



# **FOOD ADULTERATION IN THE HONEY INDUSTRY**

NMR-based Honey-Profiling

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# Addressing Honey Fraud in Global Food Chains

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Sep 22 2021

## Thought Leader

Gillian Wade  
Peter Awram



*Honey fraud is a longstanding and deeply rooted problem that is widely recognized as having a direct correlation to the survival of beekeepers. Honey fraud is also a very real threat to worldwide food supplies, as beekeepers fulfill the important role of supporting pollinators which are vital in the maintenance of global food chains.*

*In this interview, Peter Awram is an expert from the Worker Bee Honey Company, the largest apiary in British Columbia, Canada, and Gillian Wade, an expert in consumer class action litigation, discuss the issues facing honey producers.*

## For both speakers: Can you introduce yourself and provide a bit about your background?

**Peter Awram:** I am a second-generation beekeeper, and my dad started way back in the 1950s. I started as a kid and have been beekeeping quite a bit since then. I did take a break off to go to university and ended up with a Ph.D. in science and some postdoctoral work.

Then I came back to the family business and had been beekeeping pretty heavily since then. We are a typical North American operation, which is migratory and does a mixture of pollination and honey production.

**Gillian Wade:** I am a plaintiff's lawyer in Los Angeles, California. I have a particular emphasis on consumer fraud class actions. I lead a consumer fraud department at my law firm, and I have done pretty extensive work in food fraud litigation. It developed naturally over time.

## **Gillian, how did you originally come across honey fraud and honey adulteration as an issue through your work? Can you talk about how it has become such a big part of what you do?**

**Gillian Wade:** Consumer fraud comes in many different shapes and sizes, and forms. Over the 17 years, I have been doing plaintiff-side consumer fraud litigation, I have seen there is a lot of fraud in the food industry. That ultimately led me to Professor Michael Roberts, who is the Executive Director of the Resnick Center for Food Law and Policy at UCLA.

Through that affiliation, I am on the outside advisory board, which is comprised of food industry leaders really from all different backgrounds. There are even some people on the board who I have sued before. Michael Roberts has been looking at this issue for many years about honey fraud.

The reason I was so drawn to it is because there is a direct correlation between honey fraud, the survival of beekeepers, and our food supply. If this continues down the path it is on, we will have nothing to eat. That was all from Michael Roberts introducing me to this problem and introducing me to some beekeepers and what they are experiencing.



*Image Credit: Egeris/Shutterstock.com*

## **How has honey fraud come to be such a big problem?**

**Peter Awram:** It is a complicated issue, and this extent of the problem is unbelievable. I had heard about honey fraud all my life, but I had not looked into it until it came to my attention through a talk by Norberto Garcia.

He had done a lot of work on looking at how exports had changed throughout time there. About 12 years ago, they had started increasing substantially.

It is likely to have started closer to the turn of the century here. Around the 2000 to 2003 mark, China suddenly started exporting a lot of honey to the US and these products were caught with a lot of antibiotics in them. This honey was because this antibiotic was causing problems in people.

China has a huge amount of honey on hand because they are the biggest producer. Thus, they were trying to get rid of it and started finding methods that allowed them to get around.

Suddenly, countries that were never producing honey exporting huge amounts to the US because they were moving honey out of China into places like Vietnam or India. These exports had contamination problems, so countries started developing huge resin filtering factories.

As a result, there was a huge increase in prices in the US and Canada for honey, incentivizing the development of these methods.

At the same time, high fructose corn syrup was becoming big in the US, and the same method for producing high fructose corn syrup also works with rice. China has a big supply of rice and with it can produce high fructose rice syrup.

Honey is not complicated food to fake, and high fructose syrup resembles honey in a lot of ways. Around 2008, they have been allowed to develop all these methods that worked really well in honey fraud.

Over time, we saw a degradation of retail honey on the shelves, particularly in the US. Generally, the US and Canada produce light-colored honey. On the shelves, honey color has gotten much darker and that is because of the imports being brought in by packers in the US to keep prices low.

## **What consequences have you observed over the last ten years and what effect have they had on your business?**

**Peter Awram:** Around 2003, there was a really high price and around that 2008 to 2010 mark, the price dropped about two and a half times on the Canadian side of the market.

Generally, there has been a huge fluctuation in price and it has made beekeeping a really frustrating business because you don't know how much you are going to get for that honey that you produce.

The costs of beekeeping have increased considerably over time. We have not seen the prices that were in the early 2000s at all. Almost 20 years later, the price has decreased while costs likely doubled during the same period.

This has resulted in a considerable decrease in the number of commercial beekeepers in Canada. An aging population, beekeepers, were coming to retirement age, and they retire, and the business ends at that point.

Very few people are working as beekeepers because the cost to get into beekeeping right now is significant, and the returns are not good enough to get bank loans. In general, there is a decrease in the number of beekeepers that are out there.

You have no control over the price as a beekeeper. When beekeepers have huge expenses at the end of the season, the buyers come and offer really low prices.

Beekeepers are put in a situation where they are forced to either take it so they can afford to pay off all these expenses they incurred, or they are out of luck.

Buyers put a lot of pressure on the beekeepers to accept low prices because they have this other source of so-called 'honey' they can grab if beekeepers reject their price.

**Gillian Wade:** The reality of the situation for beekeepers is that it is not economically feasible for them to survive. Because of imported fake honey, the price of honey is controlled by the packers who are mixing real honey with fake honey.

They set the price because no one can compete with these prices. Beekeepers in the United States are sitting on millions of pounds of real honey they cannot sell because the market is flooded with fake honey.

The beekeepers need the packers to sell it to the retailers, but the packers are buying less beekeeper honey at lower prices because they are mixing it with the fake honey.

Between 2018 and 2019, 40% of the hives in the United States were gone because of colony collapse, which is related to honey fraud. There are fewer and fewer bees because they are dying all over the world.

We have beekeepers who are keeping hives, and their production should be up. Normal economics would show that when demand is up, which it is, and supply is down, that prices would go up, and the opposite has happened.

In Canada, there is overproduction. Canadians do not consume all of the honey that they make. The extra is exported to the United States. Their prices are down too. Like Peter was explaining, it is all because of the fraud and its

epicenter in the US.

The fact that this has gone on for as long as it has is so alarming to me because everybody knows. The most troubling thing about this is that the retailers know and they could stop buying fake honey, and then the packers would not be able to do this to the beekeepers.

When they are all in this together, the beekeepers do not stand a chance, and we are not going to be able to survive if it continues down this path.

## **What are some of the legal checks that are supposed to be in place to stop fraud from happening and why haven't they worked in this case?**

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**Gillian Wade:** Regulatory bodies include the USDA and FDA. The USDA does not have certain powers in these circumstances and the responsibility of checks mainly falls to the FDA. The FDA, however, does not address food issues unless there is a health safety crisis currently happening.

They do not have the resources and therefore do not enforce the legal checks on honey fraud. Historically, the FDA has been notified of the problem and they have the power to detain or reject imported products. However, they are not testing the product when it arrives.

There are no existing checks and balances. Even though the FDA has a definition of what honey is supposed to be, there is no enforcement mechanism for labeling, which leads us to rely on private enforcement or lawsuits.

Lawsuits have their limits as well. Consumer Fraud in the United States is really focused in certain states because there is no federal cause of action for consumer fraud. Each state in the union has its own consumer protection type statutes or laws.

Because when we're dealing with products like honey where prices are down, and sales are up with retails for between \$4 and \$10, the average honey price



would be in that range.

