Opinion

Open Access

The emerging market of propolis of stingless bees in tropical countries

Abstract

Propolis is hive product containing chiefly beeswax and resin derived from plant tissues or exudates. Many health benefits derived from propolis have been pointed out. International market of propolis is represented solely by propolis produced by *Apis mellifera*. In tropical countries there has been a trend toward consumption of products from hives of native bees. Among them stand out species of Meliponini, many of them characterized as stingless bees. Studies about propolis of stingless bees have indicated that they are chemically similar with honey bee propolis. Several biological activities of propolis of stingless bees have been reported, such as antimicrobial and anti-tumoral. Stingless beekeeping is an emerging market in several parts of the world, with the possibility of being practiced in forest habitats. In Brazil, it has favorable perspectives of bringing about economic, social and environmental benefits.

Keywords: meliponini, pollination, phenolic substances, flavonoids, antimicrobial activity, anti-tumoral activity

Volume 7 Issue 2 - 2019

Antonio Salatino, Leonardo Regnier L Pereira, Maria Luiza Faria Salatino
Department of Botany, University of São Paulo, Brazil

Correspondence: Antonio Salatino, Department of Botany, Institute of Biosciences, University of São Paulo, Rua do Matão 277, 05508-090, São Paulo, SP, Brazil, Tel (+5511)3091-7532, Email asalatin@ib.usp.br

Received: February 28, 2019 | **Published:** March 12, 2019

Introduction

Propolis is a honey bee product commercialized internationally as a complementary and functional food, although it is also used widely in traditional and popular medicine. A wide diversity of industrial products containing propolis is available in several countries, including tinctures, sprays, candies, ointments, creams and toothpastes. Propolis contains chiefly beeswax and resin, which is collected by laborer bees from plant buds or exudates. Major countries regarding propolis production are Russia, China and Brazil. In the latter country, propolis is produced by colonies of Africanized *Apis mellifera* (family Apidae, subfamily Apinae). All propolis produced in Brazil derives from resin collected by bees from plants growing in the wild. Two plant species stand out as propolis resin sources: *Baccharis dracunculifolia* (the source of Brazilian green propolis)[1] and *Dalbergia ecastaphyllum* (source of red propolis).[2]

In tropical habitats, there is a wide diversity of other species of bees of the subfamily Apidae. Among them, stand out species of the tribe Meliponini. Because these bees are unable to sting, they are known as stingless bees. Recent estimates admit that there are 391 species of meliponine in the tropical New World.[3] Relevant examples of stingless bee species native in Brazil are: *Melipona compressipes* ("jupará"), *M. fasciculata* ("tiúba"), *M. marginata* ("manduri"), *M. quadrifasciata* ("mandaçaia") and *Tetragonisca angustula* ("jataí"), among many others. Some species have recently acquired economic relevance, although their taxonomic status is still pending; an example is the "tubi" bee (*Scaptotrigona* aff. *postica*) from the state of Maranhao (northeast Brazil). Different from *Apis mellifera*, whose hives grow optimally only in open habitats, many species of stingless bees are adapted to forest habitats. In fact, the pollination of many forest species is benefited by workers of stingless bees,[4,5] in addition to the benefits that these bees bring about as pollinators of crop species.[6,7]

Domestication of stingless bees and exploitation of their products and gains derived from crop pollination by these insects date to pre-Colombian times.[5] Mayan civilization practiced meliponiculture by means of a bee species they called Xuna-Kab (*Melipona beecheii* Bennett). Thus, they obtained honey, wax and resin. Mayan meliponiculture was not only a source of food and medicine, but the honey and cerumen produced were used in religious ceremonies.[5] For centuries, Kayapó Indians from Brazilian Amazon have been using natural nests of several bee species to obtain honey, brood and pollen. Bee species involved include *Melipona seminigra pernigra*, *M. melanoventer*, *M. rufiventris flavolineata*, *Scaptotrigona nigrohirta* and *S. polysticta*.[8]

Propolis from stingless bees: composition

Usually, propolis from stingless bees has been characterized as distinct from propolis obtained with *Apis mellifera* because meliponine bees add clay (soil) or mud to their propolis. For this reason, propolis from some species of stingless bees is called "geopropolis". On the other hand, there are meliponine which produce propolis with no aggregation of clay or mud.

