

# An explanation of why the MGO level in manuka honey does not show the antibacterial activity

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## Editor's note

The following article by Professor Peter Molan is presented for your information. This debate is expected to continue through until this year's annual conference in Masterton. Following are some basic facts about methylglyoxal:

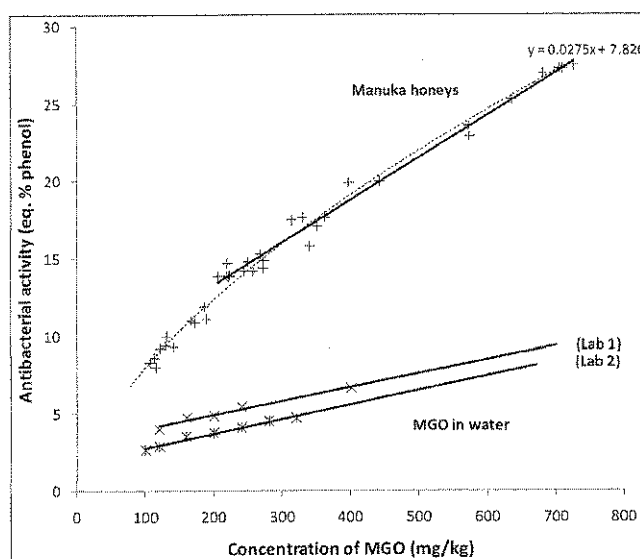
1. Methylglyoxal is one chemical compound found in non-peroxide honey often branded and marketed as Unique Manuka Factor (UMF<sup>®</sup>)
2. Methylglyoxal is one of a number of elements that make up the Unique Manuka Factor.
3. The research findings relating to methylglyoxal was conducted in Germany, independent of New Zealand companies and in the public domain.
4. The measurement of the non-peroxide activity is a measure of an outcome (the action of the honey upon biological subject matter), while the measurement of methylglyoxal quantifies the presence of a chemical compound.
5. Methylglyoxal reacts differently to biological matter ('bugs') when in honey than on its own.
6. Other elements within the honey change how this chemical works.

## Key points

- The antibacterial activity of manuka honey is due to synergy between MGO and non-antibacterial components in the honey. This synergy accounts for half or more of the UMF activity.
- The antibacterial activity of MGO is far less when it is in water than when it is in honey—it has less than half of the antibacterial activity that is seen when the same level is in manuka honey. **This is scientific proof that the MGO present does not by itself account for the non-peroxide (UMF) antibacterial activity of manuka honey.**
- Increased levels of MGO just add to the base level of activity, which is why the antibacterial activity of the honey does not increase in proportion to the level of MGO. **That is why the MGO rating misleads consumers—they may be getting only half of the activity they are expecting from the higher MGO ratings.**

Figure 1: The antibacterial activity associated with various levels of MGO in commercial manuka honeys, and with MGO on its own (i.e. in water).

The activity (non-peroxide) was tested by the standard method used to assay the UMF rating. This data and the data for the level of MGO in manuka honey are as was published in the paper in *Carbohydrate Research* by Dr Marilyn Manley-Harris's group. The data for the activity of MGO on its own was obtained independently by the Honey Research Unit and by NZ Labs.



In March 2008 *The New Zealand Beekeeper* published an article that I wrote explaining why consumers are being misled by it being claimed that displaying the level of the active antibacterial component of manuka honey shows them the antibacterial activity of the honey. But it is still being claimed that the MGO<sup>™</sup> Manuka Honey scale will become the standard against which manuka honey will be measured in future: (<http://www.manukahealth.co.nz/main.cfm?id=93> [accessed 29/05/08]). Therefore I have written this additional article to explain even more simply why the MGO scale does not show the non-peroxide antibacterial activity.

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What is being ignored is a well-established, basic, simple, scientific principle that is very widely known. That is the principle of synergy. *Wikipedia* defines it:

**Synergy** (from the Greek *syn-ergo*, συνεργός meaning working together, circa 1660) pp refers to the phenomenon in which two or more discrete influences or agents acting together create an effect greater than that predicted by knowing only the separate effects of the individual agents.