As a consumer, what you can get back would be the difference between what you paid for the product you purchased and what you actually received.

This gets really complicated because a smart defendant will always argue that there is some value to what you purchased because it had some honey in it. It also gets really complicated to calculate damages for each individual.

That limits people to four or five states that have a private right of action where this would become a decent consumer protection case. Are the cases worthwhile? Yes. Are we going to see more of them? Yes. Is it going to stop the conduct? I do not know.

This fraud runs deep, a deeply rooted problem that has been around for a long time, and a lot of people are making a lot of money perpetuating this fraud. In order to get this to stop, it needs to be looked at through a different lens and addressed in a different way.

When I do the analysis, when your damages are low, the defense will argue you have got to prove that every single bottle of honey for that manufacturer is not real. There are different ways that you can demonstrate that, but it is very expensive to do it.

For example, you spend a million dollars on a Ph.D. economist to calculate it and they tell you your damages are \$200,000.

There are a lot of factors to consider that make a consumer case tricky. In terms of self-regulation, industry groups and trade groups have the same people perpetuating the fraud in leadership roles like sitting on boards recommending different forms of testing and suggesting what should be done.

Those same people are the ones importing the fake honey who do not want more rigorous testing and are controlling all of this. This is where the problem lies.



*Image Credit: Marek Svec/Shutterstock.com*

## **Are there any other inhibitors to the fight against fraud in the honey beekeeping industry?**

**Peter Awram:** There is also the issue of beekeepers being a tiny industry. That alone inhibits the ability to fight against this fraud that much because those profiting are powerful. Yet, the influence of bees is substantial.

The entire almond industry in the US would disappear if there were no bees in the US. The entire population of hives in the US goes to California for almond production. This is because the number of hives has dropped so dramatically.

It is about a third of what it was about 60 years ago, and you see this trend in Canada as well.

The testing methods are not adequately addressing this. The labeling regulations are lacking and inappropriate for what we are seeing. It is often not

clear where your honey originated from. There has been a commoditization that favors the people who are bringing in the fake honey.

Consumers, in general, do want to support local producers, but this designation is often not clear on the labels or product presentations.

## **Can you talk about how that differs from the kind of tests that are the current standards in the industry? What kind of resistance have you seen to that new method, and is there a path forward for it becoming a sort of new standard?**

**Peter Awram:** Most of these older methods are very limited. When identifying a specific compound, you can remove it if it is an artifact from adding a syrup. That is how resin columns originated, used to remove artifacts that shouldn't be in the honey. Some examples include rice syrup and arsenic.

On the other hand, with NMR spectroscopy, researchers and producers can start putting things in honey that needs to be in it. Examples include enzymes like prolene or diastase.

With magnetic resonance, you are looking at the whole thing. It is a bit like a DNA fingerprint with a huge amount of information. It is more difficult for somebody to fake that because magnetic resonance sees so much more.

The other advantage of magnetic resonance is it depends on the database. You start getting an actual picture of what honey truly is. If you have a database of authentic honey, suddenly, you have the ability to describe it better.

With these resin filtered, you have all these portions of the honey that are basically non-existent. It is no longer honey, just another form of syrup. The big advantage of magnetic resonance is the ability to look at the entire composition, a complex mixture of unique components.

The other advantage is the movement away from the commoditization of honey. Honey is like wine, originating from different kinds of flowers to produce different types of honey. In wine, you have a specific grape that gives you a specific flavor.

This is what allowed fraud to persist because there is no distinction between honey on the shelves. We also have the ability to look at the country of origin or geographic region. With our own product, we can tell the difference between blueberry honey that is produced on the west coast versus on the east coast of Canada.

All these can be used as selling points, just as they are in the wine industry. Honey is not just a sweetener, and marketing it as a sweetener has been a big disservice. Without that distinguishing ability there, honey can never compete on price to something like basic white cane sugar.

We need to move away from that commoditization because it benefits those importing fake honey.

## **Is there a route there that looks promising in emphasizing the premium nature of honey as a product and differentiating it from its image as a sweetener?**

**Gillian Wade:** We have all sorts of honey on the market, all labeled as labeled honey, and they are not honey. Improving labeling would be a good route. There are some products that say honey syrup which I have actually bought before and not realized that is what I purchased.

I think some stores, specialty markets, and farmer's markets carry real honey, but it is priced at about \$10 to \$15, which is tremendously more expensive.

However, even this real honey could be mixed. For example, I have spoken to small local farmer beekeepers selling to local farmers' markets. What they tell me is they don't have enough bees and are not producing as much honey as they can actually sell at the farmers' market.

So they will go to Costco and buy a 60-pound tub of honey because it is cheap. They are mixing that with their honey that they are unknowingly putting sugar syrup into their honey.

I don't know how to stop this at this time, especially with the way the market is so flooded with fake honey, bees that are dying, and colony collapse.

Beekeepers are looking for other methods of ways to survive, which does not

involve producing authentic honey, so there is less and less real honey coming into the market. I wish NMR testing was the standard.

## **Has there been pushback from food industry groups regarding NMR testing to regulate honey authenticity on the market, and if so, for what reasons?**

**Peter Awram:** Pushback from industry is a problem. They are seeing that NMR testing actually works and it has the advantage that it gets better as the database gets better. The more data we get and the more samples that we test, the better the results are going to be.

You can take this same technique of looking at a database and identifying what honey really is and can start using it with other sorts of machines.

For example, mass spectrometers are becoming much more used, and when you combine a mass spectrometer with a magnetic resonance machine, you cover everything that is in the honey. Those two machines together will be pretty much impenetrable.

The industry is going to push back because there is evidence of what is in their fake honey products. They are sending samples of varying concentrations of honey to syrup mixed into people using NMR technology to figure out how they can get past this regulatory check. It is not that easy to circumvent.

In a lot of ways, the testing companies are in a bind because the people that are supporting them are the ones trying to get fake honey on the shelves.

## **Is there currently a standard test for the authenticity of honey and similar food products and if so, why is it not effective?**

**Peter Awram:** There is one kind of standard test, the AOAC 988.112, which has been enshrined in law across the world. It is considered the standard test, and it does not work because it only detects the C4 syrups ( basically corn syrup).

There has been this massive switch away from corn syrup as a result because

rice syrup is readily available.

Rice syrup is undetectable by this testing method and actually cheaper than corn syrup. Companies do not mind this test being used and can point to the fact that countries have put this in law as the official test, stating their honey products have passed.

There was a big news outbreak in Australia, where the company that was accused of bringing in fraudulent honey and defended themselves, stating they had passed this standard test.

This can discredit the prosecution, despite the fact that companies know perfectly well the honey they are buying is a third the price of what they would pay if it were locally produced.



*Image Credit: Darios/Shutterstock.com*

## **What is a solution to this problem of accountability in the honey industry?**

**Gillian Wade:** We need to hold the retailers accountable because the

beekeepers do not have the power, money, or choice. I have heard from beekeepers directly that when they speak up and try to do something, they get retaliated against.

The packers that are controlling the market refuse to buy their honey and will go to another source which exacerbates the problem. Beekeepers are afraid to do anything because they have even less of a chance of survival if they get blackballed, and no one will buy their honey.

There are some packing companies that are not doing this to beekeepers, but they are very small and also cannot compete. They pay more for real honey, and they have to, in turn, sell it to the retailers for more. Retailers are not going to pay more when they could pay less.

For them to turn a blind eye and say they do not know what is in their product is false. They know, and they just don't care. We are seeing in the United States retail chains saying they are going to be testing their own products for safety, that they care so much about what is going on, and then they start banning products.

