The History of Honey Fraud

By Peter Awram, True Honey Buzz, British Columbia

The international traffic of adulterated honey has increased to unsustainable proportions in recent years. Peter Awram is at the forefront of attempts to stamp this out through rigorous honey testing and database development.

Fake honey is not a new problem. In 1889, Dr Harvey Wiley of the US Department of Agriculture testified before the US Congress that honey was the most adulterated food in the country. Regulations that were introduced to combat the problem were reasonably effective, but through the 20th century there were scares and bad publicity involving heavy metals (lead) or antibiotics (chloramphenicol). Regulators in Europe, the US and elsewhere reacted with bans and import duties. An initial anti-dumping duty was levied on Chinese honey in 1994 by the US. Then in 1997 China had an outbreak of American foulbrood (AFB) in their hives and used chloramphenicol, a banned antibiotic that causes aplastic anemia in humans. When the industry recovered the next year, China started exporting high levels of honey to take back market share, resulting in a new anti-dumping duty on China that prevented sales to the US. Prices shot up in North America because of the shortage of honey, but probably kickstarted the current explosion in fake honey.

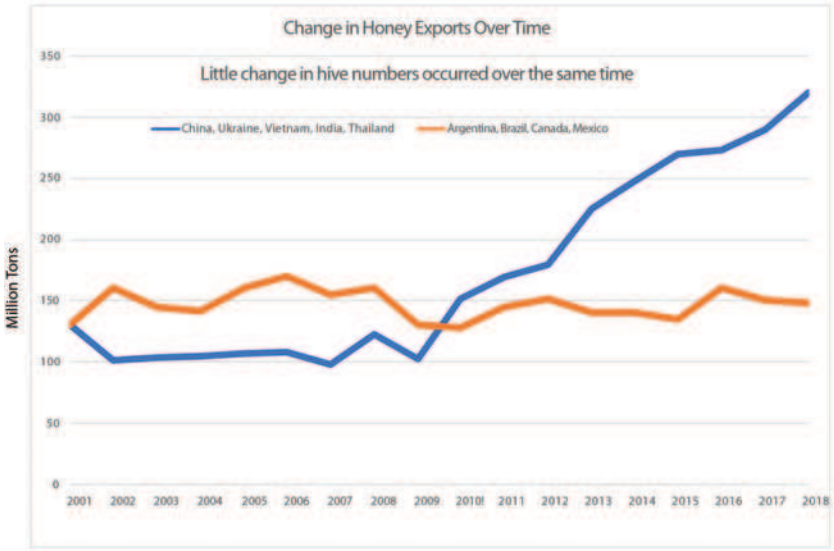

Figure 1. Norberto Garcia first started showing the export data in this manner. It shows the stark contrast between exports in North and South American countries (orange line) vs East Asian countries (blue line). Exports of honey tripled over the last decade despite relatively stable hive numbers over the same period.

With the bans and anti-dumping duties, China suddenly had a huge surplus of honey and no place to sell it. The altered honey was diverted through other countries such as Vietnam and India where the export rules were not as strict, relabelled as honey from those countries, and distributed throughout the world. This practice is referred to as trans-shipping. In 2008, federal agents in the US uncovered $80-million in evasion of shipping bans and anti-dumping duties through trans-shipping. This is the largest successful food fraud prosecution in history. Yet it appears to be a drop in the ocean, and honey fraud has continued to accelerate at an enormous rate.

Carbon isotope analysis no longer detects 'fake' honey

During this period a number of other issues have contributed to the incidence of fraud. Methods were devised to remove the banned chemicals, which also removed many natural components of honey (ultrafiltration). The production of rice syrup increased dramatically. High fructose corn syrup (HFCS) was the adulterant of choice previously, as it had a composition similar to honey. Because of a different carbon isotope ratio in corn (a 'C4' plant), it is possible to distinguish the sugars from those normally found in honey, which come from 'C3' plants and the C4 or stable isotope ratio analysis (SIRA) test was developed to detect this. However, the process used to turn starch into sugars for HFCS can also be applied to rice starch. Rice is a C3 plant, which cannot be detected by this method. In fact, it is now cheaper to produce high fructose syrups from rice than from corn. This has been a disaster for the honey market. With the lack of any test that can adequately distinguish fraudulent honey the incidences of fake honey exploded.

