TECHNICAL SUMMARY

# HMF: THE EFFECTS OF AGING AND HEAT TREATMENT OF HONEY

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In honey, hydroxymethylfurfural (HMF) is used as an indicator of aging and heat treatment. HMF is commonly tested for as part of the mānuka 3-in-1 test along with DHA (dihydroxyacetone) and MGO (methylglyoxal). International standards, including CODEX, specify that honey should contain no more than 40 mg/kg of HMF (Codex Alimentarius Commission, 2001).

## HMF is found in all honey (and many other foods)

HMF is present in honey of all floral types and is not unique to mānuka honey (unlike DHA and MGO). HMF forms naturally over time and with heat as a result of two chemical reactions: caramelisation (breakdown of sugars with heat and acid) and the Maillard reaction (sugars reacting with amino acids) (Zirbes et al., 2013). These two processes are responsible for the flavour and appearance of many foods we eat every day—think roasted coffee, the golden-brown of bread crust, or the browning of seared meat (Shapla, Solayman, Alam, Khalil & Hua Gan, 2018).

The high sugar content and natural acidity of honey make it an ideal environment for HMF formation. As HMF levels increase, the honey colour becomes darker and there are noticeable changes to the smell and taste (Shapla et al., 2018).

## Heating and aging will contribute to increased levels of HMF

In general, freshly extracted honey will have little to no HMF (Grainger, 2015). Time and temperature are the two main factors that will influence the increase in HMF. The longer the storage time and the higher the temperature the honey is exposed to, the higher the HMF.

In the international market, high levels of HMF can indicate the following:

1. the honey is old and less fresh
2. the honey has been heat-treated or over-processed
3. the honey has been adulterated with HMF-containing additives such as sugar syrups.

For these reasons, honeys produced internationally are typically packed when the honey is fresh and efforts will be made to avoid heat-treatment in the production process (Shapla et al., 2018).

Mānuka honey is unique in that there are benefits to storing and aging the honey. In mānuka, DHA converts into MGO over time, resulting in an increase in the non-peroxide activity (NPA) of the honey. Honeys with a high NPA have greater antibacterial properties and therefore fetch a higher market price. Heating mānuka honey will cause DHA to convert more quickly to MGO but it will also increase the speed of HMF formation (Grainger, 2015). Care must be taken when aging mānuka to maintain a balance between growing MGO/NPA and keeping HMF levels low.

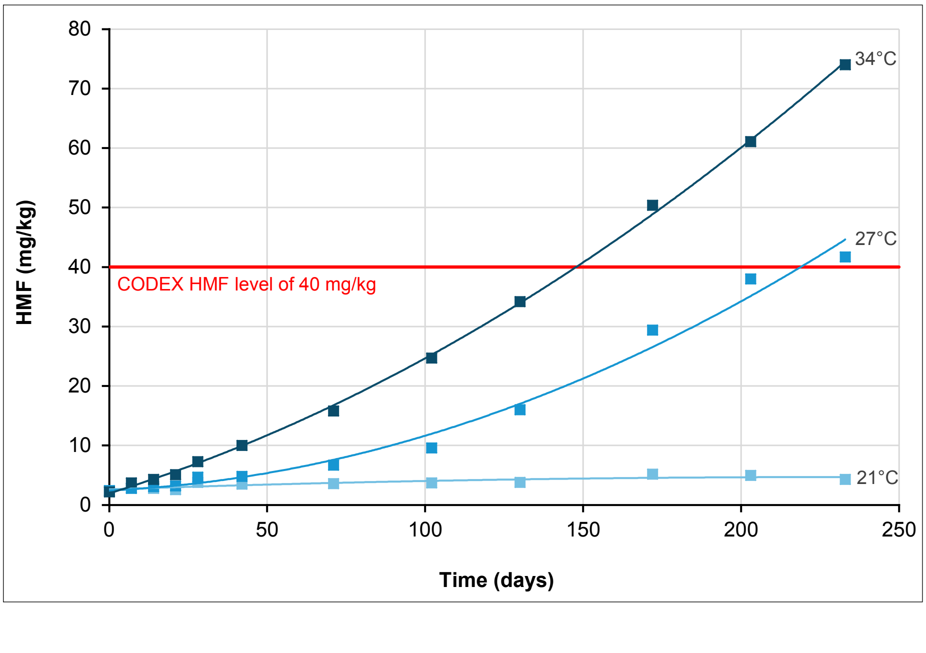
## How to manage HMF levels in your honey

It is important to consider how storage conditions and handling may be affecting the HMF of your honeys, especially when heat is involved. Figure 1 shows how HMF levels are predicted to change in a honey with an initial HMF concentration of 2 mg/kg when stored at three different temperatures. After 150 days of storage at 34°C, the HMF in this honey has already reached the CODEX limit of 40 mg/kg and will continue to grow if kept at this temperature.

Exposing honey to high temperatures at any stage of the honey production process is likely to increase HMF. An example is when honey is heated to high temperatures for a short period of time (commonly one minute at 68°C) during pasteurisation, it is not uncommon to see a slight increase in HMF (1 or 2 mg/kg). The key is that temperature and time are controlled to minimise the spike in HMF.

