The explanation of why the level of UMF varies in manuka honey

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A few years ago many beekeepers kindly supplied samples of manuka honey, from the spring 2001 season, directly from hives in various specific locations so that a study could be conducted to investigate the possible reasons why there is variation in the level of UMF in manuka honey.

The work was done as a PhD thesis topic for which an Enterprise Scholarship was provided by the Government. A condition of this award is that 50% of the scholarship is paid by a company. Initially this was paid by Bee & Herbal, but then by Comvita when Bee & Herbal was acquired by Comvita. Additional funding was provided by Comvita to cover the costs of the services provided by NIWA in the analysis of environmental factors and the population genetics study. In recognition of the investment made by individual companies there was an agreed delay before the thesis would be made publicly available. The thesis has now been published and a summary of the findings is given here.

Because of the commercial sensitivity of the location of sites yielding honey with a high level of UMF there has been no disclosure in the thesis of the actual site locations—only more general regions are identified. Unfortunately there are geographic gaps in the knowledge obtained from this study as samples were not obtained from all localities where manuka honey is harvested.

Various theories to explain the variation in UMF had been raised, so each of these was examined in detail. The possibility that the variation may arise from another plant or animal species, the blending of nectar sources by honeybees, the impact of a physical or climatic factor, or an inherent difference between the *Leptospermum scoparium* (manuka) populations were explored.

It had been suggested that UMF may arise from the nectar of another plant rather than *L. scoparium* or is the by-product of another species associated with *L. scoparium*. The introduced plant species in New Zealand that yield surplus nectar for honey production were investigated and were not considered to be the source of UMF, as these species are harvested in other geographic regions of the globe where UMF is not recorded. Honey derived from the clover and thistle species now widespread throughout New Zealand are reasonable examples. Likewise the indigenous plant species in New Zealand were investigated, and only *L. scoparium* was significantly common in the variety of environments in which honey with UMF is harvested in New Zealand. *L. scoparium* exhibits the widest environmental adaptability of the indigenous scrub flora. For example *Kunzea ericoides* (kanuka) is a sensible alternative species as the nectar source, being common in many areas where UMF active honey is harvested, particularly hill scrub environments; however *K. ericoides* is not a significant member of wetlands throughout New Zealand where active honey is also harvested.

Possible animal and fungal associations were investigated, with honeydew derived from scale insects or fungal spores from the associated sooty moulds on *L. scoparium* and other plant species being the most likely candidates. However the possibility that these associations are the source of UMF can be dismissed because the distribution of the scale insects does not correlate with the geographical regions in which UMF active honey is harvested, and furthermore honey produced from areas where the scale insects are common does not contain UMF after the *L. scoparium* flowering has finished. Therefore it was concluded the UMF in manuka honey is derived from *L. scoparium*.

It has long been known in the beekeeping industry that there are differences in the level of UMF in honey. This was confirmed when the UMF activity of the 461 samples obtained from around New Zealand was assayed in this study. There were significant differences between regions in which manuka honey is produced, and within regions the variability also differed. Some sites yielded high UMF activity honey yet others provide moderate or low activity, and some sites inactive honey. The results are summarised in Table 1.

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All of the samples of manuka honey used for this study were obtained freshly produced and were kept refrigerated to minimise any increase in the level of UMF occurring before the assay of UMF were carried out, because it was recognised that the level of UMF increases on storage of manuka honey, especially if it is stored in a warm place. As many beekeepers do not get their honey tested for UMF until it has been stored for a while, this increase in activity would account for why the activity levels found in this study may be lower than beekeepers find in the honey they produce from the same areas.

Although the samples of honey had been obtained from sites which were considered to produce good manuka honeys, it was probable many of the samples may have been diluted by nectar collected from other plant species. A method was devised to measure the proportion of *L. scoparium* nectar in honey, based on the unusual feature of manuka honey being thixotropic. By measuring the viscosity of honey samples with minimal disturbance of the honey so that the thixotropic gel did not become liquefied, it was possible to determine the proportion of a honey sample that was derived from *L. scoparium*.

