Revista Brasileira de Zootecnia
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ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., v.40, p.48-51, 2011 (supl. especial)

New horizons on stingless beekeeping (Apidae, Meliponini)

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ABSTRACT - Stingless beekeeping, or meliponiculture, is an ancient activity, especially in the Neotropics. Recently, especially in Brazil, it has been flourishing. It is widely practiced in several regions with several species. This is possible because of new advances in our knowledge of meliponine basic biology and in how to manage stingless bee colonies. In this article we give an overview of these advances reached, especially those in Pará State, by the Embrapa Amazônia Oriental and the Universidade Federal do Pará. We focus on advances reached in their techniques for hiving bees, the storage and processing of honey, and food supplementation for healthy colonies. We also point out specific issues that should still be dealt with in order to promote sustainable meliponiculture.

Key Words: hives, honey, meliponine bees, pollen

Novos horizontes na criação de abelhas nativas sem ferrão (Apidae, Meliponini)

RESUMO - A criação de abelhas sem ferrão, ou meliponicultura, é uma atividade antiga, especialmente nos Neotrópicos. Atualmente, especialmente no Brasil, ela experimenta um novo florescimento, sendo amplamente praticada em várias regiões, pela criação de diversas espécies. Isso tem sido possível por avanços no conhecimento de sua biologia básica, assim como em seu manejo. Neste artigo é apresentado um panorama dos avanços alcançados, especialmente no estado do Pará, pelo grupo de pesquisa em abelhas da Embrapa Amazônia Oriental e da Universidade Federal do Pará. Focou-se nos avanços alcançados com as técnicas de manejo de ninhos, o armazenamento e processamento de mel e a suplementação alimentar para as colônias, além de apontar questões específicas que ainda devem ser tratadas para se alcançar uma meliponicultura sustentável.

Palavras-chave: mel, meliponíneos, ninhos, pólen

Introduction

Beekeeping with the honeybee *Apis mellifera* is well known, having been widely practiced since antiquity (Bishop, 2005).However, beekeeping can also be practiced with stingless bees, and is also a viable practice in Brazil (Venturieri et al., 2003; Magalhães & Venturieri, 2010). Currently, stingless beekeeping is attracting more attention from beekeepers and the government, which is regulating beekeeping by creating new laws and management guidelines.

In this article we aim to give an overview of the advances achieved on stingless beekeeping (also known as meliponiculture) in Brazil, especially advances developed in the Pará State by the bee research group of EmbrapaAmazônia Oriental and the Universidade Federal do Pará. We will focus mainly on the development of hives, the processing of honey, and the development of artificial diets as substitutes for honey and pollen.

Background

Stingless beekeeping is an ancient activity, especially in the New World, where it was practiced by the Mayans in the Yucatan peninsula (Villanueva-g et al., 2005) and, on a smaller scale, by other indigenous people in the Americas (Camargo & Posey, 1990; Rasmussen & Castillo, 2003). However, most of the indigenous knowledge of stingless beekeeping was lost, both by the intentional destruction of native culture by Europeans, the slow decline of practice, the rural exodus following industrialization, and the introduction of *A. mellifera* (Villanueva-g et al., 2005).

The only written records of stingless beekeeping by Native Americans that survive to the present day are in the Tro Codex (Cortopassi-Laurino et al., 2006), a small part of the Mayan Codices (Nogueira-Neto, 1997). Almost all the other works were destroyed by the Spanish colonizers.

However, there are efforts, by several research groups, notably in Brazil, Colombia, Mexico and Australia to promote

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stingless beekeeping by studying the great diversity of stingless bees and their applied and basic biology. At least in Brazil, these efforts have led to a new flourishing of meliponiculture, especially by using bees from genus *Melipona*, the larger bees from the group. This has been made possible by several technical advances, especially in the hiving techniques of stingless bees, the processing of honey, and colony food supplementation.

Hives for meliponiculture

One of the main issues for practical meliponi culture is how to extract honey and divide nests for colony propagation. Traditionally, most beekeepers just kept the colony inside a single wood chamber, or logs, without divisions. When a beekeeper wanted to remove the honey, two main options were used. One was to make an opening at the rear the log or chamber and then, with an object, to perforate all honey pots, to allow the honey to drain and be collected (Villanueva-g et al., 2005). Although traditional, this practice is not recommended because the honey passes through the garbage area of the colony and is contaminated. Also, this procedure causes a lot of damage to the colony, which loses several food potsand causes a high mortality of adult bees and the loss of a great percentage of the laid eggs. These eggs are killed by the shaking of the colony, which causes the eggs to sink into the larval food (see Jungnickel et al., 2001).

A breakthrough for stingless beekeeping was the developing of hives that allowed nest divisions and honey extraction without damaging the colony. There are several kinds of hives used for keeping stingless bee colonies. These were developed more or less independently (Portugal-Araújo, 1955; Nogueira-Neto, 1997; Sommeijer, 1999; Oliveira & Kerr, 2000; Venturieri, 2004) and are often species-specific.

For example, the hives developed and used in EmbrapaAmazônia Oriental have different diameter-entrances adapted for the size of the species they are intended to keep (*M. flavolineata*, *M. fasciculata*, and *Scaptotrigona* species) although they can also be used for other species. These hives allow the entry and exit of foragers and provide colonies with a ready-made entrance tube (Venturieri, 2008), which most species naturally build (Nogueira-Neto, 1997). However, the main contribution of this hive is to facilitate easy nest division. This type of hive is modular, and allows the transfer of brood combs to a new hive (Oliveira & Kerr, 2000; Venturieri, 2008). It also makes honey extraction easier, allowing extraction without disturbing with the brood combs (Venturieri et al., 2007).

