Traditional knowledge and actions of the Pisel Nek-mej (*Scaptotrigona mexicana*) stingless bee honey production in Cuetzálan, Puebla

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ABSTRACT

Objective: During the last few years, the production of honey from stingless bees has become significant, as a result of its therapeutic properties. However, its production and commercialization are limited by the low yield per colony and its high sale price. This study seeks to recover the lore and actions that a group of producers from Cuetzálan, Puebla, Mexico has about the production of honey from the *Scaptotrigona mexicana* species of stingless bees. The objective was to collect information about the handling, production, and commercialization of tis bee species, as well as the challenges that producers face in the Cuetzálan region.

Design/Methodology/Approach: This research was carried out using a qualitative approach. Semi-structured interviews were conducted to gather the information. The participants were chosen using the snowball sampling technique, contacting stingless bee honey producers in Cuetzálan, Puebla, Mexico.

Results: The lore about the handling of the stingless bees is passed on from generation to generation. This traditional handling is understood as a cultural symbol. This type of honey is renowned for its medicinal properties; however, its production is scarce, and the resulting product is very expensive. Consequently, the theft and adulteration of honey has become a major problem, creating mistrust among consumers.

Study Limitations/Implications: More producers should be interviewed, and additional proof of the handling processes used to identify adulteration should be gathered. This information would be used to develop recommendations that could be applied in other producing regions of the country.

Findings/Conclusions: The social and scientific recognition of the properties of stingless bee honey shows the importance of adopting innovations; however, including organizational processes to improve the commercialization channels and to minimize unfair honey production practices is also very important.

Keywords: honey, stingless bees, Cuetzálan, *Scaptotrigona mexicana*.

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INTRODUCTION

In Mexico, meliponiculture was practiced way before the arrival and settlement of the Spanish conquistadors (Alquisira-Ramírez, 2019; Ayala *et al*., 2013). The archaeological

evidence suggests that the Mayans carried out meliponiculture about 2,000 years ago and that stingless bees played an important role in their social, religious, economic, and politic activities (Christoph, 2020; Vit *et al.*, 2013). Plenty of information about this subject can be found in the illustrations of the Madrid Codex (Źrałka *et al.*, 2014). Despite the lack of detailed information about this subject in other regions of México, the diverse ethological and ecological lore —which has been passed on from generation to generation— is living proof that the stingless bees handling took place in other regions of México as well (Chan Mutul *et al.*, 2019). Out of the 46 recorded stingless bee species, 19 are exploited in México (Ayala *et al.*, 2013). In the Yucatán Península, the Mayans still handle the *Melipona beecheii*, while meliponiculture activities are still carried out with the *Scaptotrigona mexicana* species in the Sierra Norte of Puebla (Cuetzalan), the Huasteca Potosina, and the Totanacapan region in Veracruz. Meanwhile, in Sierra de Atoyac (Guerrero), stingless beekeeping is carried out with the *Melipona fasciata* and *Scaptotrigona hellwegerii* species (González Acereto, 2012). In 2002, because of the growing interest in "miel virgen", meliponiculture was revaluated in Cuetzálan. At that point, although the activity was just a fading memory in the minds of some producers, meliponiculture activities were taken up again (Padilla-Vargas and Vásquez-Dávila, 2013). Cuetzálan became the main producer of *S. mexicana* honey in México and is now considered to be one of the main producers of "miel virgen" in the country (Guzmán Díaz *et al.*, 2011). Consequently, the objective of this study was to provide information about the handling, production, and commercialization of the *Scaptotrigona mexicana* stingless bees, as well as the challenges faced by the producers of the Cuetzálan region, México.

MATERIALS AND METHODS

A qualitative method was used for this study. Additionally, interviews were conducted to gather information. The interviews included 45 questions, arranged in four categories: the first category included general information; the second category focused on the practices used to harvest the honey from the stingless bees; the third category referred to the commercialization practices; and the fourth category tried to identify production problems. The following criteria were used to select the participants: they had to be stingless bee honey producers from Cuetzálan and they should be willing to freely take part in this research. Eight producers were contacted using the snowball sampling (*i.e.*, chain reference) described by Navarrete *et al.* (2022). They agreed to be part of an approximately 40-minute-long interview. In addition to the interviews, articles, books, and other scientific communications on this subject were reviewed. A 6-axis trend analysis was carried out, including: a) meliponiculture in Cuetzálan; b) honey harvest process; c) medicinal properties; d) commercialization; e) cultural and environmental value; and f) problems faced by meliponiculture in the study area.