This method showed many of the samples contained significant amounts of other nectar types, and proportionally adjusting the measured UMF values according to level of dilution in the samples revealed three factors. Firstly there was still considerable variability between the regions in the UMF, secondly the variability within each region was mostly reduced, and thirdly there were distinct identifiable areas within the regions that were much less variable, and in these discrete geographical areas the level of UMF was not significantly different.

In effect there were discrete geographical areas throughout New Zealand that yielded similar levels of UMF activity if the honey was monofloral; however these locations were not necessarily found within a specific region. Analyses of these discrete areas showed there were no areas that yielded an average activity of 4–7.9 UMF units, 21 areas yielded 8–9.9 UMF units, 20 areas yielded 10–11.9 UMF units, 14 areas yielded 12–13.9 UMF units, and 16 areas yielded 14–15.9 UMF units. Thirteen areas yielded manuka honey that the viscosity method determined to be solely derived from *L. scoparium* and 100% monofloral, and therefore the UMF activity of these areas was not adjusted. These areas had an activity range of UMF 10–15.6, agreeing with the range of UMF activity obtained with the adjusted activity measurements. The adjusted results are summarised in Table 1.

Samples in which the UMF activity was too low to measure in the agar diffusion assay method (<4 UMF units) could not have their activity level adjusted proportional to the purity of the honey determined by viscosity. The viscosity measurements of these samples revealed that they contained less than 30% *L. scoparium* nectar. All the areas that produced manuka honey also yielded an adjusted activity greater than 8 UMF units. Thus it was concluded manuka honey, provided

it contains a reasonable proportion of *L. scoparium* nectar, will contain UMF activity. Inactive manuka honey is a dilute blend where the strong flavour and scent of the *L. scoparium* nectar incorporated into the honey masks the other nectar constituents.

It had been suggested that the variability in UMF may be due to differences in environmental factors. The use of the NIWA database for climatic and physical characteristics of the sites allowed multiple regression analyses to establish correlations between the level of UMF in honey from each site and environmental factors. The climatic and physical characteristics analysed significantly alter plant performance; such as mean annual temperature and solar radiation, soil water deficit, and drainage. The conclusion was drawn that mean annual temperature is the most important factor in the set of environmental variables, accounting for approximately half the UMF variability encountered. However when a region code detailing the discrete areas of similar activity was included in the analysis, in addition to the environmental factors, that conclusion was significantly altered. The region code accounted for much of the variability, and the environmental gradients became less important, and therefore a factor independent of the environment in these locations was influencing the level of UMF.

Several different varieties of manuka have been identified by botanists in New Zealand, and these are broadly associated with particular regions. Analyses of morphological characteristics, chemotaxonomic essential oil profiles, and population genetics of *L. scoparium* populations were conducted, and the conclusions that were drawn from each of these three studies were very similar. Four varieties were identified, divided into two divisions. The northern division, which contained core populations in Northland and the Waikato, represented *L. scoparium* var. *incanum* and *L. scoparium* var. *linifolium*. This division mostly yields manuka honey with high UMF activity, typically ranging from 14 to 16 UMF units. Interestingly other studies have indicated the *L. scoparium* present on the West Coast of the South Island is closely related to this division. The southern division, which contained core populations in Central North Island and East Coast, represented *L. scoparium* var. *myrtifolium* and an unnamed variety. The latter, growing principally on the East Coast, uniquely contains triketones in the essential oil, giving the oil antibacterial activity. For the most part the southern division yields manuka honey with low to moderate UMF activity, typically ranging from 8 to 12 UMF units. The insignificant variability within these discrete geological areas can most probably be ascribed to environmental factors and hybridisation of the wild varieties.

Hybridisation between these varieties has and will continue to occur, and this has been hastened by widespread land clearance; leading to a range of UMF activity in manuka honey that is difficult to predict in any location, given that varying amounts of hybridisation is often seen in a region.

Acknowledgement: We are very grateful to the many beekeepers who took the trouble to provide samples of honey and information on the sites where the samples were produced. Without their help it would not have been possible to gain this understanding of why the level of UMF activity in manuka honey varies. We are also grateful for the financial support of Bee & Herbal and Comvita that allowed the study to be undertaken.

Table 1. The average measured and adjusted UMF activity recorded from 11 regions throughout New Zealand.