Substitutes for honey and pollen

A common procedure in animal science is the research of artificial diets for better animal management. Although bees can forage for resources on their own, if they are kept outdoors, they may need to be artificially fed. Bees typically need to be artificially fed after honey harvesting, when the colony loses a certain amount of food storage, and during periods of dearth, when natural food sources are scarcer. Eventually, bees may also be kept in confinement, such as in greenhouses, where they may be used for controlled pollination of certain crops (Venturieri et al., 2010). In this case, supplemental food is also necessary because food is very limited in this kind of environment.

The main food resources bees need for their nourishment are nectar and pollen. Nectar is the main energy source for bees. Pollen is their protein source (Somerville, 2005), and this is especially important for the queen, who needs it to continue to lay eggs and produce new workers. For nectar, some viable recipes have been developed in the research group of EmbrapaAmazônia Oriental. This artificial nectar has achieved good results as measured by considering the ovarian development of the queen and how well it is accepted by the species *M. flavolineata* (Costa & Venturieri, 2009).

In the case of pollen, it is more difficult to find a substitute. Bees are very selective about pollen and throw it away in the garbage area if they do not accept it. A viable option, which was accepted by some species, is a soybean-based substitute with a pollen inoculum, which has some of the characteristics of stored pollen (Fernandes-da-Silva & Zucoloto, 1990). This pollen substitute was tested, and it was consumed by the stingless bees *M. fasciculata* (Pires et al., 2009) and *M. flavolineata* (Costa & Venturieri, 2009). However, the digestibility and nutritional value of this pollen should be further tested, in order it can be used in a broader scale for meliponiculture.

Honey processing

With respect to the honey processing of stingless bees, there have been advances in understanding the chemical properties of stingless bee honey, in how it should be extracted from colonies as well as its processing and pottingfor human consumption. The stingless bee honey has different physical-chemical properties compared with the honey of the honeybee (Vit et al., 2004; Fonseca et al., 2006; Souza et al., 2006; Venturieri et al., 2007), which is the most common honey that is commercialized.

One of these characteristics is the water content of meliponinehoney. Stingless bee honey has a higher water content compared with *A. mellifera* honey. Thus, meliponine honey can ferment much more rapidly and with greater likelihood than honeybee honey (Nogueira-Neto, 1997; Venturieri et al., 2007). This higher fermentation rate is a problem for meliponiculture, because the sale of honey is an important source for income for farmers (Venturieri et al., 2003). Furthermore, unprocessed meliponine honey does not have a long shelf life, as compared with *A. mellifera* honey (Venturieri et al., 2007; Sodré et al., 2008). Nowadays, there are four different methods to deal with fermentation, as described below.

In some regions of Brazil stingless beekeepers developed a method called "maturation process". After harvesting, the honey is maintained in closed recipients at room temperature where the honey is naturally fermented. The containers are opened every week to release the gases produced during fermentation. After about three months the fermentation stops and the honey can be stored in room temperature for a long period without deteriorating. Although this method changes the natural characteristics of the honey to a more acid flavor, many people appreciate it (Drummond, 2010). This process was an important solution to places where energy source is difficult, like in indigenous communities, but still need more research to be fully understood.

A solution to this problem, adopted by Embrapa Amazônia Oriental, as well as in other institutions, is pasteurization. The pasteurization process involves heating the honey up to 60-70ºC, followed by its natural cooling at ambient temperature. The honey is pasteurized in the container in which it will be sold and stored on the shelf. This avoids contamination that could occur if the honey were to be transferred to a new jar. This process makes the honey sterile. It then has a shelf life up to 2 years after the date of pasteurization. The entire pasteurization process is described in Venturieri et al. (2007). There may have slight changes in the honey flavor and it affects some enzymes of the honey, but represents a good method for commercializing it.

Another procedure adopted is to keep the honey under refrigeration after the honey harvesting. Some kinds of honey can crystallize with this method, although the liquid appearance of the natural honey is lost, the process provides special texture to the honey. In this process the natural properties of the honey are maintained for few years without fermentation, however it makes more difficult to commercialize because need to be refrigerated since harvesting until consumption.

These solutions make the commercial consumption, storage, and sale of stingless bee honey far more viable. However, there are still some problems that should be dealt with in order to make commercial meliponiculture more feasible. The most serious issue is that the Ministry of Agriculture, based on the *Codex Alimentarius*, defines "honey" as a product of the honeybee, *A. mellifera* (Codex Alimentarius, 1981). Thus, since stingless bee honey differs in several characteristics from *A. mellifera* honey, it can not be sold "honey". In Brazil, some groups have tried to dehydrate meliponine honey (Sodré et al., 2008), thus allowing it to conform to the physical-chemical standards of the "official" honey. It is viable solution, and can be stored at room temperature without fermentation, but affects the natural flavor and texture of the stingless bee honey and makes it very similar to *Apismellifera*'s honey.

Conclusions

Meliponiculture was, for several years, considered to be a recreational activity, since colonies were thought to be low-productive compared with the honey bee. However, meliponiculture is being shown, by several studies, to be a feasible and profitable activity, especially for low-income farmers (e.g. Venturieri et al., 2003), and also for people interested in using them as pollinators of commercial crops(Heard, 1999; Cortopassi-Laurino et al., 2006). There have been advances on their management techniques, as shown in this article, but there are still many advances to be done, especially in legal area, regarding the stingless bee honey regulation, and the acquisition of natural nests. It must be stressed that natural nests to increase or start a meliponary are not difficult to find anymore, and they must be obtained in a sustainable way in order to avoid the depletion of natural populations and an increase in deforestation (Venturieri, 2009).

Acknowledgements

We thank Dr. James Nieh for his critical review of the manuscript and linguistic advice.

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