

TECHNICAL SUMMARY

USING C3 SUGAR FOR HIVE FEEDING MAY CREATE MORE PROBLEMS THAN IT SOLVES

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Analytica Laboratories explains the downstream risks to beekeepers and processors of feeding C3 sugar to hives.



Supplemental feeding of bees.

High C4 sugar results in monofloral mānuka honey continue to be a problem for many honey producers and processors. In part this can be blamed on the fact that C4 sugar test results in mānuka honey increase over time (the 'mānuka effect'), due to changes in mānuka honey that affect the test. Some people are considering the use of C3 sugar (like beet sugar) as a hive feed, rather than cane sugar, to help reduce C4 sugar test results. This might reduce C4 sugar results close to extraction, but it is not likely to prevent an increase in test results over time due to the 'mānuka effect'.

However, beekeepers and processors should beware that widespread use of C3 sugar as hive feed carries a risk that New Zealand honey will have C3 sugar residues detected in it when tested overseas. If this were to happen, it could introduce a requirement for a whole new range of expensive tests for New Zealand honey that would affect beekeepers and processors.

Introduction

We live in a world where, unfortunately, the sale of fake or adulterated honey is a big problem. Honey is regarded as being honey when (among other things) it is made

only from nectar or honeydew collected by bees from plants. However, it's now common internationally for various types of sugar syrups to be used as a way of making 'honey'—either by feeding them to bees, adding them in to honey, or creating artificial 'honey' using the syrups as a main ingredient. In New Zealand our beekeeping and honey production practices are genuine, and it's hard for us to appreciate just what some people will do around the world to make money.

The Netflix documentary series 'Rotten' includes an episode on adulterated honey in the USA, which may be of interest to those

who have not seen it before. <https://www.netflix.com/nz/title/80146284>

In response to this, there is been a huge international requirement for testing of honey to show that it has not been adulterated with sugar. Most honey producers in New Zealand are aware of the C4 sugar test. This was hardly ever used five years ago, but is now more or less a requirement for anyone wanting to sell mānuka honey.

The C4 sugar test does not work well in mānuka honey

A number of articles have been written on the C4 sugar test in past editions of *The New*

Examples of common tests used for detecting sugar adulteration internationally.

Test Name or Type	Description	Approximate Cost
Sugar profile	Measures the percentage of glucose, fructose, and sucrose in honey. Results can be compared to CODEX standard.	\$110
C4 sugar	Based on the AOAC 998.12 test, and indirectly referenced by CODEX. The method itself identifies honey with a result >7% as being likely to contain C4 sugars.	\$60 – screen \$140 – AOAC
LC-IRMS	Has some similarities to the C4 sugar test, but is far more detailed as it checks whether individual types of sugar in honey (glucose, fructose, etc.) appear to be from a C4 plant.	\$300–400
NMR	A recent method which includes the sugar profile (above) as well a number of markers for a range of C3 and C4 sugars based on an NMR analysis.	\$250–350
HR-MS and/or LC-MS/MS	Looks for chemical markers that are typical of different types of sugar syrup, and would not normally be found in honey.	\$250–350
SMX	A confidential test developed and operated by Chinese laboratories to detect a range of sugars that honey may be adulterated with.	Not easily available

Zealand BeeKeeper journal (Rogers, 2010; Rogers, 2013; Grainger, 2015; Chernyshev, 2017; Chernyshev, 2018; Rogers & Braggins, 2018). These are listed at the end of this article, and many can also be accessed from the 'News & Resources' section of Analytica's website.

You can genuinely get a high C4 sugar result in honey due to sugar syrup residues arising from hive feeding practices. For example, it's quite common to see C4 sugar results above 7% in early season honey extracted from hives that have been used for pollination. This is likely to be a result of feeding sugar supplements to strengthen the hives leading up to and during pollination.

Unfortunately, the C4 sugar test does not work well in mānuka honey. Results for a monofloral mānuka honey can easily increase by 6–8% between extraction and when they stabilise after 12–24 months, in what is sometimes referred to as the 'mānuka effect' on the test. These increases result from changes in the honey (which affects the C4 sugar test itself) that have nothing to do with sugar being added into the honey.