Meliponine propolis plays the same biological role as the propolis from *Apis mellifera*, i.e. it is used in the hive to seal holes and crevices, line the entrance of the hive and protects the community against microbial infections. Thus, it is expected that meliponine propolis has composition and biological activities similar with the propolis from European and Africanized honey bees. Not much has been studied about meliponine propolis. Nonetheless, the data available indicate that propolis from both stinging and stingless bees are similar regarding composition and biological properties. Reviews about chemistry and therapeutic effects of propolis from stingless bees have been published.[9] All in all, it seems that the classes of compounds commonly found as constituents of *Apis mellifera* propolis characterize also meliponine propolis. Flavonoids have been found frequently in meliponine propolis. For example, the flavonols 3'-methyl quercetin (**1**) and kaemferol-7-methyl ether, the flavone tricetin (**2**), the flavanone sakuranetin (**3**) and the flavanonol aromadendrin 7-methyl ether were isolated from propolis of the nest of *Trigona spinipes* ("arapuá"), together with cycloartane triterpenes, such as mangiferolic acid (**4**). It was concluded that the plant source of

resin is an exudate of the bark of *Eucalyptus citriodora*.[10] Prenylated cinnamic acids characteristic of Brazilian green propolis, such as artepillin C (**5**), were also detected in propolis from *Tetragonisca angustula* ("jataí").[11] Volatile terpenes, which are components of essential oils, have been detected as resins carried by bees of three species of *Frieseomilitta silvestrii*.[12] Examples of these substances are the monoterpene borneol (**6**) and the sesquiterpene spathulenol (**7**). Triternoids, such as β-amyrin (**8**) were also detected in the same resin.

The high resemblance between the chemical profile of the propolis from *Apis mellifera* and propolis from meliponine suggests that the same plant sources provide resin for both groups of insects. Probably *Baccharis dracunculifolia* was the source of artepillin C (**5**), detected in propolis of *Apis mellifera* and *Tetragonisca angustula*.[13] Recent studies indicated *Tetragonisca angustula* seems to exhibit preference for resin from *Schinus terebinthifolius* (Anacardiaceae), *Lophanthera lactescens* (Malpighiaceae) and *Araucaria angustifolia*.[13] Young tissues have been shown to be the source of resin for a green propolis of Africanized honey bees and for geopropolis of *Scaptogrigona* aff. *depillis* as well.[14,15]

Some chemical characteristics observed in propolis of meliponine seem to deviate from the chemical profile of propolis from honey bees (Figure 1). Flavonoids from propolis of *Apis mellifera* are commonly not glycosylated, because it has been shown that honey bee glycosidases in the saliva of honey bees hydrolyze flavonoid glycosides.[16] However, glucosides such as myricetin-3-O-glucoside and naringenin-4'-glucoside were detected in propolis of *Melipona interrupta*.[17] Either meliponine (or at least *M. interrupta*) have no glycosidases in their saliva or the plant resin is not treated with the meliponine saliva in the same way *Apis mellifera* does when it produces propolis. This seems to be a point to be investigated in the research of meliponine propolis. Another aspect differentiating honey bee propolis from meliponine propolis regards the recent report of pyrrolizidine alkaloids in the geopropolis of *Scaptotrigona postica* from the state of Maranhão (southeast Brazil).[18] It has been argued that some classes of secondary metabolites have never been reported as constituents of honey bee propolis,[19] among them the alkaloids. It seems that *Apis mellifera* and meliponine may have distinct sensitivity to chemicals present in plant resins. Because many pyrrolizidine alkaloids are widely known as toxic (particularly to the liver), caution seem to be necessary toward consumption of propolis from meliponine.

Propolis from stingless bees: biological activity

Similar with the research on honey bee propolis, most papers reporting biological properties of meliponine propolis have dealt with antioxidant and antibacterial activitiy. Antibacterial and antifungal activity of propolis from a considerable diversity of meliponine has been evaluated.[9] Most studies have dealt with *Staphyloccocus aureus*, in general with positive results. Satisfactory activity has been obtained also against other Gram-positive bacteria, such as *Micrococcus luteus*, *Streptoccocus mutans* and *S. pyogenes*. Negative and positive results have been obtained in tests against the Gram-negative *Escherichia coli* and *Pseudomonas aeruginosa*. Positive results have been obtained in essays against pathogenic fungi, such as *Candida albicans* and *Trichophyton rubrum*. Results about inhibition of growth of cancer cells involving extracts of meliponine propolis are scarce. Antitumoral activity have been reported for extracts of *Melipona fasciculata*, *Scaptotrigona* spp. and *Tetragonisca angustula*.[9] Anti-HSV (herpes simplex virus) activity was observed using extract of geopropolis from *Scaptotrigona postica*.[17] Distinct from studies about biological activity of honey propolis, nothing or very little has been done with meliponine propolis regarding biological effects such as anti-inflammatory, antinociceptive, ardioprotective, gastroprotective, hepatoprotective, hypoglycemic, immune-modulatory and wound-healing.