For example, Costco stopped carrying a line of coconut milk and coconut water products because of a PETA investigation about monkeys being used as slave labor to acquire the coconuts.

If we are not carrying a product because of monkey slave labor, why is Costco carrying products like fake honey that is going to destroy our food supply worldwide?

If all of the bees die and the beekeepers all go out of business, we are not going to have anything to eat, and then we are all going to die. This problem needs to be addressed because if it continues to be sold, consumers are going to buy it.

## **How can consumers hold companies accountable for the products they sell?**

**Gillian Wade:** People don't know about this problem, and the light at the end of the tunnel is that it is finally getting some mainstream press. I think that is going to be the start of taking these bad actors down.

The consumer needs to be made aware and to start holding the retailers accountable and not buying it. That will solve the problem but will take a Herculean effort because it is not going to be easy to overcome.

**Peter Awram:** A few of the efforts that have occurred, certainly in Canada, have produced results. An online petition went out objecting to the fact that they were using imported honey in their products which got a lot of news coverage and made waves.

Companies felt this in their bottom line, but their products are still on the shelves. It did make a difference and I think that is the only way that to get any sort of action. Real pressure ultimately comes from the people buying the honey, and they have to make it clear that they are not going to accept the fake product.

## **The problem of labeling was mentioned briefly earlier. Could you go into more detail on how this can be addressed?**

**Peter Awram:** We need to have the labeling correctly. Honey does sell things. For example, in honey mustard sauce, the top ingredient is some sort of glucose, fructose syrup. Honey is fourth or fifth down on the line. Companies are using the label honey to sell products, but that is not what they are selling.

The token amount in products is the cheapest stuff companies could find on the market and is likely more glucose or fructose syrup which does not do anything for a beekeeper anywhere.

**Gillian Wade:** That is another type of labeling problem that is really difficult to address. If you talk to some of the food manufacturers, they will say they are the victim. However, it is hard for me to fathom that they do not know. Of course, they want to use the cheapest thing possible, and it is a real problem.

This is even more difficult to address from a consumer standpoint. For example, you buy a cereal that says sweetened with real honey on the front. You have to prove that it was not sweetened with real honey and then show what your damage is because of that.

So on a \$3 box of cereal, you still got cereal. It just was not made with real honey, it was made with fake honey. Your damage might be four cents a box



which is a really tough case.

It is actions like this that are perpetuating the problem. Consumers really do care what they're buying, eating, and putting in their bodies.

Some food manufacturers care what they are buying, but if there are no regulations and making sure that they are buying real honey, it just complicates and exacerbates the problem.

## **What are some legal actions to take that could help with product labeling issues?**

**Gillian Wade:** One thing that is available under some of the state statutes, including California, as a remedy is setting aside the damages portion of it and the financial portion as we see it. We do have a way to seek injunctive relief, which would be to force proper labeling.

That may make a difference, but you have to make the same showing on liability to get that remedy because it can be tricky to get. If we can prove that what is in those bottles consistently is not honey, then one of the remedies we can seek is to force proper labeling.

If we can enforce proper labeling, then consumers will be able to see this product like honey, and this one is not.

Forcing proper labeling of products would be the function of the FDA. From that standpoint, there may not be as much incentive for the plaintiff's attorneys to seek out these cases because the financial piece is small, and we still have to pay for the litigation. This is a reality that has to be balanced here because these are not big damages cases.

These are injunctive relief cases that have real meaning, but you have to be willing to put in the resources to get that change, and you need a well-funded operation which can be a challenge.



*Image Credit: Alessandro Cristiano/Shutterstock.com*

## **What are some other food products that also face authenticity issues, and can these product fraud regulations help the honey industry?**

**Gillian Wade:** There are other product areas where that happens where there is a clear imitation product or a lower tier in the market, but it is labeled clearly, and people know what the product is. The example that occurred to me was maple syrup.

There is still fraud and people trying to pass off any old syrup as maple syrup, but there is a much better labeling in the products and a much better consumer awareness of when you are getting actual real maple syrup and when you are getting generic breakfast style syrup.

When there is a cheaper imitation product, it stands out. If you are not paying over \$10 for it, then it is not maple syrup.

The same thing happens with certain other products like wines, as mentioned previously. Peter is trying to sell honey more like wine is sold. Again, it is not

like there is no fraud, but consumer awareness at least is better in those areas.

Magnetic resonance can also be used to combat wine fraud and catch the passing off cheaper wine as more expensive varieties.

There is growing consumer awareness, and the tendency is towards clearer labeling as well. For example, for real olive oil, you have classifications like extra virgin olive oil, and there are certain standards that have to be met to put those labels on.

The fraud problem does not disappear, but it at least is more out in the open. Hopefully, consumers are a bit more aware of it and those consumers who do want their premium products know that they have to pay a little more for it and trust they are getting that.

## How can NMR technology as a regulatory test help solve these accountability and labeling problems?

**Peter Awram:** NMR is a quality assurance tool where you are able to look at the entire product. The best-known case of magnetic resonance is the MRI in the hospital, which is a way to think of this technology in relation to honey.

We are imaging the honey and get a whole picture of it that we are able to use. You can look at pictures of authentic honey and see what it is supposed to look like.

The advantage of magnetic resonance as a testing method is that it is the kind of machine that you can apply to a whole series of foods or even things like supplements and other areas that are not well looked at.

In the same way that you look at the entire spectrum of compounds that are in honey, you can look at the entire spectrum that is in wine or olive oil too.

You can do the same comparing and matching of the database. With this information, you can identify where it came from and how it was produced. Those natural compounds are in there, and when they are missing, then it

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alerts you that something is going on that is different.

For instance, if you are having every Costco with an NMR machine in the back room, they can be testing everything that is going through their stores and really improving our whole food system.

## **What do you hope might happen over the next few years that might give us some light at the end of this tunnel?**

**Gillian Wade:** I hope that this issue gets more attention and that consumers are made more aware. I think we are on that path. With more press and more lawsuits filed, I think more pressure on the retailers, which is my goal.

For example, if Walmart will not sell the product, then people will not buy it (and I'm not singling out Walmart for any particular reason except that Walmart is one of the biggest retailers in our country). If they hold the packers and people selling them the honey to a higher standard because there is public pressure to do so, then the problem will stop.

My hope is that the consumer will be demanding a real product and proper labeling, and that will result in putting an end to this.

**Peter Awram:** In the end, the only pressure that is going to be effective is from the consumers. It definitely is going to have to be backed up with some ways of actually identifying where the problems are. I do not see any way of doing that without technologies like magnetic resonance, where you can actually tell what you are looking at.

Consumers do not have the ability to test what is on the shelf. Certainly, there are things like taste, but in the end, consumers are at the mercy of what is on the shelf.

We need technologies like NMR to back us up and make sure. Pretty much everything should undergo some sort of testing, both at the ports when they come in, but also inside the country as well because it is possible where things can happen there too.

You can legally bring in some of these syrups into the country and then have the mixing and fraud going on inside. Testing and regulation have to happen all

along the chain.

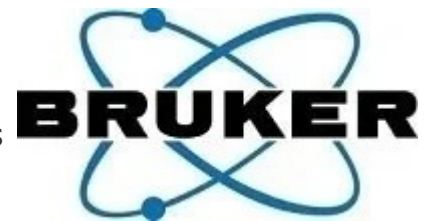
Bruker has worked in partnership with producers and experts like Peter to create this combination of robust, repeatable profiling and comprehensive statistical modeling, which could help you to ensure the authenticity of your food products.

