FOOD STANDARDS Australia New Zealand
Te Mana Kounga Kai – Ahitereiria me Aotearoa

8 May 2024

289-24

Supporting document

Risk and technical assessment
Application A1257 – Australian native bee honey

Executive summary

Food Standards Australia New Zealand (FSANZ) received an application from the Australian Native Bee Honey Association Inc. to vary the Australia New Zealand Food Standards Code (the Code) to include a definition, compositional requirements and requirement for a prescribed name for honey produced by stingless bees native to Australia. The applicant claims that in contrast to honey produced by honey bees, native bee species produce honey containing higher concentrations of the sugar trehalulose, less total reducing sugars and more moisture.

FSANZ has undertaken an assessment to determine the differences between Australian native bee honey and European honey bee honey and to evaluate potential public health and safety concerns that may arise from the consumption of Australian native bee honey.

Australian native bees of interest are of the genera *Tetragonula* and *Austroplebeia* and therefore are not honey bees, which are within the genus *Apis* of the bee clade, all native to mainland Afro-Eurasia. Australian native bee honey does not meet the compositional requirements for honey in the Code as follows:

- the minimum reducing sugar content of native bee honey is 50%, less than in honey bee honey
- the maximum moisture content found in native bee honey is 28%, more than in honey bee honey.

There is no convincing evidence that consumption of native bee honey at the requested compositional requirements present a health risk to the general population if beekeepers apply good hygienic practice during harvest and processing. Risks to vulnerable populations are comparable to those from consumption of honeybee honey. In particular:

- Trehalulose consumption does not appear to have any adverse effects in humans.
- It is possible for honey from honeybees to contain hazardous natural substances such as alkaloids synthesized by plants. The risk of dietary exposure to such contaminants is similar for native bee honey.
- Infants are at risk from honey contaminated with *Clostridium botulinum* spores, regardless of the source of that honey.
- Fermentation and natural microflora in native bee honey are unlikely to cause illness.
- Some individuals are allergic to pollen, propolis or royal jelly in honeybee honey. Native bee honey most likely poses similar risks to sensitive individuals.

Table of Contents

1 Introduction

The Australian Native Bee Honey Association Inc applied to Food Standards Australia New Zealand (FSANZ) to amend the Australia New Zealand Food Standards Code (the Code) to include a definition, compositional requirements and requirement for a prescribed name for honey produced by stingless bees native to Australia.

The objectives of this risk and technical assessment were to:

- determine the differences between Australian native bee honey and European honeybee honey
- evaluate potential public health and safety concerns that may arise from the consumption of Australian native bee honey.

Native stingless bees and European honeybees share many of the same floral sources for nectar and pollen, however native bees are known for their smaller foraging distance (Zhou *et al.*, 2018). In Australia, Aboriginal and Torres Strait Islander peoples have a long history of safely using honey from native bees, such as the stingless bees (*Tetragonula* spp), for both food and medicinal purposes. Records exist of early European settlers also consuming honey from Australian native bees.

When European settlers arrived in Australia, they introduced the European honeybee (*Apis mellifera*). As European settlement spread across Australia, so did keeping European honeybees. Over the years, the European honeybee honey industry grew, with various regions in Australia becoming known for particular honey varieties, such as eucalyptus and macadamia honey.

In recent years, there has been a growing recognition and appreciation for the traditional knowledge and cultural practices of Aboriginal and Torres Strait Islander peoples related to honeys and native bees (Perichon *et al.* 2021). FSANZ recognises and appreciates the traditional knowledge and cultural practices of Aboriginal and Torres Strait Islander peoples related to honeys and native bees. The significance of native bees in Australian ecosystems and their potential for sustainable pollination and honey production has gained attention (Bernauer *et al.* 2022).

There has also been a growing interest in commercialising native bee honey (Halcroft *et al.* 2013). The production of native bee honey is limited by the bees' small colonies and the small amount of honey (1 kg per hive per year) they produce compared to European honeybees. This scarcity makes native bee honey a niche food product with a high commercial value.

Different floral sources yield European honeybee honey with distinct flavours, colours and other properties. However, native bee honeys have a unique flavour and are composed of sugars and other components that differentiate it from other honeys. As with European honeybee honey, they are a suitable ingredient in food, potentially contributing flavour and functional attributes to a wide range of products.

There are 28 species of native bees in New Zealand (Hart 2007). They do not have hives or produce honey like honeybees. Therefore, native bee honey cannot be produced in New Zealand.