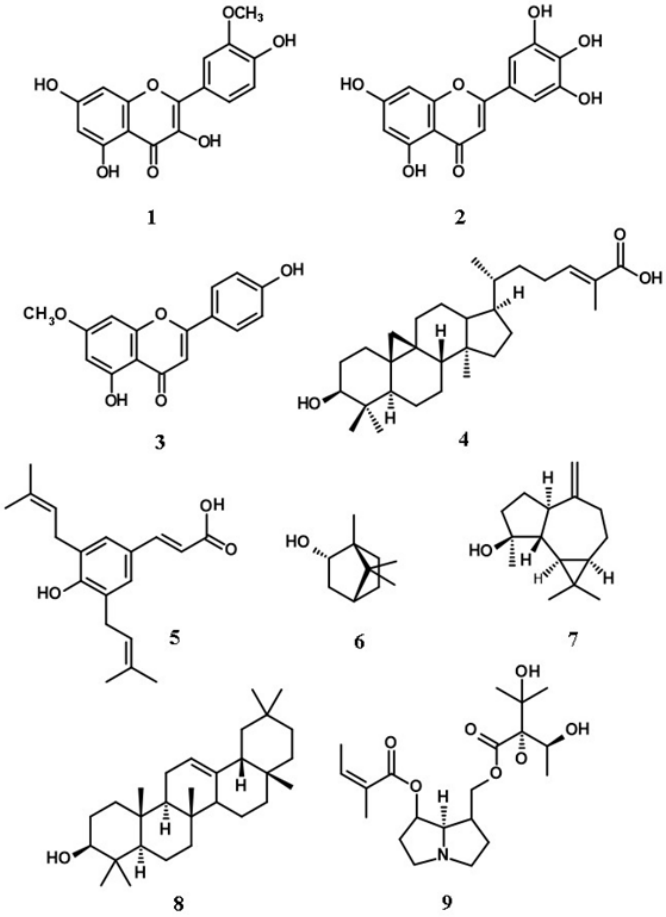

Figure 1 Chemical profile of propolis from honey bees.

Propolis from stingless bees–economic and social perspectives in tropical regions

In the past 30 years, the focus in many apiaries in Brazil has shifted from honey to propolis. In certain areas of the littoral of northeast Brazil, the production of red propolis took over crab fishing in mangroves by many local families, which meant a substantial economic and social improvement in the region. So far, the production of meliponine propolis has no chance of competing with honey bee propolis, at least in productivity, since Africanized bees are far more productive than stingless bees. This comment holds not only for honey, but also for propolis. It has been estimated that the amount of propolis produced by a hive of honey bee lies in the range 150-200 per year.[20] Propolis yield of hives of stingless bee vary widely, but generally far below that estimate. However, meliponiculture is an activity that has gained momentum in several parts of Brazil. In the state of São Paulo, stingless beekeeping has been practiced by people with little commercial interest while highly motivated by leisure and conservationist reasons regarding native bees.[21] Similar trend has been reported regarding meliponiculturists from Australia.[22] In other parts of Brazil, however, stingless beekeeping (meliponiculture) has been practiced with commercial interest, trying to meet the growing

demand of products of native bees.[23] Despite many difficulties that need to be overcome to stimulate and strengthen the market of products from hives of native bees, stingless beekeeping in Brazil has experienced some growth in recent times. *Propolis*es from several species are available for purchase, such as propolis of "jataí" (*Tetragonisca angustula*), "mandaçaia" (*Melipona quadrifasciata*), "tiúba" (*Melipona fasciculata*) and "tubi" (*Scaptotrigona* aff. *postica*).

Conclusion

In addition to the possibility of spreading propolis, honey and pollen markets, stingless beekeeping may represent an economic social input in many tropical areas, such as the northeast and north of South America. These are areas in the Brazilian territory with the most serious economic and social needs. Most communities of indigenous people live in the northern region. Besides the exploitation of the hive products, other benefits may be gained with stingless beekeeping, such as increments in the rate of pollination of forest and crop species, with the possibility of increasing the harvest in small scale agriculture, still practiced in many areas of tropical countries.

Acknowledgments

AS is fellow researcher of CNPq (Conselho Nacional do Desenvolvimento Científico e Tecnológico, Brazil).

Conflicts of interest

None.