In addition to honey, Bruker also offers food screener solutions for wines and fruit juices.

If you want to know how food screening could help you, or if you just want to learn more about the technology, then please go to [bruker.com/foodscreener](http://bruker.com/foodscreener) and reach out to Bruker experts.

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# Investigating Food Fraud in the Honey Industry

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Mar 16 2021

## Thought Leaders

Ron Phipps

Vice President

Apimondia Scientific Commission on Beekeeping Economy



*With a growing focus on healthy eating, the demand for honey has been increasing. Producers of genuine honey cannot compete with the fraudsters since their honeys are continually being undercut by cheap imitations.*

*In this interview, News-Medical talks to Ron Phipps about food fraud within the honey industry and the methods for investigating it.*

## Can you give us an overview of food fraud and why it is such an issue for honey production?

Food fraud has devastating consequences, particularly in the field of honey production, which the U.S. Pharmacopeia has classified as the third largest area of adulteration in the current era. Our aim is to find solutions to solve this problem and prevent its recurrence.

During the past two decades, there has been a food fraud epidemic. This has involved economically-motivated adulteration, customs fraud, label fraud and other types of fraud; including a variety of products such as honey, meats, coffee, wines, juices, maple syrup, edible oils and frozen versus fresh fish.

The USP's food fraud list describes foods that have been the most common subjects of adulteration. In response to this food fraud epidemic, a growing international movement is working to oppose food fraud - this includes the United Nations Food and Agricultural Organization.

Food fraud in the sphere of international honey has provided the international community with a very vivid case study. Over a 20 year period there has been explosive growth in the quantities of product produced, but at the same time, the number of beehives throughout the world has been stable.

During the same period, numerous factors affecting bees and plants have caused productivity (measured by the weight of honey per hive) to decline. This decline in productivity is coupled with the collapse of honey pricing resulting from food fraud.



*Image Credit: Billion Photos / Shutterstock.com*

## **How has this impacted the honey market?**

We have seen a contradiction between retail and wholesale honey prices - patterns that have been described as manifesting a complete aberration of the laws of economics. Demand has increased and prices have increased on the retail level, but on the beekeeper level, both prices and productivity have declined while the cost of production has substantially increased.

In this scenario, the prices of input should dramatically increase, not collapse. Food fraud has created an existential economic catastrophe for beekeepers producing authentic honey, who now find themselves in price competition with sellers of low-priced fraudulent products. Dr. Stan Daberkow (Emeritus Economist from the U.S. Department of Agriculture) has illustrated this contradiction, whereby the prices of honey on the retail level have increased

and the prices for the beekeepers have collapsed.

Two scientific committees representing the World Congress of Beekeepers issued a report regarding the decreasing prices of honey. This report describes adulteration as the greatest threat to beekeepers in the history of beekeeping, showing that the economic damage to beekeepers who

produce authentic honey is approximately \$1 billion. When we look at a more macro position, however, the losses are in fact many billions of dollars just during the past 5 years.

**Ron Phipps: Honey  
Authenticity**

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## **What methods are being used in honey adulteration?**

Authentic honey can be understood as honey resulting from the complete interaction of zoological and botanical lifeforms, bees transforming nectars and other secretions of plants into honey. Reports of adulteration in Europe, Canada, Australia, and India, as well as numerous reports in the Chinese press and the Indian press indicate that adulterated honey is being sold to consumers all over the world.

In the United States, honey anti-dumping orders resulted in a number of prosecutions by the U.S. Department of Commerce, charging honey importers with criminal activity, and highlighting the collusion of packers, importers and exporters. This was referred to as Honeygate and was described as the largest example of food and customs fraud in the history of the United States.

There are various modes of adulteration in the honey industry, including addition of extraneous sweeteners, use of resin technology, added pollen, and extraction of unripe honey, and these modes are used separately and/or in combination with one another. It is relevant to note that currently a composite containing adulterated products - irrespective of the percentage of the adulterants - is regarded as adulterated. This is per Codex standards.

These methods of illicit production have created a situation where the quantities of adulterated honey have no ceilings and their prices have no floors. This allows those engaged in adulteration to reap illicit profits while those who produce authentic honey have faced declining economic incentives, putting in jeopardy their economic survival as beekeepers.



Recently a report of French beekeepers who were interacting with a Chinese delegation in France was published on the website Apiservices. The beekeepers were mocked by the Chinese delegation who described the French modes of authentic honey production (which are similar to American, Canadian and Argentine modes of production) as archaic. Walter Haefeker (President of the European Beekeepers Association) described the Chinese method of honey production as comparable to a modern European brewery, certainly not the classic modes of honey production. He further contrasted the methods as "fast food vs. slow food."



*Image Credit: Shaiith / Shutterstock.com*

## **What methods are being employed to investigate the authenticity of honey products?**

The detection of any of the above modes of adulteration requires the use of most advanced scientific instrumentation, along with a comprehensive global honey database. This is especially true for a food product like honey, which is the product of many variables and manifests great chemical diversity.

Fortunately, the analytic toolbox for detecting food fraud in honey, as well as

numerous other products, contains very sophisticated scientific methodologies. The quality and authenticity of food products cannot be abstracted from either their chemical constituents or the modes of production of those products.

Nuclear magnetic resonance (NMR) is one of the most prominent scientific tools used for the analysis of honey. This technology is continuously being updated, and there are currently approximately 20,000 samples which form the global database of honey, which is continuously expanding.

This contrasts with the database of traditional methods used to deal with the types of adulteration that were prevalent 20 years ago - then, the database had only 100 samples, and 98% of these were from American beekeepers.

NMR can be used to test over 36 parameters characterizing the chemical profiles found in authentic honey. It can detect numerous features including geographic and local origin, as well as botanical origin, and must be used in a comprehensive way.

The struggle against food fraud and for justice in the honey industry has led to a wide range of countermeasures including deferred prosecution for honey circumvention involving 30 countries. All of the honey that was being circumvented, in order to avoid anti-dumping duties, was believed to be adulterated honey, produced using models of production which are not consistent with the authenticity of honey.

### **NMR in Honey**

[Click Here to Learn More](#)

## **Where can our readers find out more about the issue of honey adulteration?**

There is a very important Netflix documentary 6 part series called Rotten, the first of which concerns honey adulteration. Also, the U.S. Department of Agriculture released a commercial description of honey in December, 2019, and the U.S. Pharmacopeia's has released a standard for honey in 2020 and has now completed its comment period.

Professor Michael Roberts, a legal expert in food fraud, has two important "White Papers" regarding food fraud in the honey industry. These should be mandatory reading because they describe the importance of honey on a global basis. Not only are beekeepers an endangered species, as Michael describes,

but their endangerment constitutes a grave threat to global food security and ecological sustainability.



*Image Credit: Shablon / Shutterstock.com*

## **What are the global honey industry's next steps in the fight against adulterated honey?**

The Apimondia Forum on Honey Adulteration was held in September 2019 in Montreal, Canada. It had 5,000 members in attendance, a thousand of which attended the largest meeting on honey adulteration in the history of the honey industry.

That meeting was an inflection point, because those who had historically opposed NMR testing and those who had supported modes of adulteration like adding bio-engineered sweeteners, use of resin technology, or extraction of immature honey before it has been properly transformed from nectar into honey, became totally isolated. These members were forced to realize the impact that improper practices had on the honey industry, and these milestones can be understood as a tributary flowing into a large river, leading to an era of justice for beekeepers.

