DHA, MG, and manuka honey activity

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In recent years the words methylglyoxal (MG) and dihydroxyacetone (DHA) have become linked with manuka honey.

They are strongly related to the 'activity' of manuka honey, which we measure as NPA/UMF®. This article gives some explanation of how the 'activity' of manuka honey is measured, and how MG and DHA fit with this.

Since ancient times, honey has been known to have antibacterial properties. In most floral types, the antibacterial action is due to three things: hydrogen peroxide in the honey (which is produced from the breakdown of glucose by the enzyme glucose oxidase), low water activity, and acidity (low pH).

In the 1990s, manuka honey (from the nectar of *Leptospermum scoparium*) was found to have an extra antibacterial property which is not explained by hydrogen peroxide, water activity or pH, and is often referred to as Non Peroxide Activity (NPA). Initially, researchers could not identify the compound responsible for the NPA, and the term 'unique manuka factor' (UMF®) was coined by Professor Peter Molan from the University of Waikato. NPA and UMF® are both used to describe this extra antibacterial property in manuka honey.

The NPA of manuka honey was originally indirectly measured because the compound responsible for it was unknown. The test was carried out on an agar plate, and involved the procedure described below.

- The enzyme catalase was added to a honey solution, which removed its hydrogen peroxide activity.
- The honey was then placed in wells on microbiological agar plates that were infused with the bacteria *Staphylococcus aureus*, before incubating overnight.
- At the same time, a known antibacterial compound (phenol) was added to wells on each plate in known concentrations, to provide a set of standards that the honey could be compared against.
- Honey with non-peroxide activity prevented bacteria from growing close to the well, and formed a clear zone around it. The higher the NPA, the larger the clear zone.
- The diameter of the clear zone was compared to the diameter of the clear zone around the phenol standards. The NPA of the honey was expressed against those standards; for example, a honey with a clear zone the same diameter as a 20% phenol standard has an NPA of 20.

In 2008 there was a breakthrough! Two independent laboratories (Mavric et al., 2008; Adams et al. 2008) discovered that NPA/UMF® in manuka honey arose from the presence of methylglyoxal (MG) in the honey. Fast, accurate and high-throughput testing methods using high performance liquid chromatography (HPLC) can now directly measure the MG in honey. The correlation between MG and NPA/UMF® has been established, so that the NPA/UMF® rating can be calculated from MG. For example, a honey with NPA/UMF® of 10 contains 263 mg/kg MG and a honey with NPA/UMF® 20 contains 829 mg/kg MG. More information on the calculation of NPA/UMF® from MG is available on the Grading System page of the Unique Manuka Factor® Honey Association's (UMF®HA) website.

Researchers also observed that the concentration of MG increases over time in many honeys. In 2009 it was discovered that DHA, which is found in the nectar of the manuka flower, is a precursor of MG in honey (Adams et al, 2009). DHA does not have antibacterial properties. But over time DHA converts to MG through a natural chemical reaction, and therefore measurement of DHA in manuka honey gives an idea of the potential for MG to increase (and therefore NPA/UMF® to increase) in the honey over time.

DHA is unique to manuka nectar, and has not been found in any other floral types of honey. The conversion of DHA to MG occurs slowly over time, and there are almost certainly other compounds in honey that affect this conversion. This is the subject of a lot of recent and current research. The conversion of DHA to MG is not a 1:1 reaction and current research will help us to better understand this conversion in the future.

Treatment during storage is another factor that affects the conversion of DHA to MG. Although heat accelerates the conversion of DHA to MG, if storage conditions are too warm, DHA and MG may convert to side products.

Measuring the DHA in freshly harvested honey tells the beekeeper about the potential that honey has to develop MG (and therefore NPA/UMF®) in the future. Honey with a higher starting DHA concentration has the potential to have higher MG concentration after storage than a honey with a lower starting DHA concentration.

Increasingly, honey is being sold and purchased based on both its MG level (the current NPA/UMF® of the honey) and its DHA level (its potential to 'grow' in the future). Beekeepers can expect that with ongoing research and development, there will be better tools available to predict the NPA/UMF® of a honey in future.

References

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