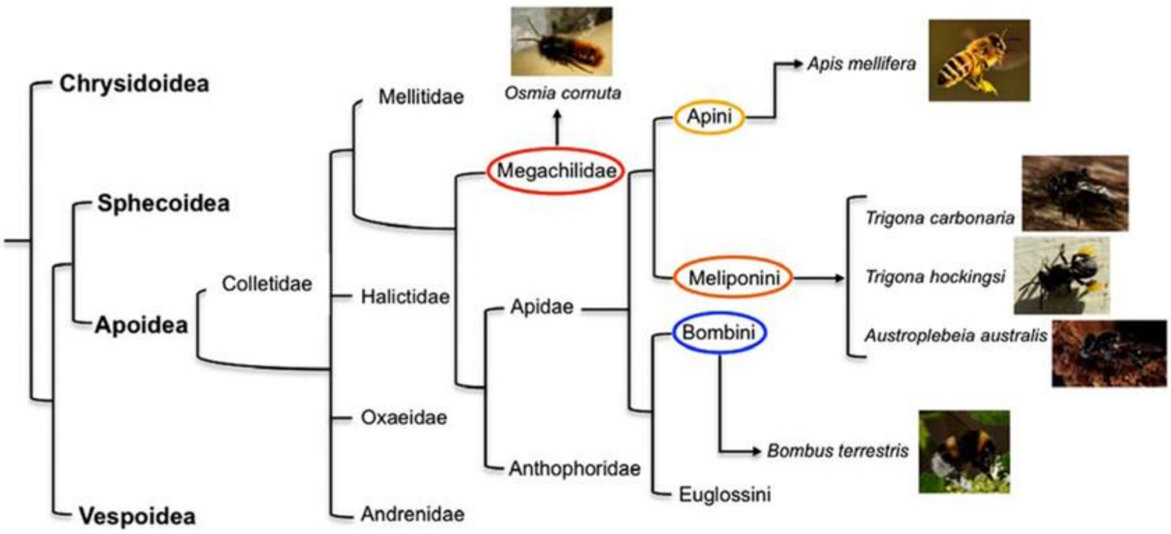
2 Food Technology Assessment

2.1 Identity and purity

Apidae is the largest family within the superfamily Apoidea, containing at least 5700 species of bees. The family includes honeybees but also includes stingless bees also used for honey production (Figure 1)[1]. Stingless bees belong to the tribe Meliponini, honeybees to the tribe Apini.

Currently, the definition for honey in the Code includes … *the natural sweet substance produced by honey bees*…. A honeybee is a eusocial flying insect within the genus *Apis* of the bee clade, all native to mainland Afro-Eurasia (Han et al. 2012, Whitefield et al. 2006). In Australia, this refers to *Apis mellifera* (Ruttner 2013). In contrast, stingless native bees of interest are of the genera *Tetragonula* and *Austroplebeia* and therefore are not honeybees.

Figure 1: A family tree for Apidae (Frasnelli 2013)[2]



Native honeys usually have a unique pollen profile corresponding to the local flora of the region where it was produced (Sniderman *et al*. 2018, da Costa *et al*. 2018) The isotopic composition of such honey will also vary based on the plants the bees feed on and the local environmental conditions (Liu *et al*. 2023). Specific compounds or markers found in native honey can indicate origin and quality. Native bee honeys often have unique sensory

[1] The family Apidae includes, in addition to its historical classification (honey bees, bumble bees, stingless bees, orchid bees), all the genera previously classified as Anthophoridae and Ctenoplectridae (Michener, 2007). Most apid bees, including several cleptoparasitic species, are solitary despite the most visible members of the Apidae being social (O'Toole and Raw, 1999). In the old family Apidae, there were four tribes (Apini, Euglossini, Bombini, Meliponini), all of whom have been reclassified as tribes of the subfamily Apinae, along with all of the former tribes and subfamilies of Anthophoridae and the former family Ctenoplectridae, which has been demoted to tribe status. A 2005 Brazilian classification places all existing bee families under the name "Apidae" (Melo and Gonçalves 2005).

[2] The diagram labels *Tetragonula carbonaria* and *Tetragonula hockingsi* as ‘Trigona’. *Trigona* was a genus name in use from the 1960's until 2013, when it was changed to *Tetragonula* (Roubik 2013).

characteristics due to the local flora and environmental conditions (Saludin *et al.* 2019, Deliza and Vit 2012).

Honeys from Australian native bees usually have a lower fructose and glucose content on a w/w (weight for weight) basis than conventional honeys. However, all honeys' sugar profiles depend on the nectar source, the season and other factors. Consequently, the concentration of these sugars is not a characterising feature of native bee honey (Zawawi et al. 2022).

Besides reducing sugars[3], honey contains other sugars, such as sucrose and maltose. They are present in lower concentrations than fructose and glucose, or not present at all. Typically, sucrose may be 3-4% of the total sugar w/w of honeybee honeys. The amount of sucrose detected in stingless bee honey ranges from traces to 32 g/100 g, about 4 g /100 g on average, very similar to honeybee honey (Zawawi et al. 2022).

The key characteristics of honey (from honeybees) and stingless bee honey are set out in Table 1.

Table 1: Key characteristics of honey (from honeybees) and stingless bee honey

	honey (from honeybees)	stingless bee honey
Major carbohydrate	Sugars	sugars
Typical total sugar	71-73 g/100 g	62-66 g/100 g
Typical reducing sugars	At least 60%	55 to 62%
Typical sucrose	3-4%	4%
trehalulose	Traces only	at least 2%
Moisture content	Less than 21%	17 to 28%

The most differentiating feature of native bee honey is the high concentration of trehalulose compared to conventional honeys. Trehalulose is a disaccharide made up of a molecule of fructose bound to a glucose molecule. Like isomaltulose, it is a structural isomer of sucrose, also found in small quantities in conventional honey. Trehalulose is a reducing sugar because the anomeric carbon of the fructose moiety is not involved in the glycosidic bond (Chen *et al.* 2022). See section 3.2 below for information about the trehalulose content of native bee honey.

Establishing the identity and purity of native bee honey can be carried out using various methods that may find whether the honey is genuine, pure and produced by native bee species in a specific region (Ávila *et al.* 2018). Emerging technologies like blockchain can be used to create transparent supply chains (Jahanbin *et al.* 2023), allowing consumers to trace the journey of honey from hive to table and verify its authenticity.

Methods that are used to test the authenticity of honey include:

- Pollen Analysis (e.g. Sniderman et al. 2018)
- Isotope Analysis (e.g., Liu et al. 2023)

[3] Sugar that serves as a reducing agent due to its free aldehyde or ketone functional groups in its molecular structure. Examples are glucose and fructose.

- DNA Barcoding (e.g. Manivanan et al. 2018)
- Chemical Composition Analysis (Zawawi et al. 2022)
- Sensory Evaluation (e.g. Deliza & Vit 2012)
- Microscopic Analysis (e.g., Mehryar & Esmaiili 2011).