Region	Areas	Samples	Measured UMF		Adjusted UMF	
			Average	St. dev.	Average	St. dev.
Northland	10	35	14.0	1.4	14.8	1.0
Waikato	2	6	14.9	1.2	15.3	0.6
Coromandel	17	128	9.1	3.2	11.8	2.1
Taranaki	6	51	8.7	2.1	10.0	1.4
East Coast	8	39	8.8	2.2	11.8	1.1
Gisborne	2	9	10.4	0.6	10.4	0.6
Hawkes Bay	5	48	5.4	0.7	8.4	1.1
Wairarapa	3	20	6.9	1.7	9.4	1.4
Northern South Island	6	50	5.7	1.3	9.1	0.8
Eastern South Island	4	14	6.7	2.0	9.6	0.7
West Coast (South Island)	12	61	10.9	3.0	12.9	2.1

Key Findings

1. The UMF in manuka honey is derived from the nectar of *Leptospermum scoparium*.
2. The incorporation of nectar from other floral sources in a manuka honey reduces the UMF activity of the honey.
3. Manuka honey without UMF activity is a blend of different nectar sources with an insignificant proportion of the honey derived from *L. scoparium* nectar.
4. Environmental gradients have a limited effect on the variability of UMF in manuka honey.
5. The different varieties of *L. scoparium* that grow in different parts of New Zealand yield different levels of UMF activity.

Varieties of *L. scoparium* and their distribution

Northern branch:

L. scoparium var. *incanum* is widespread in Northland, and in the areas of the Coromandel that yield honey with high UMF activity. There are also morphological traces of this variety on the East Coast. This variety yields honey with high UMF activity.

L. scoparium var. *linifolium* is closely allied to *L. scoparium* var. *incanum* and is found in the Waikato. This variety yields honey with high UMF activity also.

Other studies of *L. scoparium* have revealed an unnamed variety present on the West Coast and the reported characteristics of this variety are shared with *L. scoparium* var. *incanum*, areas of that region yielding honey with medium to high UMF activity.

Southern branch:

L. scoparium var. *myrtifolium* is present in the Central North Island. The level of UMF activity in honey from this region is low.

Another unnamed variety is associated with *L. scoparium* var. *myrtifolium*, and is principally present on the East Coast. This variety yields essential oils containing the antibacterial triketones. The areas of the East Coast where this variety is located yields honey with a medium UMF activity. A blend of these characteristics is present in the Coromandel indicating hybridisation.

Essential oil analysis has also revealed triketones in the essential oil present in *L. scoparium* in the Marlborough Sounds.

Easy check for AFB

Here is a challenge for a beekeeper/dog lover.

On Animal Planet (channel 75 on Sky), I happened on a programme 'K-9 to 5', with various activities of trained dogs. One beekeeper had trained his dog to indicate any hive with AFB. It was simple, really; as with Customs sniffer dogs, this dog would trot alongside hives, sniffing, and indicating which hive was diseased, without opening the boxes. Of course, as with Customs, any indication was proved by opening up for a visual confirmation.

Wouldn't it make life so much simpler and easier, if you could train your dog to help in this way?

- Ron Morison

ACC reminder

Most beekeepers use the ACC Cover Plus scheme to give themselves a calculated income in case of an accident, as their income tends to fluctuate from year to year.

Last year I had an accident that took me completely out of work for two and a half months and for the first time in my life, I relied on ACC for an income.

I have superannuation so calculated that I'd use ACC to pay for a worker to assist me if I was incapacitated, so only opted for a modest level of income. However in working out the amount, I had not calculated that ACC would take out income tax at source, so ended up a bit short to be able to do this.

With the increase to four weeks' leave, vehicle running and living expenses, all beekeepers should review their ACC schemes and increase the amount so that it covers all contingencies.

- Frank Lindsay

Errata

We made an error in the February 2008 issue:

In the photographic captions and credits for front and back covers (page 7), we mistakenly said that the late Sir Edmund Hillary was named the Beekeeper of the Year at the 1994 NBA Conference. In fact, this honour was awarded to Bruce McCusker. On the back cover Sir Edmund is pictured with Bruce McCusker, his wife Jenny McCusker, and Steve Olds, one of the sponsors of the event.

We regret the error and apologise to all concerned.