Several years ago, Professor Norberto Garcia, President of the International Honey Exporters Association at the time, documented this increase by comparing export data to hive numbers and it became

clear that countries could not possibly be producing the amounts of honey they were exporting (Figure 1). The numbers suggest that between 25% and 40% of honey labelled as 'pure' is not, with that increase occurring largely within the last decade.

EU testing confirms fraud

This jump was becoming more apparent and in 2015 the European Union instructed their Joint Research Commission (JRC) to look into the issue. They found that 14% of the samples were outright fraudulent and another 20% were suspected to have added syrups. These tests were performed using older analytical methods.

Magnetic resonance was not available at the start of the JRC honey adulteration project, but it became available to some of the testing laboratories part way through the multi-year study. When these laboratories analysed the samples using magnetic resonance they found 18% more adulterated samples than were detected by the older analytical methods.

The JRC saw a decrease in the use of corn syrup and an increase in the use of rice syrup during the course of the study. In addition to not being detected easily by the standard methods, rice syrup is cheaper to produce. The lack of enforcement and readily available syrups has led to a proliferation of producers advertising that they can provide these syrups to mix with honey (Figure 2).

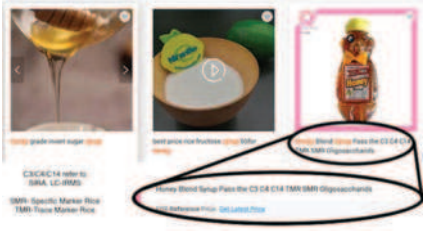

Figure 2. Advertisements like this are plentiful on Alibaba.com. No effort is made to hide the purpose, which is to mix syrup with honey and that they can evade detection using the older tests.

The damage to beekeeping and beekeepers by adulteration is incalculable

For beekeepers during the last decade, the crazy swings in honey price were frustrating. It is very difficult to run a business when you are dependent on weather for your honey crop and have no certainty of sustainable prices. Every time a roadblock in honey adulteration was raised the scammers found a way around it. It was clearly necessary to implement a significant new technology and work to raise awareness of this issue before the industry reached a point where the pure and natural image of honey was sullied beyond repair, fraudulent syrups flooded the market at unrealistic prices and beekeepers would be unable to make a living. Despite a few cases of prosecution, effective enforcement has been lacking. Government agencies do not have the resources to identify problems that are not related to health and generally only investigate if there are complaints.

Honey fraud caps beekeepers' price expectations

It is not apparent to some beekeepers that the fraud affects everyone. Many beekeepers sell all their honey directly to consumers for local or farm-direct premium prices. They feel that they are isolated and seem unaware that the supermarket shelf price affects their prices. However, an abnormally low price on a supermarket shelf sets a price in the consumer's mind. The farmer's market price that they are willing to pay will be guided by that price. I cannot count the number of times that I have been told: *"but Costco sells 3 kg of honey for $20 Why are your prices so high?"*

Magnetic resonance and similar technologies are a significant improvement on the earlier technologies, which are in use now. These methods look at all parts of the sample and the complexity and richness of honey is revealed; it marks the start of the Honey Analysis 2.0 era.

Honey analysis 2.0

Existing tests were designed to look for specific markers and once the scammers figured out what they needed to change, they did. An 'arms race' had arisen between the testing laboratories and the scammers with modifications being made to existing tests as well as designing new tests to look for new markers in fraudulent honey samples. This has resulted in a confusing bank of tests to look for adulteration and the costs to analyse a single sample by all the different tests becomes greater than $1,000. However, new technologies have emerged that promise to put a serious dent in the adulteration issue.

MRI leads the way forward

These new techniques are able to look at much more than a single marker in one test. They also tend to require little preparation and machine running time, making them very cost-effective. While capable of measuring multiple known compounds in a sample at once, they are non-specific and can also measure unknown compounds. The most evolved of these techniques uses magnetic resonance. This is the same technology used in magnetic resonance imaging machines (MRIs), which are found in hospitals around the world. We can create a similar 'image' for honey. This image contains a huge amount of data, allowing even small discrepancies in the honey to be found.

