotanical knowledge with the purpose of research, human resource formation, sustainable use and management]. JFMP thanks the project TECN M 10816.21-p *“Principales características tipológicas de los meliponicultores en localidades de la etnia maya de Calkiní, Campeche y Chemax, Yucatán”* [Main typological characteristics of Melipona breeders in localities of the Maya ethnic group of Calkiní, Campeche and Chemax]. HMJLC thanks CONACyT for the scholarship granted for Master’s degree studies, #005815. ENS thanks the project Cátedras CONACyT #364 *“Reconversión productiva sustentable para el desarrollo de los productores rurales de Campeche, México”* [Sustainable productive reconversion for the development of rural producers in Campeche, Mexico]. We thank Vidal Pat from the company, *Miel de la familia Pat*, for sharing information about economic aspects of meliponiculture.

REFERENCES

- Acereto, J. A. G. (2012). La importancia de la meliponicultura en México, con énfasis en la Península de Yucatán. *Bioagrociencias* 5(1). 34-41.
- Arnold, N., Zepeda, R., Dávila, M. A. V., & Maya, M. A. (2019). Las abejas sin aguijón y su cultivo en Oaxaca, México. ECOSUR, El Colegio de la Frontera Sur, 1ª ed. San Cristóbal de Las Casas, Chiapas
- Ayala, R. (1999). Revisión de las abejas sin aguijón de México (Hymenoptera: Apidae: Meliponini). *Folia Entom Mex.* 106, 1-123.
- Ballivián J.M. (2008). Abelhas Nativas sem ferrão. Brasil: Editora Oikos Ltda. Disponible en: <https://comin.org.br/wp-content/uploads/2019/08/abelhas-nativas-1229104261.pdf>
- Bernard, H.R. (2006). Research methods in anthropology: qualitative and quantitative approaches. Washington DC: 4th ed. Library of Congress.
- Calkins, C. F. (1974). Beekeeping in Yucatan: a study in historical-cultural zoogeography. Canada. University of Nebraska.
- Carrillo-Magaña, A. (2004). Meliponicultura: El mundo de las abejas nativas de Yucatán. Merida, Yucatán. Los Talleres de Litho Art.
- Cauich, O., Quezada-Euán, J. J. G., Macias-Macias, J. O., Reyes-Oregel, V., Medina-Peralta, S., & Parra-Tabla, V. (2004). Behavior and pollination efficiency of *Nannotrigona perilampoides* (Hymenoptera: Meliponini) on greenhouse tomatoes (*Lycopersicon esculentum*) in subtropical Mexico. *Journal of Economic Entomology.* 97(2), 475-481. Doi: 10.1093/jee/97.2.475
- Cerna Chávez, E., Lara Sánchez, E. D., Ochoa Fuentes, Y., Hernández Bautista, O., Aguirre Uribe, L. A., Landeros Flores, J., & Flores Canales, R. (2015). Comparación de cuatro especies entomófilas sobre parámetros agronómicos del fruto de tomate de invernadero. *Revista mexicana de ciencias agrícolas.* 6(11), 2241-2246. Doi: 10.29312/remexca.v0i11.806
- Crane, E. (1992). The past and present status of beekeeping with stingless bees. *Bee world.* 73(1), 29-42. Doi: 10.1080/0005772X.1992.11099110
- De Matos, A., Fernandes, P. (2007). Manual de manejo de abelhas sem ferrão. Brasil. Instituto de Desenvolvimento Ambiental Sustentável (IDEAS).
- Echazarreta, C. M., Quezada-Euán, J. J., Medina, L. M., & Pasteur, K. L. (1997). Beekeeping in the Yucatan peninsula: development and current status. *Bee World.* 78(3), 115-127. Doi: 10.1080/0005772X.1997.11099346

