TECHNICAL SUMMARY

DHA AND MGO: THE MOST COMMON TESTING IN MĀNUKA HONEY

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The single most common lab test requested for mānuka honey is the '3-in-1' test, which measures concentrations of DHA, MGO, and HMF in honey. This article provides a brief history of testing the grade of mānuka honey. It describes how DHA and MGO test results change over time, and how they are used to help with grading and valuing of honey.

The medicinal benefits of the bark and leaves of the mānuka *(Leptospermum scoparium)* plant have been well known to Māori for centuries. Mānuka honey production became possible with the arrival of the European honey bee, although it took a long time for its unique properties to be recognised.

The late Professor Peter Molan was the best known of a group of people who first investigated the unique characteristics of mānuka honey in the 1970s and 1980s, and their work has been fundamental in developing the New Zealand mānuka honey industry to its position today.

Non-Peroxide Activity (NPA) is a unique feature of mānuka honey

It's common for fresh honey to inhibit the growth of bacteria, which is a result of the activity of hydrogen peroxide formed by enzymes that bees add to nectar as they digest it and turn it into honey. This is measured in the laboratory using a Total Activity (TA) test, which is a type of microbiology assay. Peroxide in honey tends to break down reasonably quickly, meaning that for most honey the TA is highest when it is fresh, and reduces over time.

The first important discoveries about mānuka honey were:

1. it often had a high level of TA; and
2. the TA did not reduce over time like other honey; and
3. this activity was not dependent on peroxide.

Professor Molan developed a new variation of the TA test, where the peroxide in the honey was deactivated (by adding the enzyme catalase), and called this the Non-Peroxide Activity (NPA) test.

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You will see reference to NPA on many laboratory test reports today. Usually this is a calculated NPA, based on the concentration of methylglyoxal (MGO) in the honey. However, it is still possible to carry out TA and NPA tests in their original form if requested.

The UMF® grading system was originally based on NPA

The small group of pioneering beekeepers and processors who were working alongside Professor Molan agreed to use the term Unique Manuka Factor (UMF®) to grade honey. The UMF® grade of a batch of honey was originally based on its NPA test result.

Today, the UMF® grading system involves a wider range of features, and includes a grade that is based on its MGO concentration as a component of this.

Dihydroxyacetone (DHA) and methylglyoxal (MGO) are responsible for the current and future NPA of mānuka honey

While Professor Molan's work had shown that mānuka honey had NPA, the reason for this was not understood. Between 2000 and 2010, research in New Zealand and overseas showed that:

- mānuka nectar naturally contains DHA
- when mānuka nectar is turned into honey by bees, some of this DHA converts to MGO. This conversion process continues over time, and as a result DHA concentration tends to decrease and MGO concentration tends to increase rapidly for 12-24 months after the honey is harvested
- MGO concentration is correlated to the NPA test result for a honey.

DHA is naturally found in the nectar of mānuka *(Leptospermum scoparium)* in New Zealand, and some of its close relatives (other *Leptospermum* species) in Australia. It has also been recorded at low levels in the nectar of other species of plant overseas. High concentrations of MGO only tend to occur naturally in honey made from nectar collected from *Leptospermum* species.

Modern testing uses chemistry to measure concentrations of DHA and MGO in mānuka honey

Discovering the importance of DHA and MGO meant that chemistry testing could be used to grade mānuka honey. The test changed from the NPA microbiology assay taking five days, to one using modern high-throughput chemistry methods that can be completed overnight. And the price changed from hundreds of dollars per sample, to current prices of $40–50 per sample.

The most common test that is used for mānuka honey grading in New Zealand is referred to as the '3-in-1' test, which includes both DHA and MGO (as well as HMF). In most cases, laboratories doing this testing will also report a calculated NPA grade of the honey, based on the MGO concentration (see next section).