Study area

The research was carried out in the Cuetzálan municipality, located in the Sierra Nororiental of Puebla (19° 57' 00" and 20° 05' 18" N and 97° 24' 36" and 97° 34' 54" W), in the meridional region of the Sierra Madre Oriental (INEGI, 2010) (Figure 1). The

Figure 1. Location of the Cuetzálan Puebla, México.

climate is mostly temperate; however, as a result of its closeness to the tropical climate of the Gulf of Mexico, it has a semi-warm subhumid climate. Rain falls all year long and the area has an uneven topography, as a consequence of which two types of vegetation can be found in this area: cloud forests in the highlands and medium semi-deciduous forests in the low parts (Rzedowski, 2006).

RESULTS AND DISCUSSION

Meliponiculture in Cuetzalan, Puebla

In the Cuetzálan region, the Nahuas call the *S. mexicana* stingless bees *pisilnekmej* ("small bees") (Castillo Hernández, 2020). They handle these bees using two clay pots attached by their rim s, commonly known as *mancuernas* ("dumbbells") (Crane, 1999). Meanwhile, in the Yucatan Peninsula, hollow trunks (called *jobones*) are used to breed the stingless bees (Christoph, 2020; Źrałka *et al.*, 2014). These strategies are part of the indigenous stingless bees breeding legacy in both regions and they are still in use today. Although stingless beekeepers have tried to introduce wooden boxes to improve honey production In Cuetzalan, their attempts have been fruitless because, according them: "*bees tend to abandon artificial hive boxes, because the boxes do not have the appropriate climate characteristics for the region*" (Carmen, personal communication, November 18, 2021). Meliponaries are placed under the overhang of the house (to avoid direct sunlight) or under roof structures nearby the house of the producer (to avoid rainfall). These structures are called *casa de las abejas* ("beehouse") and are usually located near the area of foraging activity: "*we place the bees near coffee, vanilla, banana, orange, jonote, litchi, chalahite, and several sweet flowers*" (Martín, personal communication, November 18, 2021). Consist of clay pots placed on rustic wood, bamboo, or rods: "*we use ashes to attach the mouths of the clay pots or mancuernas, but we must leave a hole for the bees, so they can make the 'trumpet'*. This is the door of the bee colony"

(Margarita, personal communication, November 19, 2021). According to five interviewees: "*the care of the meliponaries is easy. We spend approximately 15 minutes per day, every morning, checking them. We clean the place where they are placed, to protect them from spiders, lizards, birds, and big ants, which sometimes invade the mancuernas*" (Martin, Margarita, Mateo, Julián, and Carmen, personal communications, November 18 and 19, 2021).

Nahua and Totonaco stingless beekeepers are the main stingless bee honey producers in Cuetzalan. Some of the regional stingless beekeepers are independent producers; however, most of them belong to the Sociedad Cooperativa Agropecuaria Regional Tosepan Titaniske. This organization is very important to the community and to the region. Paredes and Rodríguez (2014) pointed out that Tosepan was created in 1980 to deal with the needs of coffee and pepper crops (Garza and Garcés, 2009). However, the interest in stingless bee honey came later (Medina, 2015), leading to the foundation of Tosepan Pisilnekmej in 2017. This organization is fully dedicated to the production of honey from *S. mexicana* (Meza, 2017).

The interviewees said that they owned 10-200 meliponaries; however, other producers of the region own more than 400 stingless bee colonies and have more than 40 years of experience as Melipona stingless beekeepers (Castillo-Hernández, 2020). They have different practices and ideas about their handling. For instance, one of the interviewees said: "*we burn incense before we open the clay pots. This is a small ritual in which we burn some honey, beeswax, and propolis to thank the pisilnekmej*" (Mateo, personal communication, November 19). This is a frequent practice, which has been described in detail by Dávila-Vargas *et al*. (2014). Harvests are usually carried out in the morning; however, some producers prefer to harvest in the evening or at night: "*I harvest at night because at that time the bees are not so attracted by the honey and I also prevent bigger bees [Apis species] from taking the honey*" (Toño, personal communication, November 17, 2021). Nevertheless, producers share some technical aspects, as a result of the meliponiculture information and practices that have been passed on from generation to generation in Cuetzálan: "*our parents learned from their parents. We teach these practices to our sons; we teach them to our daughters before they get married. We also learn from other Melipona stingless beekeepers. At the Tosepan cooperative we participate in courses about the breeding of stingless bees*" (Mateo, Carmen, Toño, Margarita, and Martín, personal communications, November 17, 18, and 19, 2023).