Common examples of this are the use of the non-herbicide penetrant *Pulse* as a synergist to increase the herbicidal potency of *Roundup* on woody weeds, and the use of the non-insecticidal enzyme inhibitor piperonyl butoxide as a synergist to increase the insecticidal strength of pyrethrum against houseflies.

There is no argument about MGO being the only antibacterial compound of any significance in manuka honey, but the level of it present falls far short of accounting for the antibacterial activity of the honey. Something in manuka honey, without any antibacterial activity of its own, acts as a synergist with the MGO to create an effect greater than that predicted by knowing only the separate effect of the MGO.

To illustrate this point, I had the antibacterial activity of various levels of MGO on its own (i.e. in water) assayed. This was done independently in two different laboratories. The results are shown in Figure 1 for comparison with the activity levels found when MGO is in manuka honey. The importance of the synergism in creating the antibacterial activity of the honey is strikingly obvious—the **antibacterial activity of the honey does not correspond with that due to the amount of MGO present.**

This point was missed by the group who first proposed that the non-peroxide antibacterial activity of manuka honey is due to MGO. Much prominence is given in the promotion of MGO™ Manuka Honey to the expertise of Professor Henle at the University of Dresden: (<http://www.manukahealth.co.nz/main.cfm?id=54> [accessed 29/05/08]), whose research student discovered by chance the high level of MGO that occurs in manuka honey. But what is not mentioned is that Professor Henle's acclaim as a scientist is as a food chemist specialising in the area of harmful substances formed when foods are spoiled by heating.

The recently published paper by Professor Henle that is referred to is, according to the databases of scientific literature, only the second paper Professor Henle has published on honey and on antibacterial activity, and his first on the antibacterial activity of honey. The Manuka Health website quotes Professor Henle as saying: "In our studies, we found for pure solutions a concentration of around 70 to 100 mg methylglyoxal per kilogram is the minimum concentration needed to inhibit *E. coli* and *S. aureus*." (<http://www.manukahealth.co.nz/main.cfm?id=98> [accessed 29/05/08]) But my research, published in the *Journal of the Royal Society of Medicine* in 1999, demonstrated that manuka honey with a UMF rating of 13.2 will inhibit *Staphylococcus aureus* when diluted down to as

low a concentration as 2–3%. From the graph in Figure 1, UMF 13.2 is seen to be equivalent to a content of approximately 200 mg of MGO per kg of honey. With the honey diluted to 2–3%, the MGO would be at a concentration of only 6–8 mg per litre. Thus with the synergy involved when MGO is in honey the amount needed to inhibit the bacteria is **about ten times lower** than the 70 to 100 mg per kilogram reported from University of Dresden as being the minimum needed. Similar results for the minimum concentration of manuka honey needed to inhibit bacteria have been published by other researchers. **This clearly demonstrates that MGO alone does not account for the antibacterial activity of honey.** Perhaps it was because Professor Henle was not familiar with the many research papers that have been published on the antibacterial activity of manuka honey that he did not notice the very large discrepancy between his findings for MGO and the published findings for manuka honey.

The amount of the synergistic action varies with the level of MGO in the honey, which explains the curve in the data on the graph of MGO vs UMF. MGO on its own gives a straight line relationship. I have fitted a curve to the data (shown as the dashed line in Figure 1), but this does not fit the data as well as the straight line fits the data for values above UMF 12. (The R<sup>2</sup> values are 0.9833 for the curve cf 0.9859 for the straight line.) The most likely explanation for the data being on a curve for the low values of UMF is that commercial manuka honey with low UMF values will have a low proportion of manuka nectar in them. (See the summary of the findings from the study of Dr. Jon Stephens which was in the March 2008 issue of *The New Zealand BeeKeeper*.) We have found differences in the amount of synergy between honeys of different floral sources, and are currently investigating this more extensively. This would also account for the scatter of the data on the graph of UMF vs MGO, and would make it unlikely that analysis of MGO could be used with an acceptable level of accuracy to estimate the UMF rating from a calibration curve.