- González-Acereto, J., De Araujo Freitas, C. (2005). Manual de Meliponicultura Mexicana. Mérida, Mexico. Impresos Gramma.
- Grajales-Conesa, J., Meléndez-Ramírez, V., Cruz-López, L., & Sánchez, D. (2013). Native bees in blooming orange (*Citrus sinensis*) and lemon (*C. limon*) orchards in Yucatán, Mexico. *Acta zoológica mexicana*. 29(2). 437-440.
- Guzmán M., Balboa C., Vandame R., Albores M.L. y González A. J. (2011), Manejo de las abejas nativas sin aguijón en México: *Melipona beecheii* y *Scaptotrigona mexicana*. San Cristobal de las Casas, Chiapas: El colegio de la Frontera Sur. 1ª ed.
- Macias, M. J. O., Quezada-Euán, J. J. G., Parra-Tabla, A.V., Reyes, O.V. (2003). Comportamiento y eficiencia de polinización de las abejas sin aguijón (*Nannotrigona perilampoides*) en el cultivo del tomate (*Lycopersicon esculentum*) bajo condiciones de invernadero en Yucatán, México. En El Colegio de la Frontera Sur (Eds.) II Seminario Mexicano sobre abejas sin aguijón. Chiapas.
- Márquez, J. (1994). Meliponicultura en México. *Dugesiana*. 1(1). 3-12.
- Michener, C.D. (2000). The bees of the World. Baltimore, Maryland, USA. The Johns Hopkins University Press. 1ª Ed.
- Nates-Parra, G., Rosso, F. (2013). Diversity of stingless bees (Hymenoptera: Meliponini) used in Meliponiculture in Colombia. *Acta biol. Colomb.* 18(3). 415-426.
- Nogueira, P. (1997). Vida e Criação de Abelhas Indígenas Sem Ferrão. Sao Paulo, Brasil: Urna Edição Nogueirapis.
- Pat-Fernández, L. A., Anguebes Franceschi, F., Pat Fernández, J. M., Hernández Bahena, P., & Ramos Reyes, R. (2018). Condición y perspectivas de la meliponicultura en comunidades mayas de la reserva de la biósfera Los Petenes, Campeche, México. *Estudios de cultura maya*. 52 (1). 227-254.
- Pat-Fernández, L. (2016). Situación actual y perspectivas de la meliponicultura en comunidades aledañas a la Reserva de la Biosfera de los Petenes. Campeche, México: El Colegio de la Frontera Sur.
- Pereira-Nieto, A. (2005). Abejas ancestrales, una mirada a la apicultura en Yucatán. *Revista de la Universidad Autónoma de Yucatán*. 235(1), 86-91.
- Quezada-Euan JJG. (2005). Biología y uso de las abejas sin aguijón de la Península de Yucatán, México (Hymenoptera: Meliponini). 1ª ed. Mérida, Yucatán, México: Ediciones de la Universidad Autónoma de Yucatán.
- Quezada-Euán, J. J. G. (2011). Xunan cab, la señora abeja de Yucatán. La miel y las abejas, el dulce convenio del Mayab. Mérida, Yucatán: Gobierno del Estado de Yucatán.
- Quezada-Euán, J. J. G., de Jesús May-Itzá, W., & González-Acereto, J. A. (2001). Meliponiculture in Mexico: problems and perspective for development. *Bee World*. 82(4). 160-167. Doi: 10.1080/0005772X.2001.11099523
- Quezada-Euán, J., & Ayala-Barajas, R. (2010). Abejas nativas de México. La importancia de su conservación. *Ciencia y desarrollo*. 36(247). 8-13.
- Rosso, J. M., Imperatriz-Fonseca, V. L., Cortopassi-Laurino, M. (2001). Meliponicultura en Brasil I: Situación en 2001 y perspectivas. En Colegio de la Frontera Sur (Eds). II Seminario Mexicano sobre abejas sin aguijón, Mérida, Yucatán, México.
- Sistema de Información Agroalimentaria. (s/f); Secretaría de Agricultura y Desarrollo Rural. Disponible en: https://nube.siap.gob.mx/cierre_pecuario/
- Vandame, R. (2012). Diversidad de abejas (Hymenoptera: Apoidea) de la reserva de la biosfera el Triunfo, Chiapas. México DF: El colegio de la Frontera del Sur. Unidad Tapachula. Informe final SNIB-CONABIO. Proyecto No. BK063. Disponible en: <http://www.conabio.gob.mx/institucion/proyectos/resultados/InfBK063.pdf>
- Vit, P., Pedro, S. R., & Roubik, D. (Eds.). (2013). Pot-honey: a legacy of stingless bees. New York, USA: Springer Science & Business Media.