Combining multiple testing methods can supply a comprehensive picture of the native bee honey's origin and authenticity.

2.2 Total sugar content

Carbohydrates in the form of sugars are the major constituents of honey. Total sugar content of honeybee honey varies with botanical origin (Tafere 2021, Shamsudin et al. 2019). The Australian Food Composition Database - Release 2.0[4] lists the total sugar content of honeybee honey as 103.4 g/100 mL (72.8 g/100 g). The New Zealand Food Composition Data[5] base list the sugar content of multifloral honeybee honey as 70.5 g/100 g.

The total sugar content of native bee honey reported is lower than honeybee honey: 62.3 g/100 g for *T. carbonaria* honey, 65.5 g/100 g for *A. australis* honey (Oddo et al. 2008, Haley and Heard 2021).

2.3 Reducing sugar and moisture content

Under the current requirements in the Code, a food that is sold as ‘honey’ must contain no less than 60% reducing sugars and no more than 21% moisture. Native bee honeys contain more water and less reducing sugars than conventional honeys (Oddo *et al.* 2008, Zawawi et al. 2022).

In a comprehensive review of 40 studies of stingless bee honeys around the world the average moisture content was 28% and the average reducing sugar content was 56 g/100 g (Nordin et al. 2018). The moisture content of honeys from Australian native bees ranges from 17 to 28% (Oddo et al.2008, Haley and Heard, 2021, Zawawi et al. 2022). The content of reducing sugars in honey from Australian native bees ranges from 55 to 62 g/100 g (Oddo et al. 2008, Haley and Heard 2021, Zawawi et al. 2022).

[4] Australian Food Composition Database (foodstandards.gov.au)

[5] Home - New Zealand Food Composition Database

2.4 Food technology conclusion

- Australian native bees of interest are of the genera *Tetragonula* and *Austroplebeia* and therefore are not honeybees, which are within the genus *Apis* of the bee clade, all native to mainland Afro-Eurasia.
- There is a history of use of native bee honey in Australia dating back thousands of years.
- Native bee honeys usually have a higher moisture content and lower reducing sugar content.
- Native bee honeys often have unique sensory characteristics due to the local flora and environmental conditions. The most differentiating feature of native bee honey is the high concentration of trehalulose compared to conventional honeys.
- Native bee honey does not meet the compositional requirements for ‘honey’ in the Code as follows:
  - The minimum reducing sugar content of native bee honey is 50%, less than in honeybee honey (at least 60%).
  - The maximum moisture content found in native bee honey is 28%, more than in honeybee honey (less than 21%).

3 Safety assessment

3.1 Safety of contents of native bee honey

Consideration of the safety of native bee honey includes the safety of contents intrinsic to the honey that differ from that of honeybee honey (i.e. trehalulose) and consideration of potential contaminants, including the allergenic potential and the hazards of natural substances (e.g. plant alkaloids).

3.2 Trehalulose

Analysis of the sugars present in the honey of native stingless bees shows a prominent level of the sugar trehalulose (1-O-α-D-glucopyranosyl-D-fructose). The trehalulose content of honey from bees of the genus *Tetragonula* was reported to range up to as high as 48.7 g/100 g, with an average value of 18.5 g/100 g (n = 89), while the trehalulose content of honey from bees of the genus *Austroplebeia* was reported to range up to as high as 15.0 g/100 g, with an average value of 4.5 g/100 g (n = 22) (Fletcher, Hungerford and Smith, 2021). Trehalulose has also been reported in honey produced by honeybees (*Apis mellifera*), but at lower levels. Nakajima *et al.* (1990) reported levels of 0.5 to 2.5 g/100 g in a sample of nine honeybee honeys in Japan. De la Fuente *et al.* (2011) reported a mean trehalulose content ranging from 0 to 3.3 g/100 g in Spanish honeybee honeys, with a mean value of 1.14 g/100 g (n = 110).

Trehalulose is a disaccharide, an isomer of sucrose but with an α-(1→1) glycosidic linkage between the glucose and fructose moieties. Fletcher, Hungerford and Smith (2021) showed that native stingless bees fed a diet containing sucrose produce honey containing trehalulose, and native stingless bees with no sucrose in their diet do not produce honey containing trehalulose.

A literature review conducted by FSANZ did not locate any evidence of adverse effects of trehalulose consumption. On the contrary, Ooshima *et al.* (1991) found that trehalulose was less cariogenic than sucrose in rats infected with Streptococci known to be associated with dental caries. No adverse effects of consuming trehalulose at up to 56% of the diet for 58 days were observed in the rats.

Mizumoto and colleagues were granted a European patent in 2004 for the use of trehalulose and/or palatinose in nutritional compositions for controlling blood glucose levels of patients suffering from diabetes or glucose intolerance, or for obesity prevention. Wach *et al.* (2010) were granted a European patent in 2010 for a method of producing a trehalulose-containing substance for use in human food and animal feeds, to take advantage of the non-glycaemic and non-insulinaemic properties of trehalulose. The non-cariogenic nature of trehalulose was also mentioned in the patent application. Kowalczyk *et al.* (2015) filed a patent in the USA for the use of trehalulose as an antioxidant in food, animal feed, cosmetics and pharmaceuticals, after finding that that the addition of trehalulose or trehalulose-containing syrup markedly improves the oxidative stability of food or animal feed. In their patent application, they reported that trehalulose shows a much greater antioxidative effect than other known reducing sugars.

3.3 Pollen, propolis and royal jelly

There is potential for native bee honey to contain pollen, propolis and/or a secretion that serves the same function as royal jelly and may be chemically similar to royal jelly. Pollen, propolis and royal jelly in honeybee honey all have a history of being allergenic in some individuals. There is a lack of evidence to suggest that native bee honey would carry a greater risk of eliciting such a reaction than honeybee honey. The applicant has not requested different provisions for such allergens than those existing for honeybee honey.