Honey harvest process

In Cuetzálan, *mancuernas* or *nekomit* (*nektsin* —bee and *komit*— pot, from the Náhuatl), are used as beehive box for *S. mexicana* and they are two pots joined s mouths (Padilla-Vargas and Vásquez-Dávila, 2013). The lower pot works as a breeding chamber, while the upper pot is used to store the honey and pollen reserves. This honey is harvested from April to June (Guzmán Díaz *et al.*, 2011). Some interviewees told us that: "*You can also harvest in July and August, but not everybody does it because bees need to feed and it is not right to take it all away from them*" (Martín and Carmen, personal communication, November 18, 2021).

Some stingless beekeepers pointed out that they use cloths to protect their faces, a machete or a knife to separate the *mancuernas*, and ash or clay to seal them again, after the harvesting. This process is also mentioned by Castillo-Hernández (2020). "*we clean the pots*

with a cloth before we separate them, we look for the honey balls [the storage posts] in the upper pot. After that, we squeeze them and we use a net to filter the honey, to remove pollen or wax" (María, personal communication, November 17, 2021). The filtering process is very important because it removes all the impurities that produce a dark amber mass on the surface of the honey, making the product less attractive for the consumers. The identification of the storage posts is fundamental for the harvesting process. The interviewees told us that: "*it's easy, if the balls are soft, then the honey is ready. If the balls are hard, they are filled with pollen [this is called a flower ball]*" (Margarita and Mateo, personal communication, November 19). Two of the interviewees pointed out that some of the stingless beekeepers recently chose to extract the honey with a syringe because this technique is cleaner and preserves the purity of the honey. However, it is a longer process: "*we must carefully wash our hands, the tools, and the clothes or the bees will be frightened by the strong smell*" (Mateo and Julián, personal communication, November 18 and 19).

Medicinal properties

As a result of its medicinal properties, stingless bee honey was very valuable for some pre-Columbian cultures (Christoph, 2020; Vit *et al.*, 2013) and this is the main reason why it is still harvested and commercialized nowadays. The honey produced by *S. mexicana* in Cuetzálan is known for its medicinal attributes: "*our honey is quite good; it helps with the cough, sore throat, burning eyes, gastritis, and it heals wounds*" (Carmen, Martín, Mateo, and Toño, personal communication, November 17,18, and 19). The stingless beekeepers believe that the medicinal properties of the honey come from the sources of foraging activity because the bees collect pollen from healing plants (Dávila, Vargas *et al.*, 2014).

Most of the ethnopharmacological properties that stingless beekeepers associate with the honey of *S. mexicana* have been tested in research carried out with the different species of stingless bees. Some of this research proved that stingless bee honey has anti-inflammatory (Borsato *et al.*, 2014; Vit *et al.*, 2004), antioxidant (Ávila *et al.*, 2018; Biluca *et al.*, 2016), antimicrobial (Boorn *et al.*, 2010; Kimoto-Nira and Amano, 2008; Zamora *et al.*, 2017), and wound-healing (Jalil *et al.*, 2017) properties. Additionally, it can also help to treat cataracts (Pedraza *et al.*, 2015) and foot ulcers caused by diabetes (Grajales-Conesa *et al.*, 2018).

Overall, these therapeutic qualities are the result of its high sugar content, its acidity, the presence of hydrogen peroxide (Mandal and Mandal, 2011), and its vitamin and mineral content, as well as their phenolic compounds (Abu Bakar *et al.*, 2017; Jalil *et al.*, 2017), which are the cause of its antioxidant activity (Aljadi and Kamaruddin, 2004). The phenolic compounds identified include phenolic acids (*e.g.*, salicylic, p-coumaric (Biluca *et al.*, 2016, 2020), pherulic, and ellagic acids) and flavonoids (*e.g.*, myricetin, catechin, and rutin (Sousa *et al.*, 2016), aromadendrin, and taxifolin (Biluca *et al.*, 2020).