With an internationally acceptable C4 sugar test result of 7% or less, the 'mānuka effect' is a huge problem for people wanting to export honey to countries that use this test as a way of checking for adulteration.

Use of C3 sugars to feed hives is being considered as a solution by some

The term 'C4 sugars' refers to sugars that come from tropical plants that make use of the C4 photosynthetic pathway to convert the sun's energy into sugar, which the plant then uses to grow. Sugar cane (which we get cane sugar from) and maize (which high-fructose corn syrup is produced from) are both plants that produce C4 sugars. The C4 sugar test is designed to detect these in honey.

Many plants in the world do not use the C4 photosynthetic pathway, and instead use the C3 photosynthetic pathway to produce sugars. This includes pretty well all nectar-bearing plants, but also includes plants like sugar beet (which beet sugar is produced from), rice (which can be used to produce rice syrup) and some other varieties of grain and cereal that can be used to produce sugary syrups. The C4 sugar test does not detect these types of sugars in honey.

Some people are considering the use of C3 sugars as an alternative to C4 sugars to feed their hives, as a way of avoiding high C4 sugar test results.

Using C3 sugar for hive feed may reduce initial C4 sugar test results for honey that contains residual sugar from hive feeding—but it won't avoid the 'mānuka effect' on C4 sugar results over time

As described earlier, C4 sugar results in recently extracted honey can reflect the fact that there is some residual C4 sugar from hive feeding in the honey. The use of C3 sugars for hive feeding will avoid this.

The change in C4 sugar test results seen in monofloral mānuka honey (the 'mānuka effect') does not have anything to do with the sugar residues found in honey. Rather, it seems to be a result of other changes in the honey which affect the test. The use of C3 sugars as a hive feed is unlikely to have any impact on this, and as a result you can still expect to see significant increases in the C4 sugar test result in monofloral mānuka honeys over time. The rate of increase is faster at warmer storage temperatures.

Using C3 sugar as hive feed creates risk of more testing being required in NZ honey

Internationally there has been an explosion in the range of tests available to detect sugar adulteration (see table for examples). Most New Zealand beekeepers are blissfully unaware of these, with the C4 sugar test really being the only one that tends to be used widely for New Zealand honey.

If the use of C3 sugars for hive feeding increases, there is a risk that their residues will be detected in New Zealand honey when tested overseas. If that raises a concern in the minds of overseas customers or regulators about C3 sugars in New Zealand honey, that could result in new and expensive testing being required, together with a risk of honey being rejected for sale in that country by customers or regulators. I doubt that this is something that many New Zealand honey producers would want to see happening, so it would be wise for the industry to tread carefully around how C3 sugar use is adopted.

To give an idea of impact on testing costs, a C4 sugar screen test at extraction may cost someone \$60 + GST. If C3 sugar testing is required, using techniques like NMR or HR-MS, then that additional test cost would be over \$250 + GST per sample (probably a lot more), due to the very expensive equipment and slow testing speed possible.

MESSAGE ON C3 SUGARS FROM APINZ STANDARDS FOCUS GROUP

The ApiNZ Standards, Compliance and Regulatory Focus Group is also warning industry that the use of C3 sugar poses a significant risk to the international reputation of New Zealand honey.

Focus group chair Tony Wright says while there isn't any evidence currently that C3 sugars are being fed to hives in New Zealand, there is growing concern that some beekeepers may consider this option as a way to get around the C4 sugar test. "The problem is that there is no regulatory test limit for C3 sugars so if these are detected at any level, then the view of the regulator or any other recipient of the result could be that this is adulterated honey and you are trying to cheat the system," he explains.

An increase in the detection of C3 sugars via testing could in turn lead to overseas buyers demanding C3 tests from New Zealand producers as a trading requirement. "As Analytica Laboratories has pointed out, this would be expensive and would damage our international reputation as producers of high-quality honey."

"The strong advice from the Focus Group is to stick to sugar cane and don't use any other C3 sourced syrup," says Tony.

References

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