3.4 Natural contaminants

Honey can be contaminated with hazardous natural substances such as alkaloids synthesized by plants. There is limited information on contaminants in native bee honey. No evidence was located indicating that the risk of exposure to such contaminants is greater for native bee honey than for honeybee honey.

3.4.1 Pyrrolizidine alkaloids

In 2001, FSANZ established a safe level of dietary exposure to pyrrolizidine alkaloids of 1 µg/kg bw/d based on known toxicity in humans. A major source of pyrrolizidine alkaloids in Australia is the weed Paterson's curse (*Echium plantagineum*). The applicant noted the major distribution of Paterson's curse does not coincide with the areas where stingless bees are usually kept so levels in native bee honey are likely to be low.

3.4.2 Other plant-derived toxins

Tutin is a neurotoxin produced by several species of *Coriaria* ('tutu') shrubs. FSANZ proposal P1029 Maximum Levels for tutin in honey in 2014 reviewed MLs for tutin in honeybee honey and found the issue appeared to be unique to New Zealand honey. Although production of tutin by *Coriaria* species has been reported in South America, FSANZ has not located reports of contamination of honey with tutin in any country other than New Zealand. Reports of *Coriaria* species in Australia are limited to preserved specimens held in the National Herbarium of New South Wales and the National Herbarium of Victoria (Atlas of Living Australia[6]).

---

[6] Atlas of Living Australia – Open access to Australia's biodiversity data (ala.org.au) Accessed September 2023

4 Microbiology assessment

The physiochemical properties of honey, as currently defined in Standard 2.8.2, are likely to inhibit the growth of microorganisms. High concentration of sugars, low water activity, high osmotic pressure, low pH, and formation of hydrogen peroxide are not favourable conditions for survival or growth of microflora (Ebrahimi *et al.* 2022). However, Australian native bee honey has been found to be physiochemically different (Section 2.4) and is associated with a rich microbiome involved in a complex network of biological interactions (Massaro *et al.*, 2018). This microbiology risk assessment considers if the proposed compositional requirements for Australian native bee honey present a risk to public health.

4.1 Natural Fermentation

Fermentation of native bee honey, due to bacteria and yeast present in the environment, is a natural occurrence. Evidence of fermentation includes the presence of foam and escaping gas bubbles found inside native honey pots. This process continues post-harvest within bottled honey stored at room temperature but is noted to be self-limiting (Heard, 2016).

Unlike European bee (*Apis mellifera*) honey, the physiochemical properties of native bee honey provide an environment where fermentation is likely to occur. Native bee honey has a higher moisture content (26.5 +/- 0.8 g of water/100 g of honey) and water activity (0.74 +/- 0.01) when compared to *A. mellifera* honey (Oddo *et al.*, 2008). When the moisture content is above 21% xerotolerant microorganisms can grow, resulting in fermentation and spoilage (Roxo *et al.*, 2023). Additionally, native bee-associated yeast has been found to be both xerotolerant and osmotolerant and can ferment both glucose and sucrose present in honey (Echeverrigaray *et al.*, 2021, Massaro *et al.*, 2018, Teixeira *et al.*, 2003).

The core gut microbiome of the Australian native bee *species Tetragonula carbonaria*, *Tetragonula hockingsi* and *Austroplebeia australis*, are dominated by *Lactobacillus* spp., Acetobacteraceae spp., and *Bombella* spp. (Leonhardt & Kaltenpoth, 2014, Massaro *et al.*, 2018, Mills *et al.*, 2023). In addition, the bacteria genera *Gilliamella*, *Snodgrassella* and *Zymobacter* can also be found associated with native bee species (de Paula *et al.*, 2021, Kwong *et al.*, 2017, Mills *et al.*, 2023). Given that honey is produced within the bee gut as the result of enzymatic and bacterial activity and regurgitated into the honey pots, it is not unexpected to find a similar microbiome in honey as in the bees. Among these bacteria, Oliphant *et al.* (2022), identified multiple species that can ferment glucose to produce lactic acid, acetic acid and ethanol.

During native bee honey fermentation, yeasts, most likely *Starmerella meliponinorum* or *Candida* spp., utilise available sugars producing alcohol and carbon dioxide. In the presence of oxygen, the alcohol may be converted into acetic acid by Acetobacteraceae (Menezes *et al.*, 2013, Snowden and Cliver, 1996). Furthermore, sugars may be converted into water and lactic acid by *Lactobacillus* spp. (Santos *et al.*, 2021). Fermentation is self-limiting due in part to the decrease in pH (3.5-3.7, average 3.6) of the honey as it ages. The degree of fermentation and the increasing concentration of organic acids (which can also inhibit microbial growth) in the honey depend on storage conditions and can be controlled through processing.

The reported high organic acid concentrations in native bee honey supports the assertion that multiple phases of fermentation are occurring during storage giving the honey its unique flavour (Hungerford *et al.*, 2023).

Natural fermentation could lead to an accumulation of alcohol within the product. There is limited published research investigating alcohol values in Australian native bee honey. Ribeiro *et al.*, (2018) studied the effects of a 180-day maturation on the physiochemical characteristics of Brazilian native bee honey. They showed that there was no alcohol detectable immediately after harvest, however, after 180 days of maturation at either 20°C or 30°C the honey had an alcohol concentration of 0.2 +/- 0.15 g/100 g (0.2%) and 0.6 +/- 0.15 g/100 g (0.6%) respectively.

FSANZ notes that there are a number of processing methods that have been used internationally to limit or control bacterial and yeast growth in native bee honey, including refrigeration, pasteurisation, dehydration and maturation (Ávila *et al.*, 2018, Menezes *et al.*, 2013). There is no evidence that the fermentation process impacts on the safety of the honey from a microbiological perspective, however, increased pressure will occur in sealed containers.