The struggle against food fraud, both in the sphere of honey and more generically, is evolving and is being manifested in many spheres. The foundation of these efforts resides in scientific advances in detecting modes of adulteration and food fraud. It also includes developing a rigorous, comprehensive, and more intrusive traceability regime that more fully incorporates the methods of production within the traceability.

A demarcation between legitimate and illegitimate modes of production is emerging and we are in an era of unprecedented awareness, opposition, and concern with food fraud in general.

## About Ron Phipps

Ron Phipps is Vice President of the Apimondia Scientific Commission on Beekeeping Economy, and author of International Honey Market Reports which appear in the American Bee Journal and the [apiservices.biz](http://apiservices.biz) website. He is also chief author of Marketing of the American Honey Crop in the Hive and the Honeybee (Dadant, 2015). He has organized international symposiums on Honey and Health. He is a pioneer in the international honey trade and actively involved in efforts to promote authenticity of honey as the foundation for the creative marketing of honey.

His academic work includes service as the Personal Assistant to the President of the American Philosophical Association. With the support of the National Science Foundation, his work in theoretical physics has led to publications, including "An Infinite, Open and Integrated Universe," "The Modalities to Develop an Educational System of Discovery, Innovation and Creativity" and "Integral Philosophy: An Essay in Speculative Philosophy." Phipps has helped to guide the Long Island Concert Orchestra and Chamber Players International, as Chairman of the Board.

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# Fighting for Change: Detecting Fraudulent Honey using NMR

Sponsored Content by [Bruker BioSpin - NMR, EPR and Imaging](#)

Oct 2 2019

## insights from industry

Dr. Peter Awram  
CEO  
Worker Bee Honey Co.



*In this interview, Dr. Peter Awram from the Worker Bee Honey Company discusses the urgent need for comprehensive analytical techniques in the honey industry and explains why NMR spectroscopy could soon become the gold-standard for honey profiling in North America.*

## How big of an issue is honey fraud, particularly in North America?

It's a huge issue. At the moment, Canada produces between 92 and 98 million pounds of honey every year. There is so much fraud that it would take very little for scammers to increase their production and replace the entire Canadian market if they are allowed to continue.

When I started looking at the issue a few years ago, it was clear that the number of counterfeit products on the market was so significant that the possibility of the whole honey industry being destroyed by the devaluation of honey in a decade or two was very possible.



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Part of the issue is that honey fraud is not well understood. The testing methods are poor and the main method that people use – stable isotope ratio analysis (SIRA) – is not very effective anymore. This means that nobody has a good understanding of what’s happening in the industry.

The numbers of hives vs honey production don’t make any sense but indicate that the level of fraud is significant. We need to determine how many fake products are reaching the market and where they are ending up.

The Canadian Food Inspection Agency recently released a report in which they used both SIRA and NMR to look at the honey industry in Canada. They found that 22% of the samples that were analyzed were fraudulent in one way or another, but they only looked at a small amount of honey. It is clear from these results that testing needs to be much more widespread and extensive.

Similar studies around the world show similar or higher evidence of fake honey, but many of those studies are based on retail honey that is found on the grocery store shelves, and do not include products that contain honey, such as honey mustard sauces or cereals.

These types of products are not under the same scrutiny, and so the vast majority of that stuff is probably fake. When you apply this to the import, export and production numbers, the potential amount of fake honey rises exponentially.

## **From your experience, what are the most common impurities and additives found in fraudulent honey?**

We see a lot of the starch syrups with rice syrup (at a tenth the cost of honey) becoming the dominant one because it's cheap and easily available. Corn syrup is still in use but because it is easily found using the standard methods its use is declining.

Often there is little consistency with the fraud when you start looking it becomes apparent that the origin is all over the place.

It's clear that the person is just buying from the cheapest source. One day a product will contain rice syrup and the next it will be ultrafiltered from an area that uses banned chemicals. Sometimes it will be real because they have beaten down prices so low that beekeepers just need to sell the honey to pay bills.



## **How do counterfeit honey products affect other areas of the agricultural industry and the Canadian economy more widely?**

In Canada, the beekeeping industry is not particularly vibrant. We are a small family business, and yet we make up a significant portion of the hives in Canada. As a country, we could probably handle two or three times the number of hives that we have at the moment without straining.

There are millions of hectares of canola available for honey production, but there are no bees on them. Beyond no honey, that also means the farmers lose production from the pollination that bees would provide.

We have the landscape, and there are lots of good forage areas where hives would benefit. However, it is not economically viable.

There is a continual shortage of bees for pollination throughout Canada. In BC, there are not enough hives to satisfy the requirements.

In the Lower Mainland, blueberries need pollination for proper fruit production, but there is a shortage every year. This is also seen in blueberries on the east coast and for tree fruit production in other areas of Canada.

This is the situation throughout North America. In California, there is a huge demand for almond pollination and hives are transported across the country yet there are still never enough hives available. The problem is pollination fees are not enough to cover costs of hive upkeep alone and fair honey prices are required to justify increasing hive numbers.

## **What methods are currently used for the detection of fraudulent honey in Canada?**

Currently, there is only one official method throughout the world for testing honey, AOAC-998.112, the SIRA method for isotope ratio analysis. This has limitations and cannot detect rice syrup.

There are a number of methods that have been developed to deal with the deficiencies of SIRA, but they haven't been standardized or consistently applied. They are usually based on detecting a single marker which presents a problem



since the scammers find ways to get around the test.

In general most of these methods require sophisticated personnel to perform the testing which increases cost and processing time.



## How can NMR be used to improve the detection of fraudulent honey?

Nuclear Magnetic Resonance (NMR) is the next generation of lab analysis. Unlike the other testing methods where you are looking for a specific marker, you are able to identify at all of the organic molecules in the sample.

It is a very useful technique because it provides a lot of data which can be applied in different ways. Magnetic Resonance is really two tests in one. First you can measure the absolute value of a number of compounds and you can ensure they are in the ranges that would be expected.

Where the technique really shines is when you start looking at the entire spectrum – all the molecules in the sample. The flower, the soil, the weather during the nectar flow, all affect the composition of the honey.

This generates a “finger print”, then if you have a database of honey “finger prints” you can start identifying what country the honey came from, which flowers the bees were visiting. You don’t have to know what all the compounds

are, just see the indications on the spectra

Blueberry honey is a good example of this. We see certain peaks in the spectra that are only present in honey from blueberry flowers. We can also see the amount of these peaks decrease during the season as the blueberries stop flowering and the raspberries start blooming allowing us to have an idea of what percentage of the honey is blueberry vs raspberry.

Blueberry honey is a premium product and demands a higher price. With Magnetic Resonance, we can look at a sample and if we don't see the peak that indicates blueberry honey we know that someone is trying to pass off something else as blueberry honey.

We see these differences in other flowers as well. Canola from North America looks different compared to European canola. Fireweed, a very desirable honey that we obtain in the mountains looks very different from most of the other things that are in the database right now.

This is something that is not as easy to fake because you cannot just take things out, you have to add in the constituents of honey that are not present in starch syrups.

Ultimately, if someone wanted to build up a fake honey product from scratch, molecule by molecule, they could. However, scammers are not interested in doing that. They are more interested in making money, quickly. The moment that you make it difficult and expensive for it to be worth their while, they are going to target something else.

*Discover More:*

Detecting Fraudulent  
Honey using NMR

## **How does non-targeted testing help you to stay ahead of fraudulent companies?**

NMR helps us to stay ahead of the scammers because we get a really good idea of what should be in the honey and what doesn't belong there.