MGO concentration is converted to an NPA grade using a mathematical conversion equation

When the role that MGO plays in mānuka honey was discovered, a number of samples were tested using both the original NPA microbiological assay, and the MGO chemistry testing method. From these results, a mathematical conversion equation was developed which allows an estimated NPA result to be calculated from the MGO concentration measured in a sample.

This effectively changed NPA from a direct measure in honey, to an NPA grade based on its MGO concentration. While the original NPA microbiological assay detected NPA at a level of about 8 and above, the use of the conversion equation allowed for NPA grades below this (of 5 for example) to be calculated.

Table 1 shows the concentration of MGO needed for a few common levels of NPA in honey. A more detailed list is available on the UMF Honey Association's website (on the page titled 'Grading System Explained').

Some people choose to label their honey simply as being mānuka honey with no indication of grade, while others label honey with an MGO concentration. Others choose to use the UMF® grading system. Please note that while MGO concentration is one important component of a UMF® grade, the UMF® grading system has a range of other additional requirements.

Table 1: MGO concentration associated with various NPA grades.

NPA Grade	Minimum MGO concentration (mg/kg)
5	83
8	182
10	263
15	514
20	829
25	1,200

DHA and MGO are not part of the MPI mānuka definition

In December 2017, MPI finalised a definition that can be used to authenticate whether or not a particular honey is New Zealand mānuka honey. It is important to note that DHA and MGO are not included in this definition. Regardless of the DHA or MGO test result for a batch of honey, MPI's requirements must also be met if that honey is to be exported from New Zealand and labelled as mānuka honey.

Forecasting tools allow you to estimate how the grade of honey will change in future

Since 2015, forecasting tools have allowed changes in mānuka honey to be estimated based on DHA, MGO, and HMF test results, and an assumed temperature at which the honey will be stored. The NPA grade of the honey can be calculated from the MGO concentration at any point in time.

Figure 1 on page 13 shows the forecasted change using Analytica Laboratories' forecasting tool in a honey sample that contained 1,500 mg/kg of DHA and 150 mg/kg of MGO when tested soon after extraction. There are two graphs, showing change at 20°C and at 27°C.

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You will see that the rate of change is faster at the warmer storage temperature, meaning that the honey reaches maturity faster. For example, after 12 months of storage at 20°C the MGO has reached about 360 mg/kg, where it is at 460 mg/kg (and close to its maximum) after 12 months' storage at 27°C. However, be aware that the unwanted HMF concentration will also increase more quickly at warmer storage temperatures. After 12 months at 27°C, the honey in Figure 1 had HMF of about 35 mg/kg (compared with less than 10 mg/kg for the honey stored at 20°C), and would be too high for many buyers to want to purchase it.