Internationally, in countries where native bee honey is sold commercially, handling and/or processing requirements have been added to their respective food codes, including Argentina, Malaysia and six states in Brazil (ADAB, 2014, ADAF, 2016, CONAL, 2019, Malaysian Standard, 2017).

4.2 Botulism

Microbes can be introduced into the honey located in the hives directly from the bees, gathered pollen and nectar, and from air and dust entering the hive. This can include bacterial spores, including those of *Clostridium botulinum*, which have been found in a fraction of *A. mellifera* honey samples and normally at low concentrations (Snowden and Cliver, 1996). With the source of nectar and pollen likely to be the same for Australian native bee honey as for *A. mellifera* honey, the prevalence and concentration of spores found is most likely to be the same.

C. botulinum pose a significant risk of causing infant botulism because an infant's intestinal microflora is still developing and ingested spores can germinate, grow and produce botulinum neurotoxins (Ebrahimi *et al.*, 2022). As highlighted within the Infant Feeding Guidelines released by the National Health and Medical Research Council (NHMRC, 2012), Australia has public health guidance that honey should not be fed to infants under the age of 12 months. Standard 2.9.2 – Food for infants – general compositional requirements – states that unless honey has been treated to inactivate *C. botulinum* spores, food for infants must not include honey. In New Zealand the risk of infant botulism is very low, and although no specific policies exist, both the Ministry of Health and Ministry for Primary Industries have guidance for “Safe Foods for Babies” which states that honey should not be given to infants under 12 months of age (Gilbert et al., 2006, MoH 2021, MoH 2022, MPI 2023). Production of honey is regulated under the Animal Products Act, which covers good operating practices for beekeepers (APA, 2021).

4.3 Bacterial utilization of trehalulose

Pathogenic bacteria *Klebsiella pneumoniae* and *Fusobacterium mortiferum* can utilize trehalulose as a carbon source for growth (Pikis *et al.*, 2002, Thompson *et al.*, 2001). As noted in Section 3.2, trehalulose is an abundant sugar in native bee honey, with concentrations up to 48.7 g/100 g, with an average value of 18.5 g/100 g (n = 89) observed for *Tetragonula*, and up to 15.0 g/100 g, with an average value of 4.5 g/100 g (n = 22) for *Austroplebeia* (Fletcher *et al.*, 2021). In the human gut, trehalulose is digested and absorbed as glucose and fructose within the small intestine at a rate about one third that of sucrose (Mizumoto *et al.*, 2004). This metabolism of trehalulose, lowers the concentration in the gut and it is therefore not available as a prebiotic for growth of *K. pneumoniae* and *F. mortiferum* within the gut. Ingesting higher concentrations of trehalulose present in native bee honey is therefore unlikely to influence the growth of these pathogenic bacteria, nor have any significant impact on the normal human gut microbiome.

4.4 Honey harvesting

Unlike *A. mellifera,* native bees store honey and pollen in 'pots' which are associated with the brood. Furthermore, the honey pots can vary significantly in size which makes honey harvesting challenging. Even within specialised native bee hives harvesting of the honey requires that the honey pots are punctured by hand using a sharp object (e.g. fork or nail bed) and drained either by gravity (most common method used in Australia (Application Appendix 6: Harvesting methods) or centrifugation, which is then followed by filtration to remove the larger pieces of debris. The honey is then placed in sealed storage containers to minimise further contamination, including microbiological. The harvesting process can introduce microbial contamination to the honey, including potential for cross-contamination between hives. Good Hygienic Practices (GHP) used during the harvesting process will minimise the risk of the introduction of new microorganisms beyond those already naturally present in the honey, including the introduction of food borne pathogenic bacteria.

4.5 Microbiology assessment conclusion

FSANZ has reviewed the available scientific literature and any international regulatory standards to determine what, if any, microbiological risks to public health are associated with the consumption of native bee honey.

- As noted, there is a naturally occurring microbiome present in the honey, mostly derived from the bee gut, the environment where they collect the nectar and pollen from and the local environment where the hives are located.
- Due to the higher water activity and the lower level of reducing sugars present in native bee honey compared to European bee honeys, microbial fermentation can occur resulting in changes to the concentration of organic acids present, giving this type of honey its characteristic flavour. The degree to which fermentation occurs and thereby the amount of organic acids present in the honey are dependent on storage conditions but are noted to be self-limiting.
- Given the long history of consumption of native bee honey, and the lack of reported illnesses associated with its consumption, the natural fermentation and the normal microflora present in native bee honey, there is a very low risk of illness associated with consumption.
- However, increased commercial harvesting and longer-term storage of native bee honey becoming more common, there is an increased risk of the introduction of microorganisms from personnel, equipment and harvest environment which could include foodborne pathogens. This is similar for all honey production that transitions from small to large scale harvests.
- As with all honey, contamination with spores of *Clostridium botulinum* of native bee honey can occur and represents a high risk for infants.
- Based on currently available data, apart from infant ingestion, there are no significant public health risks posed by consumption of native bee honey if GHP are applied during establishment of commercial hives and harvesting of the honey.

5 Agricultural and veterinary (agvet) chemicals

There is minimal information available about specific native bee pests and diseases. As with honeybees, pests known to impact native beehives include hive syrphid fly (*Ceriana ornate*), hive phorid fly (*Dohrniphora trigonae*), and small hive beetle (*Aethina tumida*). Current management practices include good hive design and construction. Traps containing a pesticide can be used to control small hive beetle. These traps are placed at the bottom of the hive and are not likely to come into contact with the bees or the honey.