Although there is a reasonably good correlation between the levels of MGO and the antibacterial activity at higher UMF values, these levels are far from proportional to each other. Those familiar with regression analysis will note the equation shown for the regression line,  $y = 0.0275x + 7.826$ . To put it in simple terms:

$$\text{Antibacterial activity} = 0.0275 \text{ times MGO plus } 7.826$$

What this means is that in addition to the activity that is due to MGO, there is activity equivalent to 7.8% phenol that is not accounted for by the MGO alone. So, for example, it can be calculated from regression analysis that for MGO 100 honey the activity of the MGO accounts for the equivalent of less than 3% phenol. (That is close to the minimum activity needed to kill some species of microorganisms. Even a small degree of dilution would take that down below the level needed to kill.)

As the level of MGO increases in honey the resultant activity does not increase in proportion to the amount added, as can be seen in Figure 1. The extra MGO is just adding to the base level of activity due to synergy. So, for example, 200 mg/kg

of MGO adds UMF 5.5 to the base level of 7.8, giving UMF 13.3. Twice as much MGO, 400 mg/kg, adds UMF 11 to the base level, giving only UMF 18.8, not an activity of UMF 26.6 (2 x 13.3) as would be expected from having twice the level of "active ingredient". If a consumer purchases MGO 700 they would expect the activity to be seven times higher than if they purchase MGO 100, but it is in fact only three and a half times higher, **i.e. only half of what they think they are getting**. Thus the MGO rating misleads the consumer.

The UMF system is a thoroughly honest way of rating activity, activity being rated relative to a well accepted standard. Thus if the UMF number is twice as big it unarguably means twice the activity. Whereas with MGO the consumer will be getting far less than twice the activity if they purchase honey with twice the level of MGO.

Before Britain joined the EU, there were regulations that required all disinfectants sold to have their activity rated against phenol—the 'Rideal-Walker coefficient'. It is for this reason that I chose phenol as the standard when we first devised the UMF assay. Anyone looking up phenol in Wikipedia will see:

"Phenol has antiseptic properties, and was used by Sir Joseph Lister (1827-1912) in his pioneering technique of antiseptic surgery"

and numerous mentions of its use as a disinfectant. As a result of the very large amount of news media exposure I have had worldwide it has been possible to explain the UMF rating system and it is very well known and easily understood.

Stating just the level of MGO gives no indication at all of the actual antibacterial activity of the honey. To start with, MGO is not a recognised antibacterial substance—anyone looking up MGO in *Wikipedia* will find no mention of antibacterial properties. In fact there is very little mention in the scientific literature of it killing bacteria, and despite extensive literature searching I can find no mention of anyone ever reporting its use as an antibacterial agent. If it is used as a standard against which to rate antibacterial activity then consumers should be told that MGO at a concentration of 700 mg/kg is equivalent in antibacterial activity to 8–9% phenol. (UMF 10 manuka honey is equivalent in antibacterial activity to 10% phenol.)

The notion of measuring MGO in honey to rate the honey's antibacterial activity was conceived without good quantitative microbiological research being done before the system was launched. Now that the research work has been done and the notion has been scientifically proven to be invalid it should be dropped. To continue to use it in the face of the simply explained evidence presented here is to knowingly mislead consumers.

**Consumers expect honesty—they need to be told what is the actual antibacterial activity of the honey they are buying, not to be misled.**

*[Editor's note: The content of this article does not necessarily reflect the views of the National Beekeepers' Association (Inc.) or the publisher.]*



## Honey sales since the tutin toxin incident

**H**ave you noticed any difference in your honey sales since the tutin incident? I know that most beekeepers have been asked the question, "Does your honey contain tutin?" In conversation with a supermarket shelf filler a week ago, I was told that people are looking at the honey on the shelves but not buying.

We all need to get out and spread the word. By buying from established beekeepers who have a Risk Management Programme, consumers can be confident that food safety audits have been undertaken.

There has been a major change within the beekeeping industry over the last few years. Before 2005, food premises were administered under the Food Act, controlled by local authorities whose interpretation of the requirements varied from district to district.

Now large honey producers are under the Animal Products Act administered by the New Zealand Food Safety Authority, which gives customer and overseas buyers greater assurance that they are getting a quality product.

Let your customers taste your honey. A beautiful product will sell itself.

- Frank Lindsay



Have you registered for the NBA Conference yet? Don't leave it until the last minute!

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