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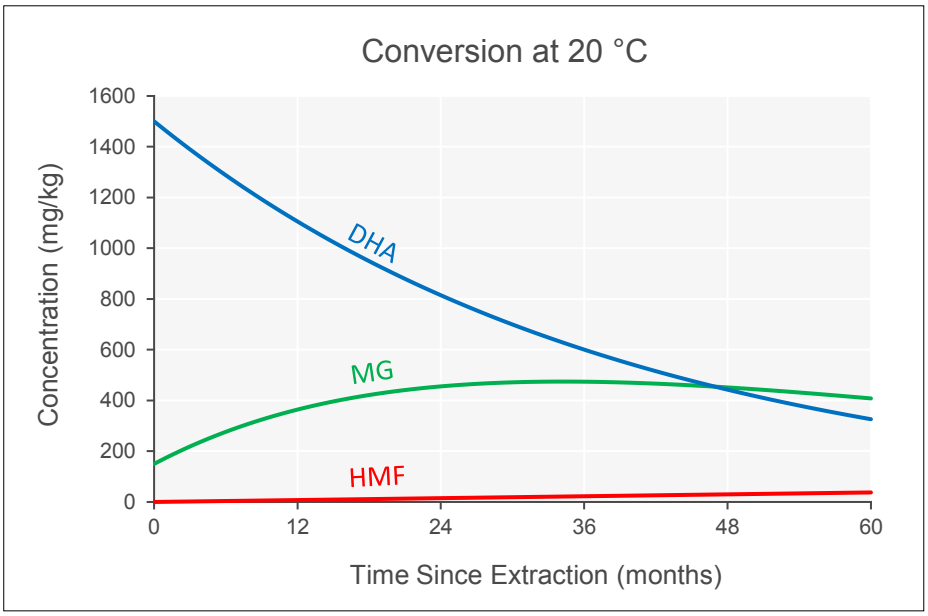
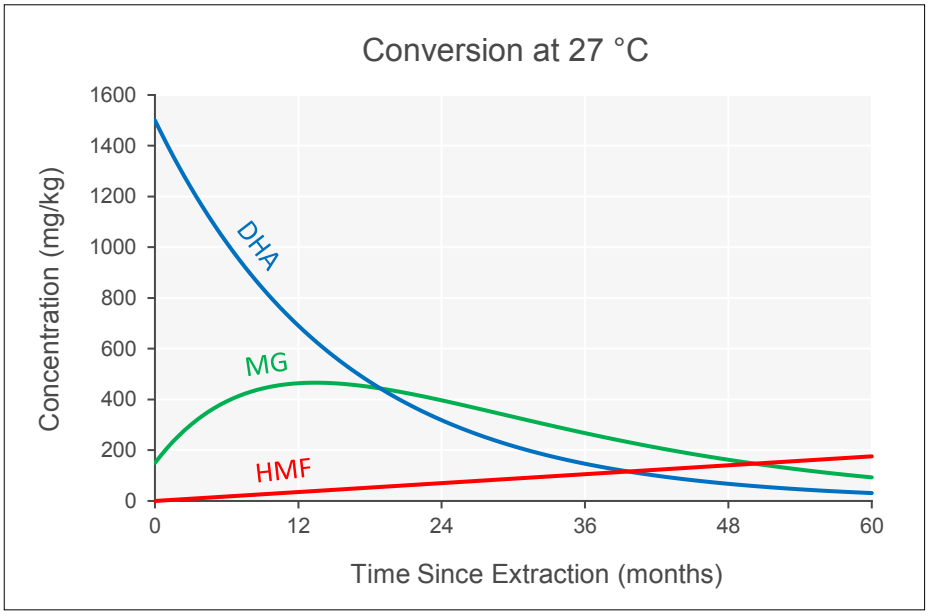
Anyone storing mānuka honey needs to make their own decision about the best way of doing so—but it is increasingly common to use a storage temperature at or below 23°C to get the best trade-off between DHA converting to MGO while avoiding rapid HMF build-up.

Figure 1: Change over time in mānuka honey with 1500 mg/kg of DHA and 150 mg/kg of MGO at extraction when stored at 20 and 27 degrees Celsius.





Other helpful hints

- The ratio of DHA to MGO is a good thing to monitor. When mānuka honey is freshly harvested, DHA concentration is often 10 times higher than MGO, and honey with DHA levels that are five times higher than MGO still has plenty of potential for future MGO growth. Processors typically want to pack honey with DHA concentrations between two and three times higher than MGO in the honey.
- When sending samples for DHA and MGO testing, make sure that they are a good representation of the drum or batch that they come from. This can be hard to do in honey that has been stored for more than 12 months, so developing a sampling method you are confident in is valuable.
- Mānuka honey is complex, and while forecasting tools give a good estimate of how honey will change over time, you may find that honey from a particular area behaves slightly differently than expected in a forecast.
- There is some variability in DHA and MGO testing carried out in a laboratory. It would not be unusual to see DHA or MGO results for the exact same sample tested by the same laboratory to vary by 5% if tested multiple times on a number of days.

CHANGE OF APINZ POSTAL ADDRESS

Please note that ApiNZ's postal address has changed. The new postal address is:

PO Box 10 414
The Terrace
Wellington, 6143