Australian stingless bees are a similar size to small hive beetle so they may enter the small hive beetle traps used in honeybee hives. These traps are therefore not used in native bee hives. The only traps used in native bee hives are small containers of vinegar (or vinegar/water/honey blend) used to control hive phorid fly. The contents of these traps do not come into contact with the bees or the honey (Heard 2016).

Brood pathogens may pose a risk to native bees but is noted as extremely rare by the applicant. Hygienic behaviour is a natural mechanism of colony-level disease resistance to brood pathogens and has been reported in honeybees and stingless bees. Australian stingless bees displayed significantly faster detection and cell dismantling which may result in lower instances of brood diseases (Le Gros *et al*. 2022).

In 2010, 67% of stingless bee colonies were kept in suburban areas, 20.5% in rural areas and 12.5% near bush (Halcroft *et al*. 2013). There is the potential of exposure to agricultural and veterinary (agvet) chemicals in these locations. The presence of environmental contaminants in stingless bee honey has been examined by Hungerford *et al.* (2020). Analyses included pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs) and trace elements. In all cases, the results showed low or negligible levels of pesticide, herbicide, and PAH contamination.

No evidence was identified to suggest the risk of exposure to agvet chemicals is greater for native bees than for honeybees.

6 Conclusion

In Australia, native bee honey has been used for thousands of years. In contrast to honey produced by honeybees, native bee species produce honey containing a high concentration of the sugar trehalulose and with a higher moisture content and a lower sugar content.

There is no evidence that consumption of native bee honey presents a health risks to the general population if beekeepers apply good hygienic practice during harvest and processing. Risks to vulnerable populations are comparable to those from consumption of honeybee honey.

7 References

ADAB (Agência de Defesa Agropecuária da Bahia) 2014. S. ADAB Ordinance No. 207 of November 21, 2014. Technical Regulation of Identity and Quality of Stingless Social Bee Honey, Genus Melipona. https://www.legisweb.com.br/legislacao/?id=277684

ADAF(Agência de Defesa Agropecuária e Florestal do Estado do Amazonas) 2016. ADAF Ordinance No. 253 of October 31, 2016. Technical Regulation of Identity and Quality of Stingless Social Bee Honey for the State of Amazonas. https://www.escavador.com/diarios/426701/DOEAM/publicacoes-diversas/2016-11-01?page=7

APA 2021. Animal Products Regulations 2021. Good Operating Practices for Beekeepers Regulation 145. https://legislation.govt.nz/regulation/public/2021/0400/latest/whole.html#whole

Ávila, S., Beux, M.R., Ribani, R.H. and Zambiazi, R.C., 2018. Stingless bee honey: Quality parameters, bioactive compounds, health-promotion properties and modification detection strategies. Trends in Food Science & Technology, 81, pp.37-50.

Bernauer, O.M., Tierney, S.M. and Cook, J.M., 2022. Efficiency and effectiveness of native bees and honeybees as pollinators of apples in New South Wales orchards. Agriculture, Ecosystems & Environment, 337, p.108063.

Chen, A., Tapia, H., Goddard, J.M. and Gibney, P.A., 2022. Trehalose and its applications in the food industry. Comprehensive Reviews in Food Science and Food Safety, 21(6), pp.5004-5037.

CONAL (Comisión Nacional de Alimentos), 2019. Argentine Food Code Chapter X "Sugary Foods" Article 783 bis.

da Costa, A.C.V., Sousa, J.M.B., da Silva, M.A.A.P., dos Santos Garruti, D. and Madruga, M.S., 2018. Sensory and volatile profiles of monofloral honeys produced by native stingless bees of the Brazilian semiarid region. Food Research International, 105, pp.110-120.

De La Fuente, E., Ruiz-Matute, A.I., Valencia-Barrera, R.M., Sanz, J. and Castro, I.M., 2011. Carbohydrate composition of Spanish unifloral honeys. Food Chemistry, 129(4), pp.1483-1489.

de Paula GT, Menezes C, Pupo MT, Rosa CA, 2022 Stingless bees and microbial interactions, Current Opinion in Insect Science, 44:41-47.

Deliza, R. and Vit, P., 2012. Sensory evaluation of stingless bee pot-honey. In Pot-Honey: A legacy of stingless bees (pp. 349-361). New York, NY: Springer New York.

Ebrahimi Y, Ramírez-Coronel AA, Al-Dhalimy AMB, Alfilm RHC, Al-Hassan M, Obaid RF, Alameri AA, Rastiani F, Yousef K, Shokri S 2023. Contamination of honey products by Clostridium botulinum spores and fungi along with their effects on human health. Caspian Journal of Environmental Sciences, 20(5):1143-1148.

Echeverrigaray S, Scariot FJ, Foresti L, Schwarz LV, Rocha RKM, da Silva GP, Moreira JP, Delamare APL, 2022 Yeast biodiversity in honey produced by stingless bees raised in the highlands of southern Brazil. International Journal of Food Microbiology, 347:109200.

Fletcher M., Hungerford N., and Smith T., 2021 Optimising bioactive content of Australian stingless bee honey. AgriFutures Australia Publication No. 21-115 AgriFutures Australia Project No. PRJ-012494.

Frasnelli, E., 2013. Brain and behavioral lateralization in invertebrates. Front Psychol 4: 939.

Gilbert S, Lake R, Hudson A and Cressey P. 2006. Risk Profile: *Clostridium botulinum* in honey. Client Report FW05115.

Halcroft, M.T., Spooner-Hart, R., Haigh, A.M., Heard, T.A. and Dollin, A., 2013. The Australian stingless bee industry: a follow-up survey, one decade on. Journal of Apicultural Research, 52(2), pp.1-7.