It's no longer possible to remove the traces left by the starch digestion and clean up partial degradation products and contaminants, with Magnetic

Resonance you also have to add in the other components that make honey special. This then becomes a much bigger problem for them to the point where it is no longer profitable for them to slip in cheap things like rice syrup.



Trong Nguyen | Shutterstock

## **What is the IAFBC and how is this organization helping to stop fraudulent honey from entering the market?**

We have been very fortunate to have a government in British Columbia that is very supportive of the beekeeping industry. They are funding a number of initiatives to promote bees.

We have been able to get funding from the Investment Agricultural Foundation (IAF) of BC to generate a database of BC honey. This will allow us to characterize the honey produced in BC. BC produces some very high-quality specialty honey. By characterizing it with NMR we will provide BC beekeepers a tool to distinguish their honey and add value.

The project requires a lot of samples of authentic honey, so the funding is vital. The money provided by the IAF allows us to go out and pull honey directly from the hive.

We have developed a process where we can track the honey directly from the hive to generating the “fingerprint” data. We take pictures, identify individual hives and frames where the honey was collected.

Tamper-evident seals, GPS tracking and pictures allow us to document a chain of custody for the sample. This allows us to provide a secure database with accurate data, and that will let us create molecular fingerprints for every geographic region.

This method gives us good information in terms of floral sources and geographic region so that we can nail down the fundamental composition of the honey.

Free Download: [Authenticity Analysis of Honey using NMR Spectroscopy.](#)

## **Why do you use the NMR FoodScreener from Bruker?**

When looking at the techniques, it was clear that the existing methods were not working. At the time Bruker had just released the first iteration of the FoodScreener.

I contacted them and started discussing the technology. I then sent some blind honey samples to Bruker, and the results were amazing. It was clear that the company understood the data very well.

There is a lot of development behind the method. Ring tests, where laboratories around the world test the same samples, blind, allow labs to ensure that the same results are generated no matter which machine performs the test. Bruker has received ISO accreditation for the process. This is an analytical laboratory standard that ensures consistency in results.

The method is well defined and will be the gold-standard over the next decade and beyond. While starch syrups can be identified now, as the database increases the surety of the method improves. NMR will be able to keep up with advances by the scammers.



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## How has the database developed over the past year?

The database is growing quickly. The second iteration of the database has been released with over 19,000 samples. I have been working heavily with Bruker in order to get samples directly from the hive into the database. Every time we get another sample, our data improves.

Honey has generally been considered a commodity in North America, with consumers thinking that it is all the same. Everything on the supermarket shelf tends to look the same. This is changing as consumers become more aware.

Honey should be thought of as more like wine. Its qualities depend on factors like the flower that it comes from and the weather that year. Magnetic Resonance gives us the tools to substantiate this.

The existing database does not cover North America as well as it should. It does not cover a lot of the world, and we are doing everything we can to change that. I have got a lot of samples from BC now because I have the funding for it.

We are also starting to cover Western Canada as well as down into the United States, and have analyzed samples from there too. We are also getting a lot of samples from Mexico and Australia because this is a world wide problem

Beekeepers are very supportive of this technology. Everyone is becoming increasingly aware of how significant this problem is and by providing me with samples, our industry is growing stronger.

## **How do the regulations surrounding honey in Canada compare with the USA?**

Canada has honey standards but they are not well enforced. It is similar in the USA. There is work being done to generate a more specific standard of honey that will allow better prosecution for fraud. But one of the big issues in food fraud is that there is not enough actual testing going on.

Traceability often consists of a large amount of paperwork. These systems can be forged and tend to put a huge cost burden on honest producers. There needs to be considerably more testing to ensure that these systems work and we are not seeing enough from regulatory bodies.

The best method is to randomly sample the food directly. This is where we need the government to take the initiative to get those samples and test it at the retail level. As well as this being more effective, it may actually be cheaper.

## **Do you think that the Canadian Food Inspection Agency (CFIA) should adopt the NMR FoodScreener as the gold standard for honey profiling?**

The Canadian Food Inspection Agency (CFIA) is looking at NMR. The push by beekeepers such as myself and others across Canada is somewhat responsible for this. As I mentioned, they did a study in which they took every sample that was collected in 2018, and ran it against both the SIRA and the NMR.

The CFIA looked at just under 300 samples. The results show that this is not nearly enough. The adulteration is so pervasive that this number needs to increase to the thousands.



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## How are honey samples prepared for analysis using NMR? How does this compare to SIRA?

One of the nice things about NMR is that the sample preparation is very straightforward. The sample prep doesn't change the honey, so you don't need to worry that you are altering the composition.

A small dilution is carried out, some larger particles are removed, and then the pH is measured. A sample can be run in half a day – which is much faster than SIRA.

The entire method is double checked throughout so any errors are caught right away. Standards are run before tests that allow proper tuning of the machine and to ensure that there were no errors in sample prep or because of bad reagents. Sample preps are not altered during measurement so it is possible to run them again if desired.

This is one of the easiest most straightforward methods that I have ever

*Read Next:*

seen done, and I have done a lot of work in labs from molecular biology to microbiology. This means that reproducibility and reliability are increased. Very few things are this simple yet can produce so much data.

Using NMR to Reduce Fraud in the Honey Industry.

## What changes would you like to see in the honey industry over the next decade?

I would like to see food fraud taken more seriously. Often, regulatory agencies do not consider anything to be significant unless there is some sort of health issue.

It is time for the regulatory agencies to become more proactive and tackle this problem head on. It is not just the honey industry that is affected by fraud, many other foods are also being adulterated. Even if the honey industry is cleaned up, scammers will move to another type of food.

NMR is extremely versatile and can be applied to these other foods too. We already have the ability to analyze wine and juices in house, and there are new protocols emerging for oils. Beyond liquids, solids like coffee can be analyzed.

All you need is a method to extract components. Coffee is extracted every day just by adding hot water. This can apply to all sorts of foods and you can take it into other fields such as nutraceuticals and health supplements.

In my opinion, the FoodScreener is a very cost-effective piece of technology for the honey industry. It is not an expensive test given the amount of data that comes out of it or compared to the costs of standard testing methods.

With the FoodScreener, results can be received straight away, so that the problem can be addressed immediately. Using older technology, the whole process takes much longer. Turnover in supermarkets is less than 6 weeks usually. If testing results can't be obtained quickly suspect batches will disappear from shelves before it is possible to take action.

Speed of analysis is essential for stopping adulteration. Test answers are needed in less than a week so that they can be addressed on the spot and fake



food can be pulled from the shelves.

## Where can readers find more information?

- [Learn more about using NMR for Honey-Profiling](#)
- [Read more about food screening using NMR](#)

## About Peter Awram, Ph.D., and the Worker Bee Honey Co.

Dr. Peter Awram is a second-generation beekeeper at [Worker Bee Honey Company](#), the largest beekeeping operation in British Columbia, Canada. Founded in 1973, the business has branches in both British Columbia and Alberta. He is also the CEO of [True Honey Buzz](#), an organization creating a database of authentic honey samples.



Peter became interested in the FoodScreener a few years ago when it became apparent just how bad the adulteration of honey had become. He is now using the technology to develop a database of honey profiles and to address adulteration in the marketplace.

Peter obtained a Ph.D. with a focus on molecular biology and has written several peer-reviewed papers. This combination of science and beekeeping is why it became apparent to him that NMR honey analysis was essential to the future of the honey industry.

