Defining mānuka honey: where we are and how we got here

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A note on this submission to Beeline Supplies in July 2020: This article was written in October 2018. The MPI definition and the challenges remain, almost two years later.

Abstract: This article reviews the development of the MPI definition of mānuka honey. The aim is firstly to collect the information in one place and secondly to stimulate constructive contributions, in order to guide future development of the definition. (The author is a retired statistics professor who has been keeping bees in New Zealand for 40 years.)

Why do we need a definition? Ever since 1988, when Peter Molan and his team at the University of Waikato published papers revealing the antimicrobial properties of mānuka honey, the demand for mānuka honey has been growing. It is now an approximately $300 million per annum NZ export business. But export volumes have exceeded NZ production and other nations are keen to join the bonanza. So a fraud-preventing, affordable definition that genuinely characterises mānuka honey coming from NZ is needed, under government control, to maintain the credibility of NZ exports of mānuka honey.

Background to definitions of honey: Two approaches exist already for defining mānuka honey:

i) The Codex Alimentarius Commission approach (or Codex for short). This is a long-standing international body that lays down rules for food description and food safety. For honey, measurements used include sensory traits such as colour, scent and taste, chemical traits such as conductivity and thixotropy (stickiness) and microscopic traits such as pollen content. New Zealand is an active participant in the Codex system and there is a rudimentary online published standard for mānuka honey (courtesy of the Bee Products Standards Council).

ii) The NZ industry approach. The beekeeping industry in NZ has produced its own definitions in recent years, largely based on the antimicrobial properties sought by the customer. They reflect the content in honey of leptosperin, DHA (dihydroxyacetone) and MGO (methylglyoxal), the last often quoted in terms of a UMF® (Unique Mānuka Factor) grade. Leptosperin is a strong determinant of mānuka honeys. DHA is the nectar precursor of MGO, while MGO is the non-peroxide antimicrobial component sought by the public. MGO content initially increases, then decreases with ageing. MGO and leptosperin are not unique to NZ mānuka honey. The industry approach can be summarized as a customer-focused "chemical" definition.

The first MPI definition: The MPI chose a third approach, opting for a "chemical profile" definition. This refined aspects of the industry approach, requiring all chemicals used to be stable (for example, over time) and to vary minimally

across the regions of NZ. Criteria were sought such that the resulting "chemical profile" would precisely identify genuine NZ mānuka honey. After gathering and analysing nectar and honey samples over two seasons they arrived at a definition using four chemicals and a new test for mānuka pollen DNA. The outcome, categorizing monofloral mānuka, multifloral mānuka and non-mānuka honey, is presented in Table 1. (Multifloral mānuka honey is sourced from the nectar of both mānuka and other flowers. It has been produced by either the bees themselves or by beekeeper blending.)

The chemical 2'-MAP is useful in that it separates NZ mānuka honey (which is sourced from *Leptospermum scoparium*) from honeys that are sourced from the numerous Australian *Leptospermum* species. High 3-PLA levels are characteristic of monofloral mānuka honey, although 3-PLA can be high in kānuka honey. At the end of the day, the establishment of the levels is guided by a statistical procedure called CART, short for Classification and Regression Trees.

Chemical	Monofloral mānuka	Multifloral mānuka
3-PLA	≥400 mg/kg	≥20 and <400 mg/kg
2'-MAP	≥ 1 mg/kg	≥ 1 mg/kg
2-MBA	≥ 1 mg/kg	≥ 1 mg/kg
4-HPLA	≥ 1 mg/kg	≥ 1mg/kg
Pollen DNA	< Cq 36	< Cq 36

Table 1. The MPI April 2017 mānuka honey definition.

MPI opted for a simple, single final definition that correctly classified 74% of the (supplier-identified) mānuka honey samples in the training data set. It must be acknowledged that uncertainty about the correct provenance of the samples will always render the development of a classification system difficult; the foundation on which the definition is built is intrinsically shaky. The 26% misclassification rate will be partly due to this and partly to the decision to keep the classification simple.

Figure 1 presents the information in Table 1 graphically. The key chemicals of interest in distinguishing monofloral mānuka, multifloral mānuka and non-mānuka honeys are 2'-MAP and 3-PLA. So if we consider honeys for which the 2-MBA, 4-HPLA and Pollen DNA conditions are satisfied we can picture the categories using the 2'-MAP and 3-PLA values, as shown in Figure 1. The resulting monofloral mānuka, multifloral mānuka and non-mānuka regions are coloured dark brown, light brown and yellow respectively.

There was an additional problem, which came to light in 2017. It permitted kānuka honey, high in 3-PLA, to be blended with multifloral mānuka honey to give monofloral mānuka honey – an unfortunate loophole. This is indicated with the black dots and blending line right-lower in Figure 1. A roughly 50/50 mix of multifloral mānuka and kānuka is shown. A 90/10 mix would be close to the multifloral mānuka whereas a 10/90 mix would be close to the kānuka.