Haley D and Heard T. 2021.Microbial and physicochemical properties of honey from Australian Tetragonula and Aus-troplebeia stingless bees. The Cross-Pollinator, Issue 20, pp 3-10, Apr 2021.

Han, F., Wallberg A., Webster, M 2012. From where did the Western honeybee (*Apis mellifera*) originate". Ecology and Evolution. 2 (8): 1949–1957.

Hart, N. (2007). Industrious Native Bees: A Case Study in Whangarei. Masters Thesis. Auckland University of Technology.

Heard TA 2016. The Australian native Bee Book, keeping stingless beehives for pets, pollination and sugarbag honey, Sugarbag Bees, Brisbane.

Hungerford NL, Yates HSA, Smith TJ, Fletcher MT (2023) Organic acid profiles of Australian stingless bee honey samples determined by ion chromatography, Journal of Food Composition and Analysis, 122:105466.

Hungerford, N.L., Tan, B.L., Tinggi, U., Zawawi, N., Farrell, M., Tsai, H.H., Hnatko, D., Swann, L.J., Kelly, C.L., R Anuj, S. and Webber, D.C., 2020. Analysis of environmental contaminants in Australian honey and comparison to stingless bee honey from Queensland and Malaysia. Multidisciplinary Digital Publishing Institute Proceedings, 36(1), p.101.

Jahanbin, P., Wingreen, S. C., Sharma, R., Ijadi, B., & Reis, M. M. 2023. Enabling affordances of blockchain in agri-food supply chains: A value-driver framework using Q-methodology. International Journal of Innovation Studies, 7(4), 307-325. https://doi.org/10.1016/j.ijis.2023.08.001

Kowalczyk J, Hausmanns S, Doerr T 2015. Highly active antioxidant based on trehalulose. United States Patent Application Publication Pub. No.: US 2015/0132462 A1

Kwong WK, Medina LA, Koch H, Sing KW, Soh EJY, Ascher JS, Jaffe R, Moran NA (2017) Dynamic microbiome evolution in social bees, Science Advances, 3:e1600513

Le Gros Kayla S., Makinson James C. and Spooner-Hart Robert N. 2022. Hygienic behaviour in the Australian stingless bees Tetragonula carbonaria and T. hockingsi, Journal of Apicultural Research, 61:5, 578-590, DOI: 10.1080/00218839.2022.2109915

Leonhardt SD, Kaltenpoth M 2014. Microbial Communities of Three Sympatric Australian Stingless Bee Species. PLoS ONE 9(8): e105718. doi:10.1371/journal.pone.0105718

Liu, H., Nie, J., Liu, Y., Wadood, S.A., Rogers, K.M., Yuan, Y. and Gan, R.Y., 2023. A review of recent compound-specific isotope analysis studies applied to food authentication. Food Chemistry, p.135791.

Malaysian Standard (2017) MS 2683: 2017: Kelulut (Stingless Bee) Honey- Specification: Quality requirements. Selangor, Malaysia.

Manivanan, P., Rajagopalan, S.M. and Subbarayalu, M., 2018. Studies on authentication of true source of honey using pollen DNA barcoding. J. Entomol. Zool. Stud, 6(3), pp.255-261.

Massaro FC, Gill L, Tarlinton B, Hauxwell C 2018. Yeasts associated with nests of Australian stingless bees (Meliponini). In 2018 International Congress of Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology.

Mehryar, L. and Esmaiili, M., 2011, May. Honey & honey adulteration detection: a review. In Proceedings of 11th International Congress on Engineering and Food (Vol. 3, No. 1, p. 7).

Melo, G.A. and Gonçalves, R.B., 2005. Higher-level bee classifications (Hymenoptera, Apoidea, Apidae sensu lato). Revista Brasileira de Zoologia, 22, pp.153-159.

Menezes C, Vollet-Neto A, Contrera FAL, Venturieri GC, Imperatriz-Fonseca VL (2013) The role of useful microorganisms to stingless bees and stingless beekeeping. In Vit P, Pedro SRM, Roubik DW (eds.) Pot-Honey: A legacy of stingless bees, Springer New York, NY https://doi.org/https://doi.org/10.1007/978-1-4614-4960-7.

Michener, C.D., 2007. The bees of the world, (The Johns Hopkins University Press: Baltimore, USA.).

Mills TJT, Nelson TM, Pearson LA, Neilan BA 2023. Hive Transplantation Has Minimal Impact on the Core Gut Microbiome of the Australian Stingless Bee, Tetragonula carbonaria Microbial Ecology.

Mizumoto K, Sasaki H, Kume H, Yamaguchi M 2004. Nutritional Compositions for Controlling Blood Glucose Level. European Patent Specification EP 1 424 074 B1.

MoH (Ministry of Health) 2021. Healthy Eating Guidelines for New Zealand Babies and Toddlers (0–2 years old). Wellington: Ministry of Health. Published in September 2021 by the Ministry of Health, Wellington, New Zealand. Healthy Eating Guidelines for New Zealand Babies and Toddlers (0-2 years old) | Ministry of Health NZ

MoH (Ministry of Health) 2023. Botulism. https://www.health.govt.nz/your-health/conditions-and-treatments/diseases-and-illnesses/botulism

MPI (Ministry for Primary Industries) 2023. Safe food for babies. https://www.mpi.govt.nz/food-safety-home/safe-food-babies/

Nakajima, Y., Sugitani, T., Tanaka, M. and Fujii, S., 1990. Occurrence of Trehalulose, 1-0-α-D-Glucopyranosyl-D-Fructose, in Nectar Honey. Nippon Shokuhin Kogyo Gakkaishi, 37(7), pp.554-558.