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# Honey Analyses: Using NMR to Reduce Fraud

Sponsored Content by [Bruker BioSpin - NMR, EPR and Imaging](#)

Oct 10 2018

## insights from industry

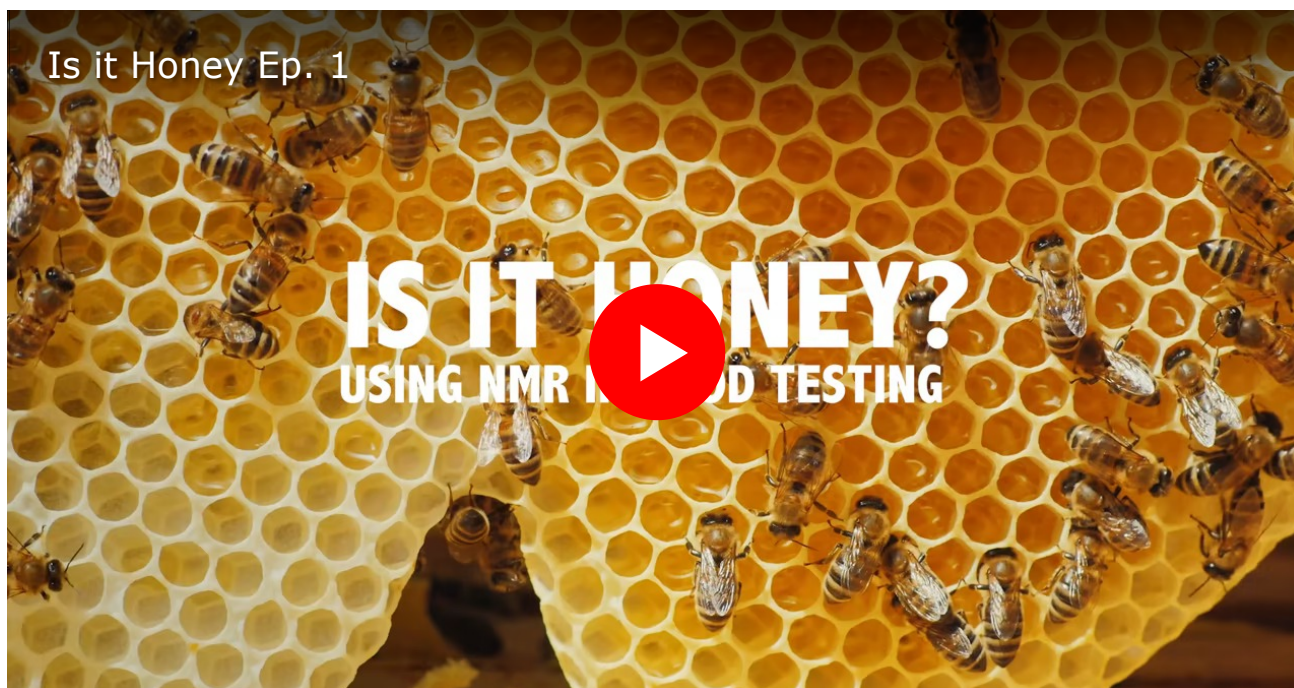
Dr. Jim Gawenis  
CEO and Chief Chemist  
Sweetwater Science Labs



## Please give an introduction to the services offered at Sweetwater.

I'm the CEO and chief chemist at Sweetwater Science Labs, and we offer a combination of honey analyses. This includes working with the FoodScreener, analyzing for antibiotics, pesticides and also doing some work which involves looking at enzymatic actions within honey.

We're also working with a pollen DNA system where we can further determine where the honey is coming from, both geographically and botanically. Our goal is to use both the foodscreener honey profiling system along with this DNA coding system at the same time to come up with an even larger, better picture of what the honeys are doing.



*[Is it Honey Ep. 1](#) from [AZoNetwork](#) on [Vimeo](#).*

Sweetwater is the only company in the United States that currently has a honey profiling system. Although it's new to this country, NMR is becoming the integral part detecting honey fraud.

## **Is there a problem with fake or impure honey in the marketplace?**

There is a substantial amount of fraud and adulteration in the honey industry. The technical term for this is economic adulteration and it comes in multiple forms.

The simplest form of which is adding inverted sugars, such as corn, rice or beet syrup to stretch the honey and charge a higher price for a lower-quality product.

Another method, called water honey, is where water is added to the honey. The water is filtered to get rid of the bad flavors and then taken back out of the honey, where the honey is then sold as a different type.

Additionally, there's ultra-filtration. This one is most commonly seen when we're working with some countries that produce a large amount of honey and are selling it at a lower price than what it takes to make the honey and maintain

the bees etc.

Whenever a company or importer tries to take over a market by selling a product in that country's market for less than what it takes to produce the material, that's called dumping, and it's illegal. Typically, the way that we take care of those laws is we raise a tariff for that particular product to bring it back up to the same level so that, within that country, we have a level playing field with the importers and with their own domestic production.

The way in which these countries are trying to get around that is through what's called circumvention. A country will take their cheap honey, have a straw seller from another country sell it as if it's from that country at a lower price that normally would not be considered a dumping country.

## **How does filtration affect the taste of the honey?**

Other than ultra-filtration, there's also another filtration that uses ion exchange resins, and that one is used when you have a really low-quality honey that has a peppery, smoky taste – something that generally people don't want in their honey.

When they run it through that resin, you end up with a really dark honey. They use that to change the flavor and the color profile, and it changes it well, but it also takes out all the pollen.

## **Please outline the methods you use to identify adulterated honey.**

The AOAC 998 method, also referred to as the C3C4 sugar test, looks at a carbon 13 ratio, where the two major isotopes of carbon is Carbon-12 and Carbon-13. They're both stable, and they both occur naturally. The ratios of those two isotopes varies based on what type of plant the honey is from. The plants that bees go to have a specific signature of carbon-13 to carbon-12 as opposed to something like corn, where we get corn syrup.

You can measure the differences to a certain extent, but where the problem lies, is that method has some limitations in the limits of where you can actually use the data. Adulterators have also found other sugars that come from

flowering plants similar to the plants that the bees go to, so now they can add those inverted sugars. Those sugars don't even show up in this test. You can have it over 50% beet sugar, for instance, in the honey, and you wouldn't be able to tell the difference from that test.

That test is largely no longer a good functional test. One of the main reasons is you're looking at one point of data, this one ratio. How much carbon-12 versus how much carbon-13 is in this particular sample, whereas with the honey profiling system with the NMR spectra, we have a multitude of points that we can look at. We have a signature series rather than just a discrete data point, and it's a much more powerful tool.

When you have this multitude of data coming off the spectra, the chances of you being able to fake a honey at that point is vanishingly small.

## What is the FoodScreener?

The FoodScreener is a nuclear magnetic resonance technique looking at the spectra of various products.

Honey has a very distinct spectrum when run through a magnetic resonance system. We can compare those spectra to other spectra of similar honeys to determine whether it has been adulterated with inverted sugars. Additionally, we can look at quality control products, such as whether it has been fermented.

Honey-Profiling Module of the  
NMR FoodScreener

[Learn More](#)

Not only can we look at geographical origins, but also by running honey samples through the food screener, we are also able to answer questions relating to the floral origins of the honey. Did the bees go to orange blossoms? Did they go to clover? Did they go to canola?

While the database is still expanding, we have found NMR has been very good at pinpointing a lot of floral origins. It's constantly growing and the technique is becoming an extremely powerful and quick way to identify honey authenticity.