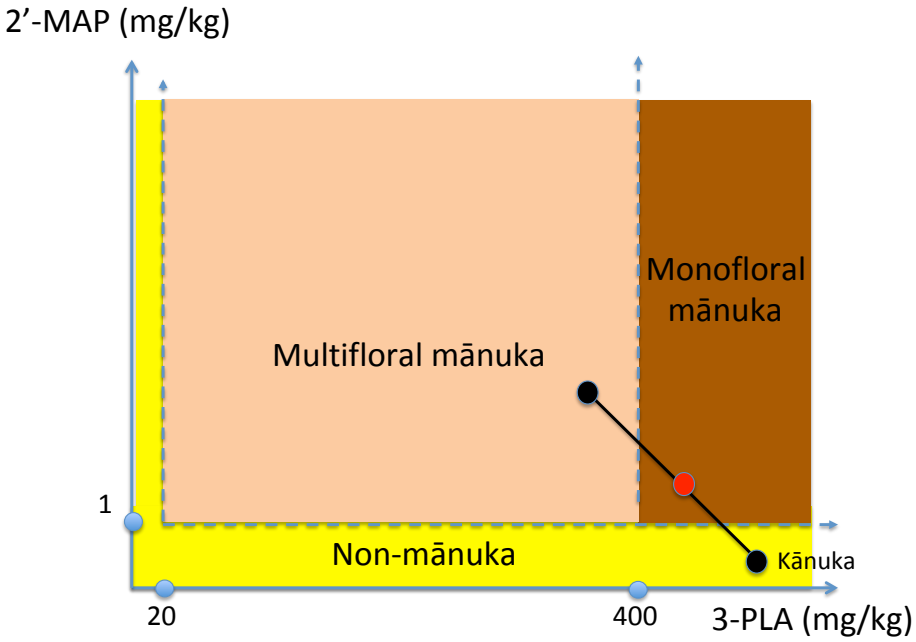

Figure 1. The honey category regions (monofloral, multifloral and non-mānuka) as 2'-MAP and 3-PLA vary, using the MPI April 2017 definition. Also shown diagrammatically is the manner in which a multifloral mānuka honey, high in 2'-MAP, can be blended with a high 3-PLA kānuka honey (both shown with black dots) to create monofloral mānuka honey (shown with a red dot).

The second MPI definition: A simple change to the definition was made by the MPI in February 2018 to plug this loophole, in response to industry consultation: for monofloral mānuka honey the 2'-MAP threshold was raised to 5 mg/kg. (Industry had also argued that 3-PLA should be removed from the definition since it was high in kānuka honey.) The region where potential blended samples might fall became labeled "non-mānuka". The new definition is given in Table 2.

Chemical	Monofloral mānuka	Multifloral mānuka
3-PLA	≥400 mg/kg	≥20 and <400 mg/kg
2'-MAP	**≥ 5 mg/kg**	≥ 1 mg/kg
2-MBA	≥ 1 mg/kg	≥ 1 mg/kg
4-HPLA	≥ 1 mg/kg	≥ 1mg/kg
Pollen DNA	< Cq 36	< Cq 36

Table 2. The MPI February 2018 mānuka honey definition. The single change from the MPI April 2017 definition is shown in boldface.

The definition in Table 2 is shown graphically in Figure 2. Note the new yellow "non-mānuka" region (mid-right) that was monofloral mānuka in Figure 1. (It is assumed, as before, that the honeys satisfy the 2-MBA, 4-HPLA and Pollen DNA requirements.)

Two new problems have since arisen. First, MPI published tables can be used to show that 11% of supplier identified mānuka honey lies in the new "non-mānuka" category. The practical outcome of this is serious, with beekeeper livelihoods being lost; smaller beekeepers are closing down as their operations become uneconomic. Second, the revised definition opens the door to a further blending possibility, that of combining the new "non-mānuka" with clover honey (both low value) to create multifloral mānuka honey (likely to be of considerably higher value). This blending possibility is indicated in Figure 2. In addition, the graphic makes evident (though this line is not drawn in) how it is now also possible to mix a multifloral mānuka honey with a "non-mānuka" honey to create a monofloral mānuka.