Commercialization

In the Sierra Norte of Puebla, the value of stingless bee honey during the 1980s accounted for only one-third of the cost of *Apis mellifera* honey (Medina, 2015). However, the stingless bee honey or "miel virgen" currently has a higher sale price: "*the purchase price*

of our honey has increased, because many people want it, now that its medicinal properties are known" (Julián, Carmen, and Toño, personal communication, November 18 and 19, 2021). The additional income that stingless bee honey can provide to their families has encouraged communities to take care of *S. mexicana* (Escobedo Ávila, 2021).

A 250-mL jar of stingless bee honey is sold at $250.00 Mexican pesos. A liter of this honey costs approximately $800.00-$1,000.00 Mexican pesos. Costs can change, because "*some producers lower the price when buyers go directly to their home. Producers that sell their product through a cooperative must adjust their prices to the price established by the cooperative*" (María and Toño, personal communication, November 17, 2021). Nevertheless, the interviewees pointed out that when the cooperative sells the honey at higher prices than the cost price, the producers receive "*a couple of extra bucks*-" Regardless of this situation, the current sale price cannot be compared with the sale price in countries such as Malaysia, where the stingless bee honey reaches a sale price of up to $100.00 American dollars per kilogram (Shadan *et al.*, 2017).

Taking into account the outstandingly high price of stingless bee honey, stingless beekeepers told us that clients are reluctant to buy this product, especially if they compare the price with the price of *A. mellifera* honey. Meanwhile, commercialization is slowed down as a consequence of the low production per stingless bee colony, which amounts to one liter per year (Chuttong *et al.*, 2014; González-Acereto *et al.*, 2006). Consequently, meliponiculture in Cuetzálan is considered a complementary economic activity. Stingless honey producers mainly work as farmers, day laborers (Guzmán Díaz *et al.*, 2011), traders, and artisans, selling their products in parks and small markets. Nevertheless, meliponiculture has opened possibilities for an alternative source of employment: "*those of us with the greatest experience provide our services during the honey harvesting to new producers or to those that don't have the time to harvest the honey*" (Mateo, personal communication, November).

Cultural and environmental value

Meliponiculture is the practice of breeding stingless bees in artificial hives to obtain products such as honey, beeswax (Lemlin, 2020), pollen, or propolis (Guzmán Díaz *et al.*, 2011). In Cuetzálan, stingless bee breeding is also perceived as a cultural symbol and some stingless beekeepers believe that "*bees stay in those households where love lives*" or that "*when a household lacks harmony, people stop caring for the bees and they leave*" (Carmen and Martín, personal communication, November 18, 2021). Therefore, stingless beekeepers believe that bees can perceive if there is balance in a household. These ideas are part of the regional cultural worldview: stingless beekeeping is the legacy of their ancestors and, consequently, stingless bees and their handling are so much more than an economic exploitation.

As a consequence of their pollination services, stingless bees provide sustenance and guarantee the food safety of the farmers (Alquisira-Ramírez, 2019; Castillo Hernández, 2020). These bees have shared a long evolutionary history with the plants and crops of their place of origin; therefore, their role as pollinators of native crops is considered a yield benefit that cannot be taken lightly (Christoph, 2020; Vit *et al.*, 2013).

Nevertheless, stingless bees face several problems, such as the presence of pesticides and the competition with exotic species (*A. mellifera*). However, one of the most important

problems is felling and the fragmentation of the forests and jungles where these bees feed and naturally build their nest. In Cuetzálan (like in many other regions of México), natural ecosystems such as the cloud forest and the medium semi-deciduous forest have been fragmented, as a consequence of the soil use change caused by agricultural activities, until only relics of the native vegetation remain (INEGI, 1996).

