RESEARCH

VARIATION (MEASUREMENT UNCERTAINTY) IN LAB TEST RESULTS

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Measurement uncertainty (MU) measures the variability in test results that users of laboratory testing can expect to see, arising from factors at the laboratory. MU occurs in all lab testing, and ISO 17025 accredited laboratories must estimate this for each method they offer. This article explains what MU is, and how to take it into account when using a lab test result (especially when that result is close to a regulatory or specification limit).

Lab testing is increasingly being used to get information about honey. If the same honey is tested more than once by a lab (perhaps by a seller and buyer of honey), the results are not usually exactly the same.

Two things contribute to this situation:

1. variation in the **sample** that is submitted to the lab, which is affected by things like the sampling technique and how uniform the honey is in the drum or vat it is sampled from. This is often the biggest source of variation between test results (Grainger, 2015)
2. variation in the **lab testing.** This is the topic of this article.

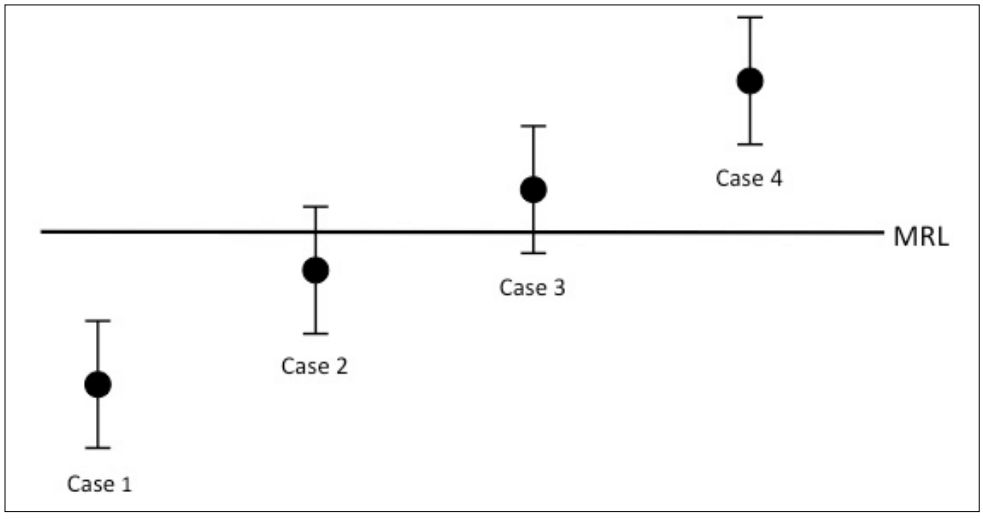
What is measurement uncertainty?

If a lab were to analyse the same sample multiple times for a specific compound, it would get a slightly different result each time. The degree to which this varies is called *measurement uncertainty* (MU). It is something that labs are required to measure when they set up a test, and monitor as they carry it out over time.

MU is caused by variation in the lab from test to test arising from a number of factors—examples being environmental conditions, equipment, or technician performance during testing. Despite a laboratory's best efforts, it is not possible to remove all sources of variation, so the lab must measure and monitor MU instead.

MU tends to be expressed as a 95% confidence interval—a statistical term that defines variation as a percentage above and below the result. While it is an oversimplification, you can understand MU by saying that when you receive a test result, it means the lab is 95% confident that the true result for that sample will lie in the range defined by the 95% confidence interval. You can only get a closer estimate of the true result for the sample by testing it a large number of times, and then averaging the results from all those tests (not something that people usually want to spend their money doing!).

Figure 1. Relationship between test result with associated measurement uncertainty and MRL.



Why is MU important?

Testing is usually carried out to see whether a sample meets a specification for reasons like meeting a regulatory standard, or meeting a label requirement. When a result for a sample is close to the required level, MU helps you understand whether there is any chance that a re-test of the sample could produce a result that falls on the other side of a level needed to meet the specification. For example:

- the maximum residue limit for tutin is 0.7 mg/kg in honey. If a sample has a result of 0.65 mg/kg, is it possible that a re-test could return a result of 0.71 mg/kg or higher?
- a batch of honey is labelled as containing 100 mg/kg of methylglyoxal (MG), and a test of the honey in the batch is 102mg/kg. Is it possible that a future test could return a result less than 100 mg/kg?

Figure 1 shows four different situations which the user could face when trying to work out how a lab test result compares to the specified level needed. In this example, we have assumed that the specification level is a maximum residue limit (MRL) such as tutin.

Case 1: The test result is below the MRL, as is the upper limit of MU.

- In this case, you are safe in assuming that any re-tests of the sample would give a result below the MRL.

Case 2: The test result is below the MRL, but the upper limit of MU is above the MRL.

- In this case, it is not possible to conclude without reasonable doubt that the test result meets the requirements of the MRL, because there is a risk that a future re-test of the sample could give a result above the MRL.

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Case 3: The test result exceeds the MRL, but the lower limit of the MU is below the MRL.

- It is not possible to conclude without reasonable doubt that the test result exceeds the MRL, because a future re-test of the sample could give a result below the MRL.

Case 4: The test result exceeds the MRL, and the lower limit of MU also does.

- You can assume that any re-test of the sample will return a result that is above the MRL.

So how do I interpret a test result close to a specification level?

It is difficult interpreting results close to a specification level, such as 'Case 2' and 'Case 3', because it is quite possible that re-tests will give results that fall on the opposite side of the specification. In these cases, there are a few options open to you.

1. The conservative approach is to treat the result as not meeting the specification (even if it has just passed), and take action based on that. We recommend this approach be taken.
2. Conversely, an optimistic approach is to treat a result which just meets the specification as a 'pass' and go ahead on this basis (even though there is a chance it could fail if re-tested in future). Caution should be exercised when selling the product into domestic or international markets, because re-testing by customers or regulators may produce a different result which does not comply with requirements to verify compliance. We do not recommend this approach.
3. Or you can get some more information by collecting and sending another sample, or asking the lab to re-test the sample they already have, to see if this casts any more light on the situation.

You can see an example of this at work when receiving results for tutin testing from a lab like Analytica. Tutin results between 0.61 and 0.70 mg/kg are indicated as 'May Not Comply', alerting the report recipient to the risk that a re-test of the sample may give a result at or above the MRL of 0.7 mg/kg.

Some examples of MU for common tests

- MG ±8%
- DHA ±8%
- HMF ±8%
- Leptosperin ±8%
- Tutin ±16%

Reference

Grainger, M. (2015, September). Representative honey sampling: avoid unexpected surprises. *New Zealand BeeKeeper, 23*(8), 13.

RECIPE

LEMON AND HONEY DRINKS WITH A TWIST!

Maureen Conquer, Wild Forage

If you need a pick-me-up, this is fast and fabulous at any time of the day!

Juice of 1/2 a lemon (or you could get creative with other citrus, like grapefruit or tangelos)

1 or 2 slices of fresh root ginger

1–2 teaspoons of your favourite honey (warmed slightly if necessary to blend)

Then top up with hot water and stir. Alternatively, add chilled water or soda for a refreshing drink.

For that extra twist and an alcoholic variation, try adding a nip of rum or whisky!

Chef's Note: Other spices like star anise, whole cloves or a cinnamon stick all blend well with lemon and honey, or mix it up with a slice of lime. During the summer months, these combinations are equally as good with ice and mineral water, either still or sparkling.