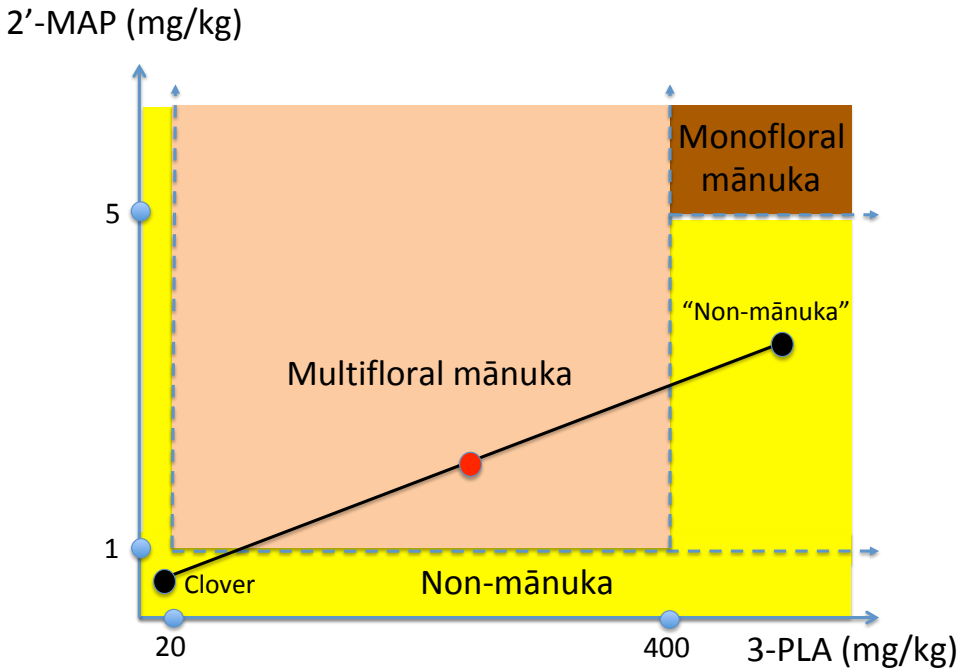

Figure 2. The honey category regions (monofloral, multifloral and non-mānuka) as 2'-MAP and 3-PLA vary, when using the MPI February 2018 definition. A new possibility for the blending of clover and "non-mānuka" honey (black dots) to produce multifloral mānuka honey (red dot) is shown.

The upshot is that this change has put many smaller commercial beekeepers out of business and leaves larger ones, who are able to blend and keep the UMF® level high, continuing to operate.

Current problems

i) Many (often smaller) beekeepers produce honey in the new "non-mānuka" category and are being put out of business.
ii) Regional variation in the levels of 2'-MAP and 3-PLA is exacerbating the problems.
iii) Blending (mild fraud): Use of a chemical profile allows blending (hence favouring big suppliers, as they have greater blending flexibility).
iv) Mixing (blatant fraud): All chemicals in the current definition are available inexpensively, making it possible to produce a mix passing the analytical test by adulterating a cheap honey with the necessary chemicals.

In summary, the industry is in chaos. Livelihoods of beekeepers are being destroyed. The credibility of the industry is threatened. We must conclude that a definition solely via chemical markers, though innovative, is fundamentally flawed. Insufficient effort has been made to date to prevent fraud in a definition.

Possible solutions to the current problems

One solution when we get lost is to backtrack to a point where we are not lost, and to move forward again, this time being careful not to take a wrong turn. All suggestions that follow involve going back in the definition development process and starting afresh at that point, having learned from the process to date. This is not a cause for concern; it is the nature of science.

i) Back up one MPI stage: Go back to the April 2017 definition. This is not a long-term solution, as the blending possibility mentioned earlier returns. It would, however, reduce the current problem level.
ii) Back up two MPI stages: Stay with the MPI chemical profile definition but go back to the point just before the kānuka pollen DNA test was dropped. A possible definition which includes kānuka pollen DNA can be seen in Figure 5 of the MPI Science of Food paper.
iii) Back up beyond the MPI work to reconsider an industry definition: Go back to a leptosperin, DHA and MGO based definition.
iv) Back up to before the industry stage, to the world stage: Further refine the existing Codex-based definition. This may be needed eventually to satisfy European importers.
v) Start afresh: There is a growing acceptance in Europe that the current Codex definitions of honey using organoleptic (e.g. aroma) and physicochemical (e.g. sugars) methods are inadequate. Chemical profiling and nuclear magnetic resonance methods are gaining traction to complement or possibly replace current methodologies (Terry Braggins, personal communication). It may ultimately be necessary to forge a completely new route to a definition.

Conclusions

Thirty years on from the landmark publications of Peter Molan in the Journal of Apicultural Research, we need to cap off that work with a satisfactory definition of mānuka honey. Some excellent work has been carried out by MPI, but it is a start, not an end. We need to back up now and continue with the science, progressively exploring the trail blazed by the MPI, but in new directions. A national action group is needed urgently, combining the expertise of MPI, industry and other knowledgeable parties, to progress this matter to a satisfactory conclusion.

Acknowledgements Dr Oksana Borowik, Dr John Craig and Dr Terry Braggins are thanked for providing the impetus to prepare this article. Simonne Samuelson is thanked for providing critical editorial input.