Keeping drums at a constant temperature is the best way to control and monitor the growth of HMF when aging honey, but this is easier said than done when there are many

*Figure 1: Changes in HMF (hydroxymethylfurfural) concentration in honey (initial concentration 2 mg/kg HMF) over 233 days at 21°C, 27°C, and 34°C.*



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tonnes of honey needing to be stored. When it's not possible to ensure honey is stored at a constant temperature, it helps to understand how changes in temperature may affect the HMF of honey in storage.

Honey is very viscous and heat transfer through honey is slow (Shapla et al., 2018). As a drum is heated, the metal exterior will heat the honey closest to the drum edges first, and this heat will slowly transfer towards the honey at the core of the drum. The outer honey will be exposed to heat for the longest time, so will often have higher HMF levels than the honey that is at the core.

As an example, a drum of honey at the top of a hot storage shed in the peak of summer may be exposed to heat in this way and HMF levels in the drum could be climbing. Agitating or mixing the honey while heating is an effective way to balance the heat exposure and HMF formation. Rotating the position of drums within a storage space can be effective too.

> When monitoring HMF levels in aging honey, sampling is key to accurate results.

When monitoring HMF levels in aging honey, sampling is key to accurate results. A sample from the outer honey (closest to the drum edge) and a sample from the drum core could have very different results. Unmixed honey that has been sitting for a long time can also produce variable results, as the honey components separate out over time.

Figure 2 shows a very old honey (stored for over 20 years!) that has separated out into two distinct layers over time. The lighter-coloured, solid layer at the bottom of the sample has an HMF concentration of 481 mg/kg; whereas the darker, liquid layer at the top of the sample has an HMF concentration of 839 mg/kg. Any sample sent to the lab should be well-mixed and representative of the whole drum.


*Figure 2: A mānuka honey aged for more than 20 years at ambient temperature that has separated into two distinct layers. The lighter bottom layer has an HMF concentration of 481 mg/kg and the darker top layer has an HMF concentration of 839 mg/kg.*

> Any sample sent to the lab should be well-mixed and representative of the whole drum.

Laboratories that carry out 3-in-1 testing may offer a mānuka forecast report that will predict how your honey will grow and change at different times and temperatures. It can be useful to ask the laboratory to issue mānuka forecast reports with temperatures and times that align with your operation to get a more accurate idea of how your honeys are predicted to change.

### HMF could be toxic to humans and bees

Although HMF is known to be a potential toxin that can be harmful to humans, an individual would need to consume an impossible amount of honey to reach near-toxic levels (Zirbes et al., 2013). It is for quality and flavour reasons already mentioned that high HMF honey will be rejected at export.

So, what can be done with high-HMF honey if it can't be exported, nor is it palatable to humans? Some markets will accept honey with a higher HMF, particularly in the tropics where honey from these regions is prone to having higher HMF levels. High HMF honey can also be blended down with low HMF honey to meet export requirements.

However, a word of warning to beekeepers that may be inclined to feed high-HMF honey back to the bees: studies have shown that HMF can negatively affect the overall fitness of bees and is potentially toxic to bees at certain levels (Zirbes et al., 2013). *[Editor's note: for more information, see the article by Dr Jacob Jaine in the March edition of the journal, listed in the References section at the end of this article.]*

*continued...*

### Conclusion

Careful management of time and temperature is key to controlling the growth of HMF in honey. Exposing honey to high temperatures or storing for too long can easily ruin the quality of your product and lead to unnecessary export rejections.

### References

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*Mānuka honeys with varying levels of HMF: (L to R) 4 mg/kg, 20 mg/kg, >200 mg/kg. Photos supplied by Analytica Laboratories.*

EDUCATION AND SKILLS FOCUS GROUP

# ROVE RECOMMENDATIONS SEEN AS POSITIVE FOR INDUSTRY

*Stuart Fraser, Chair, ApiNZ Education and Skills Focus Group*

The Reform of Vocational Education (RoVE) announced its findings and plans for the future on 1 August 2019. For full details of the release, please go to https://conversation.education.govt.nz/conversations/reform-of-vocational-education/

In essence, the Primary ITO will reduce its form and function over the next two to three years. In the future, we will be working with Workforce Development Councils to establish content for Certificates, and we will still submit these to NZQA for approval, but there will be a new way of delivering the learning, which is yet to be determined.

Our early approach to setting up online learning for the Apprenticeship appears at this stage to be a significant step in the right direction, and well ahead of its time. On the face of things as they appear today in the report, online learning and training in the workplace are the choice for the future.

While many things are unchanged for now, one change is a little more imminent for the Workplace Assessors involved in training. Primary ITO has emailed everyone involved, and the Education & Skills Focus Group team will receive an update at our August meeting.

Once we know all the likely implications of RoVE and the Workplace Assessor changes, we will be able to form a better understanding of how that will assist learning going forward. We hope to be able to engage ITO a lot more collaboratively as these changes become apparent, to ensure everyone is as informed as possible.

The RoVE recommendations are being regarded as positive growth for industry training towards smarter ways to ensure industry training meets requirements. These changes will take some time to come into effect, so please feel free to call me to discuss at any time. Your ITO Training Advisor will also be a good place to get more information.

*This photo by Gary Glasson won Gold in the Portrait category of the 11th annual Apiculture New Zealand National Photographic Competition 2019, sponsored by Ecrotek. The photo was taken in the Taramakau Valley.*