The main crop grown in Cuetzálan is Arabiga bean coffee. In order to provide shade to the crops, producers grow trees such as banana (*Musa sapientum*), lemon (*Citrus limón*), orange (*Citrus sinensis*), or lichi (*Litchi chinensis*). Benítez-García *et al.* (2015) pointed out that, according to the observations of stingless beekeepers, these are some the trees that *S. mexicana* visit on a regular basis; additionally, stingless bees also visit allspice (*Pimenta dioica* (L.) Merr.), lobster claw (*Heliconia rostrata* Ruiz & Pav.), macaw flower (*Heliconia bihai* (L.) L.), holy basil (*Ocimum* spp.), great bougainvillea (*Bougainvillea spectabilis* Willd.), huichin (*Verbesina persicifolia* DC.), American elder (*Sambucus canadensis* L.), chalahuite (*Inga vera* subsp. *Spuria* (Willd.) J. Leon), chocolate pudding fruit (*Diospyros nigra* (J.F. Gmel.) Perrier), mamey sapote (*Pouteria sapota* (Jacq.) H.E.Moore & Stearn), capulín agrio (*Ardisia compressa* Kunth) (Dávila, Vargas, *et al.*, 2014), cinnamon (*Cinnamomum* sp.), scarlet bush (*Hamelia patens*), jonote (*Heliocarpus appendiculatus*), and some wild yellow flowers akin to Devil's beggarticks (*Bidens* sp.). Unfortunately, these food sources of stingless bee do not substitute the food resource from native vegetation; consequently, stingless beekeepers have witnessed how honey production has diminished from one generation to the next. Currently, during low flowering times, they face a major problem since they obtain less than 250 mL per *mancuerna*.

Problems faced by meliponiculture

Adulteration is the main problem caused by low honey production. Stingless bees honey producers mentioned that "miel virgen" can be adulterated with piloncillo (also known as panela), water, "*honey from big bees*" (*i.e.*, *Apis mellifera*), and sugarcane —which, after some time, accumulates at the bottom of the jar. Stingless beekeepers pointed out that adulterated honey "*goes off faster*," resulting in mistrust among consumers. Ávila *et al.* (2018) mentioned that this problem is growing, given the lack of official regulation and quality standards.

Meanwhile, *mancuernas* are stolen. In Cuetzálan, some stingless beekeepers consider *mancuernas* as an inheritance for their children or grandchildren and other stingless beekeepers have bought a stingless bee colony as a consequence of their interest (Padilla-Vargas and Vásquez-Dávila, 2013). This demand for stingless bee colonies promotes the theft and clandestine sale of the *mancuernas*. Some producers told us that "*stolen mancuernas are sold for approximately $400.00-$500.00 Mexican pesos, while owners sell them for approximately $1,000.00 Mexican pesos*" (Toño, personal communication, November 17, 2021). To protect their bees against this well-known activity, several stingless beekeepers prefer to keep the number of *mancuernas* that they possess and their location a secret or to keep guardian dogs near the honeycombs.

Additionally, the lack of government support limits the growth of meliponiculture. Many stingless beekeepers told the interviewers that "*Meliponiculture in Cuetzálan needs*

support; the government should take care of the small producers of "miel virgen". This activity has been carried out for years and it is still waiting for its moment to shine. Producers need support to offer a competitive sale price and to find the right market for their product. And even if this support is provided, many stingless beekeepers do not have computers or cell phones with internet access and, consequently, the information they receive is limited to mouth-to-mouth promotion.

Additionally, the commercialization of "miel virgen" in Cuetzálan faced an unexpected challenge: the COVID-19 pandemic of 2020. This pandemic is known by the Nahuas as *kokolis uejueyinemamaualis kaxtol uan naui* or "the contagious disease from 2019". The health restrictions and the isolation imposed in the whole country drastically reduced the arrival of tourists to the area (Castillo Hernández, 2021). This situation caused a stagnation in the sales of honey because producers sell most of their production to tourists. However, stingless beekeepers are optimistic and hope that tourism will soon be normal again.

CONCLUSIONS

In Cuetzálan, meliponiculture is linked to the indigenous culture. It is not just a way to earn an additional income, it is also a symbol and a part of the regional historical legacy. This legacy has not remained unchanged, because meliponiculture includes lore and beliefs that change and whose understanding changes through time. Cuetzálan has become a place of great interest, as a result of the honey produced by stingless bees; however, it faces several difficulties. Small producers from indigenous communities require support in their fight to turn meliponiculture into a praiseworthy commercial activity.

The social and scientific acknowledgment of the properties of the honey shows the importance of using innovations that enhance the production. A horizontal approach is required, because it encourages producers and researchers to develop alternatives together. Acknowledging lore can be an opportunity to make the most of successful practices and to give a new cultural value to the production of this type of honey. Consequently, organizational processes that improve the commercialization channels and reduce unfair practices in honey production must also be included in this approach.

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