NHMRC (National Health and Medical Research Council) 2012. Infant Feeding Guidelines. Canberra: National Health and Medical Research Council. Infant Feeding Guidelines: information for health workers | NHMRC

Nordin, A., Sainik, N.Q.A.V., Chowdhury, S.R., Saim, A.B. and Idrus, R.B.H., 2018. Physicochemical properties of stingless bee honey from around the globe: A comprehensive review. Journal of Food Composition and Analysis, 73, pp.91-102.

Oddo, L.P., Heard, T.A., Rodríguez-Malaver, A., Pérez, R.A., Fernández-Muiño, M., Sancho, M.T., Sesta, G., Lusco, L. and Vit, P., 2008. Composition and antioxidant activity of Trigona carbonaria honey from Australia. Journal of medicinal food, 11(4), pp.789-794.

Oliphant SA, Watson-Haigh NS, Sumby KM, Gardner J, Groom S, Jiranek V 2022. Apilactobacillus apisilvae sp. nov., Nicolia spurrieriana gen. nov. sp. nov., Bombilactobacillus folatiphilus sp. nov. and Bombilactobacillus thymidiniphilus sp. nov., four new lactic acid bacterial isolates from stingless bees Tetragonula carbonaria and Austroplebeia australis. International Journal of Systematic and Evolutionary Microbiology, 72(9):005588

Ooshima T, Izumitani A, Minami T, Fujiwara T, Nakajima Y, Hamada S 1991. Trehalulose Does Not Induce Dental Caries in Rats Infected with Mutans Streptococci. Caries Research 25: 277-282.

Pikis A, Immel S, Robrish S, Thompson J 2002. Metabolism of sucrose and its five isomers by Fusobacterium mortiferum. Microbiology, 148(3): 843-852.

O'Toole, C. and Raw, A., 1991. Bees of the World. Blandford Press.

Perichon, S., Heard, T.A. and Schouten, C., 2021. Perceptions of keepers of stingless bees (Tetragonula, Austroplebeia) regarding Aboriginal beliefs and practices in Australia. Journal of Apicultural Research, 60(5), pp.665-677.

Ribeiro GP, Villas-Bôas JK, Spinosa WA, Prudencio SH 2018. Influence of freezing, pasteurization and maturation on Tiúba honey quality, Lebensmittel-wissenschaft + Technologie, 90:607-612.

Roubik, D.W., 2013. Why do they keep changing the names of our stingless bees (Hymenoptera: Apidae; Meliponini)? A little history and guide to taxonomy. Stingless bees process honey and pollen in cerumen pots.

Roxo I, Amaral AL, Portugal A, Trovão J 2023. A checklist of fungi isolated from honey (2000–2022). Studies in Fungi, 8:14.

Ruttner, F., 2013. Biogeography and taxonomy of honeybees. Springer Science & Business Media.

Saludin, S.F., Kamarulzaman, N.H. and Ismail, M.M., 2019. Measuring consumers' preferences of stingless bee honey (meliponine honey) based on sensory characteristics. International Food Research Journal, 26(1).

Santos ACD, Biluca FC, Braghini F, Gonzaga LV, Costa ACO, Fett R 2021. Phenolic composition and biological activities of stingless bee honey: An overview based on its aglycone and glycoside compounds. Food Research International, 147:110553.

Shamsudin S, Selamat J, Sanny M, A R SB, Jambari NN, Khatib A. A Comparative Characterization of Physicochemical and Antioxidants Properties of Processed Heterotrigona itama Honey from Different Origins and Classification by Chemometrics Analysis. Molecules. 2019 Oct 29;24(21):3898. doi: 10.3390/molecules24213898. PMID: 31671885; PMCID: PMC6864699.

Sniderman, J.K., Matley, K.A., Haberle, S.G. and Cantrill, D.J., 2018. Pollen analysis of Australian honey. PLoS One, 13(5), p.e0197545.

Snowdon JA, Cliver DO 1996. Microorganisms in honey. International Journal of Food Microbiology, 31(1-3):1-26.

Tafere, D. 2021. Chemical composition and uses of Honey: A Review. Journal of Food Science and Nutrition Research, 4(3), pp.194-201.

Teixeira ACP, Marini MM, Nicoli JR, Antonini Y, Martins RP, Lachance MA, Rosa CA 2003. Starmerella meliponinorum sp. nov., a novel ascomycetous yeast species associated with stingless bees. International Journal Systematic and Evolutionary Microbiology, 53(Pt 1):339-343.

Thompson J, Robrish SA, Immel S, Lichtenthaler FW, Hall BG, Pikis A 2001. Metabolism of sucrose and its five linkage-isomeric alpha-D-glucosyl-D-fructoses by Klebsiella pneumoniae. Participation and properties of sucrose-6-phosphate hydrolase and phospho-alpha-glucosidase. Journal of Biological Chemistry, 276(40):37415-25

Wach W, Rose T, Klingeberg M, Peters S, Dörr T, Theis S, Kowalczyk J, Hausmanns S 2010. Trehalulose-containing composition, its preparation and use. European Patent Specification EP 2 418 971 B1.

Whitfield, Charles W.; Behura, Susanta K.; Berlocher, Stewart H. 2006. Thrice Out of Africa: Ancient and Recent Expansions of the Honey Bee, Apis mellifera. Science. 314 (5799): 642-645.

Zawawi, N., Zhang, J., Hungerford, N.L., Yates, H.S., Webber, D.C., Farrell, M., Tinggi, U., Bhandari, B. and Fletcher, M.T., 2022. Unique physicochemical properties and rare reducing sugar trehalulose mandate new international regulation for stingless bee honey. Food chemistry, 373, p.131566.

Zhou, X, Taylor, MP & Davies, PJ 2018, Tracing natural and industrial contamination and lead isotopic compositions in an Australian native bee species, Environmental Pollution, vol. 242, no. Part A, pp. 54–62, viewed 7 September 2023.