Honey composition changes depending on floral source, weather and soil type. These many differences can be seen in the data by using the power of computers and data science. Using verifiable, authentic samples, it is possible to create a database to which test samples can be compared. This allows identification of floral source and geographic origin as well as detection of syrup addition, resin filtration and other adulteration techniques.

There are two ways this technology can be used to identify the addition of rice syrup to honey. First, we can look for impurities in the rice syrup itself (Figure 3). This is how many of the old testing methods worked. Second, we can look for compounds that should be in the honey but are absent. Rice syrup only provides fructose and glucose; the other natural components of honey will not be present (Figure 4).

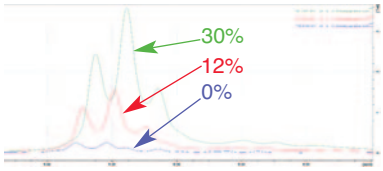

Figure 3. When we mix rice syrup obtained from Alibaba with pure honey we are able to identify the added rice syrup. Shown are examples of mixtures of the pure honey (0%) and 12% and 30% added rice syrup.

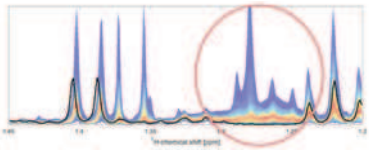

Figure 4. An portion of the magnetic resonance spectra with resin filtration. The black line represents the test sample. The coloured areas are all the samples in the database. More samples in the database are represented by the red areas while fewer samples are found in the blue areas. The circle shows where components are missing from the test sample as a result of resin filtering.

Ways to cheat the system

One way fraudsters get around this is by mixing honey in with the syrup. Detection is harder in these cases, but not impossible. It can be made easier if the floral source and country of origin labelling for the sample is given. This narrows the complexity in identification by making

better use of the 'fingerprint' aspect of the database, ensuring the honey must comply with a narrower set of components and not the broad range of the entire spectrum of honey. Honey is a very complex mixture; adulteration becomes much more difficult if missing honey components must be added.

The beekeeping industry will not survive if honey adulteration continues

The beekeeping industry has been struggling for decades as pests and diseases have increased costs dramatically. Beekeepers take great pride in their honey. This is the one pure, natural sweetener that does not need to be processed and it can be eaten straight from the hive. People have valued honey for millennia for these properties. Honey needs to stop being thought of as a commodity with one honey being like any other. Every year, every flower produces a different kind of honey. A viable system is needed to stop the fraud and to enhance the image of honey in the eye of the public; to remind them of the quality that pure honey brings to their table.

The benefits of a honey database are many

This is why we are working on a Canadian database of honey. By knowing what our Canadian honey looks like, we can see the different floral sources and regions and distinguish real from fake in a consistent, reproducible manner. Beyond having the evidence to force removal from the shelves of fraudulent product, we can also start looking at marketing the honey as specific floral sources and regions in the same manner that wine is marketed. By promoting the positives and the differences of honey, we have a quality assurance tool and a way to interest consumers in wanting to try different flavours that are a result of the different floral sources and to use honey in more of their meals.

Magnetic resonance and other tools in the Honey Analysis 2.0 era are the way to bring this industry back to where it should be. Removal of even a portion of the fake honey from the market will drop production below the demand and be a boon to the industry.

About the author

Worker Bee Honey Company is the largest beekeeping operation in British Columbia. Founded by Dr Jerry Awram in 1973, the business has thrived and now has farms in both Rosedale, British Columbia and Boyle, Alberta. Jerry's son, Dr Peter Awram, who holds a PhD in microbiology, has taken over the daily operations of the beekeeping business, as well as creating and overseeing the development of True Honey Buzz, devoted to eliminating the honey adulteration issue through honey testing and database development.

True Honey Buzz is working in conjunction with Bruker BioSpin in Germany, manufacturer of the NMR machine, to create an international database of legitimate honey.

For more information on True Honey Buzz and how to submit honey samples to contribute to their efforts to combat honey fraud, please visit their website http://truehoney.buzz