References

1. Salatino A, Salatino MLF. Why do honeybees exploit so few plant species as propolis sources? *MOJ Food Process Technol.* 2017;4(5):158–160.
2. Salatino A, Salatino MLF. Brazilian red propolis: legitimate name of the plant resin source. *MOJ Food Process Technol.* 2018; 6(1);21–22.
3. Moure JS, Urban D, Melo GAR. *Catalogue of bees (Hymenoptera, Apidae) in the neotropical region*. *Curitiba, Sociedade Brasileira de Entomologia*. 2007; 39(4):387.
4. Liow LH, Sodhi NS, Elmqvist T. Bee diversity along a disturbance gradient in tropical lowland forests of south–east Asia. *J Appl Ecol.* 2001;38(1):180–192.
5. Schuhli GS, Machado AMB. *Abelhas nativas sem ferrão (Meliponini) e serviços de polinização em espécies florestais*. Colombo. 2014. 31 p.
6. Brosi BJ. The complex responses of social stingless bees (Apidae: Meliponini) to tropical deforestation. *Forest Ecol Manag.* 2009;258(9);1830–1837.
7. Slaa EJ, Sánchez CLA, Malagodi–Braga KS, Hofstede FE. Stingless bees in applied pollination: practice and perspectives. *Apidologie*. 2006;37(2);293–315.
8. Cortopassi–Laurino MC, Imperatriz–Fonseca VL, Roubik DW, et al. Global meliponiculture: challenges and opportunities. *Apidologie*. 2006;37(2):275–292.
9. Sanches MA, Pereira AMS, Serrão JE. Pharmacological action of extracts of propolis of stingless bees (Meliponini). *J Apic Res.* 2017;56(1):50–57.
10. Freitas MO, Ponte FAF, Lima MAS, Silveira ER. Flavonoids and triterpenes from the nest of the stingless bee *Trigona spinipes*. *J Braz Chem Soc.* 2008;19(3):532–535.
11. Miorin PL, Levy Jr NC, Custodio AR, Bretz WA, Marcucci MC. Antibacterial activity of honey and propolis from Apis mellifera and Tetragonisca angustula against Staphylococcus aureus. *J Appl Microbiol.* 2003;95(5):913–920.
12. Patricio EFLRA, Cruz–López L, Maile R, et al. The propolis of stingless bees: terpenes from the tibia of three Frieseomelitta species. *J Insect Phys.* 2002;48(2):249–254.
13. Sanches MA, Pereira AMS, Serrão JE. Pharmacological actions of extracts of propolis of stingless bees (Meliponini). *J Apic Res.* 2017;56(1):50–57.
14. Ferreira JM, Fernandes–Silva CC, Salatino A, et al. Antioxidant activity of a geopropolis from northeast Brazil: Chemical characterization and likely botanical origin. *Evid Based Complementary Alternat Med.* 2017:4024721.
15. Ferreira JM, Fernandes–Silva CC, Salatino A, et al. Antioxidant activity of a geopropolis from northeast Brazil: Chemical characterization and likely botanical origin *Evid. Based Complementary Alternt Med.* 2018:7084284.
16. Zhang CP, Zheng HQ, Hu FL. Extraction, partial characterization, and storage stability of β–glucosidase from propolis. *J. Food Sci.* 2010;76(1):C75–C79.
17. Silva ECC, Muniz MP, Nunomura RDS, et al. Phenolic constituents and antioxidant activity of geopropolis from two species of Amazonian stingless bees. *Quim. Nova*. 2013;36(5):628–633.
18. Coelho GR, Mendonça RZ, Vilar KS, Figueired CA, Badari JC, Taniwaki N, Namiyama G, Oliveira MI, Curti SP, Silva PE, Negri G. Antiviral action of hydromethanolic extrato f geopropolis from *Scaptotrigona postica* against antiherpes simplex vírus (HSV–1). *Evid Based Complementary Alternat. Med.* 2015. 10 p.
19. Salatino A, Fernandes–Silva CC, Righi AA, et al. Propolis research and the chemistry of plant products. *Nat Prod Rep.* 2011;28(5):925–936.
20. Kuroptnicki AK, Szliszka E, Krol W. Historical aspects of propolis research in modern times. *Evid Based Complementary Alternat Med.* 2013. 11 p.
21. Barbiéri Jr. *Caracterização da meliponicultura e do perfil do meliponicultor no estado de São Paulo: ameças e estratégias de conservação de abelhas sem ferrão*. 2018. 83 p.
22. Halcroft MT, Spooner–Hart R, Haigh AM, et al. The Australian stingless bee industry: a follow–up survey, one decade on. *J Apic Res.* 2013;52(2)1–7.
23. Jaffé R, Pope N, Carvalho AT, et al. Bees for development: Brazilian survey reveals how to optimize stingless beekeeping. *PlosOne*. 2015;10(3): e0121157.