## **Are you contributing to the database?**

Yes, we are contributing to the database. Here in the United States, there's not many honeys in the database yet. Our job with Bruker is to create that North American database and we are working with multiple companies and beekeepers to do just that.

Sweetwater's goal is to be able to pinpoint where the honey has come from, ideally all the way down to a county level. We hope that we will even be able to regionalize down to, did that honey come from Albany, New York, or did it come from Sacramento, California?

## **Why is it important to know where the honey has come from?**

There has been a swelling of consumer concern about where their honey is coming from and what kind of honey they are getting. People are not just satisfied with 100% honey. They want to know that it's clover honey or orange blossom honey, blueberry honey, etc.

With the honey profiler technique, we can tell you whether those honeys are from those particular origins. The beauty of the NMR system is that we don't have to have pollen in the honey to do it.

Previous techniques require a light microscope and at a high power, and involve counting pollen grains to determine where the bees have gone to. We can do this through the NMR spectrum and look at the chemistry of the honey, because the chemistry from the nectar flows through into the honey.

## **What are the benefits associated with using NMR?**

When you use the NMR spectral system, you end up with a lot more information than you would do in any other tests, and to get the same amount of data it would cost you thousands of dollars in various tests involving different techniques and instrumentation. With NMR being used in this way, you have one technician working your one sample in the one instrument, giving you all the same data.

The timeframe with the honey profiler is 20 minutes as opposed to a week of just laboratory time. It's a much faster and easier technique.



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## Who are your customers?

Our customers are primarily honey packers, retailers, or anyone in the honey industry who wants to trace the origins of a particular honey. Our main focus is with the packers, because they're the ones who utilize moving large amounts of these materials.

However, we are happy to work with anyone from the hobbyist beekeeper all the way through to the wholesalers and even consumers.

## Where can readers find more information?

- <https://sweetwaterscience.com/>

## About Jim Gawenis

Dr. James (Jim) Gawenis received his PhD in Chemistry from University of Missouri in 2001 and his MEd from the University of Utah in 2008. He is currently a Research Engineer Tech at the University of Missouri-Columbia, as well as the Chief Chemist at Sweetwater Science Labs.



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# Honey Profiling for Impurities and Falsifications

Sponsored Content by [Bruker BioSpin - NMR, EPR and Imaging](#)

Dec 6 2016

## insights from industry

Patricia Beaune

Lab manager

Famille Michaud Apiculteurs



*Patricia Beaune provides an overview of the honey industry and explains the techniques that are currently being used to detect and identify counterfeit honey products.*

## Can you give an overview of honey profiling? Why is it so important for maintaining the quality and purity of the available honey?

Without testing commercially available honey, it is impossible to guarantee that is safe, natural and authentic. This is because bees are free agents, they cannot be restricted to a specific region, or to a type of plant that you would like them to pollinate. Bees may collect nectar from the desired flora or they may find other flowers that they prefer, which will change the composition of the honey, or contain contaminated nectar.



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To test for contaminants, as well as floral and geographical differences, honey has to be controlled by a competent lab with the latest adapted technologies, such as food screeners, which help to effectively screen large quantities of honey.

With the Bruker's NMR FoodScreener we create a profile of the honey we are testing and check that against the profile from the region indicated on the label and against other regions.

The nectar and the "terroir" will have had an impact on the product's composition, which allows us to differentiate which specific region the honey has come from. We are also able to check if components have been added or removed, and we can detect deviations from the normal concentration of sugars or amino acids of all parts of the honey.

We have to be able to provide customers with assurances that the honey they are consuming has come from the labelled botanical and geographical origin so we can guarantee the taste and smell that they are expecting. The NMR food screener helps us achieve our goal to provide to the consumer the best quality natural honeys.

## Is there a problem with fake or impure honey in the marketplace? What can lead to honey being rejected?

Fake and impure honey represents over thirty percent of non-complying honey that we reject every year. This is the case across the industry, for our company and for the authorities that control honey in European markets.

Within the rejected 37% of honey there are two main problems. The first is adulteration of the product. We find exogenous sugars that shouldn't be present including, wheat, cane and rice sugars. We use the food screener to detect exogenous sugars and it is also sensitive enough to identify syrup additions through sugar tracers.

Secondly honey is rejected for having a false or mismatched botanical or geographical origin. The label might list for example "acacia honey from Hungary", but when analyzed we find it is something else, for example a polyfloral honey from China.

The FoodScreener is able to detect this problem, we compare the profiles of the honey we are testing and the expected botanical signature to determine whether the label and the honey match.



*[Analyzing Honey using NMR Technology](#) from [AZoNetwork](#) on [Vimeo](#).*

## **How does the type of pollen in the honey affect its taste, smell and texture? What has been the gold standard for analyzing pollen up to this point?**

When the bees collect the nectar they also collect pollen grains. At the lab we extract the pollen grain content, which only makes up 0.5% of the composition of the honey. We observe it with a microscope to characterize the honey.

To do this the lab technicians have to identify the pollen grains. This analysis requires a high level of performance and skill because you can typically find over four hundred type of pollen grain naturally occurring and finding their way into the honey.

This method is completely manual, which makes it quite difficult, with a steep and long learning curve to successfully use this method.

## **How does NMR-based honey screening work?**

The FoodScreener is interesting because it will replace this method in a certain way. The NMR technology is based on a database, in this database we have several thousand reference profiles that are representative of many botanical and geographical origins.



NMR Spectroscopy in  
Food Safety Maintenance

When we analyze an unknown sample, the profile generated by the screener will be compared to this database, and will allow us to confirm and to detect the botanical and geographical origin of the sample.

## **How can the production process affect the quality of honey, and how can you test for this?**

The production process can affect the quality of the honey, specifically the HMF

content. HMF is, hydroxymethylfurfural, which is a molecule produced by a degradation of the sugars.

The NMR FoodScreener is able to quantify this parameter, so we can guarantee that the integrity of these products has been maintained throughout the production process.

## **What impact has the Bruker NMR FoodScreener™ and its Honey-Profiling™ module had on your honey analyzes? In what ways is it different to your previous methods of analyzing honey?**

We used to analyze with several conventional methods. The first one is the isotopic method, where we look at the carbon atoms present in the honey. Then we would use methods to detect foreign enzymes or foreign oligosaccharides.

We previously used between three and four different methods in order to ensure the level of authenticity of our products. With NMR profiling, in 20 minutes we are able to do with one method what previously took 6 days.

## **The COFRAC/ISO70025 certification represents a high standard in scientific and technical skills, what does it mean to hold this certification?**

In the honey industry we are considered as a reference because we analyze a lot of samples per year, over one hundred thousand samples, so it was a natural progression to be accredited.

We obtained the ISO 17025 accreditation in 2013, this accreditation certifies that we have the highest internal level of technical and scientific competence.

So far several laboratories have already been accredited using NMR screening for honey. We project that we will be accredited with the ISO 17025 certification with this method in 2017, which will represent NMR profiling as a reference method for honey tasting.

## Where can readers find more information?

- [NMR FoodScreener](#)
- [Famille Michaud Apiculteurs](#)

## About Patricia Beaune

I am the lab manager of Famille Michaud Apiculteurs, and I have been working in the honey industry for sixteen years.

I am also the Leader of the IHC Residues Working Group of the of the International Honey Commission, which was formed in 1990 in order to create a new world honey standard.



Fianlly, I am a scientific expert of the FEEDM (Fédération européenne des emballeurs et distributeurs de miel).

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# Using NMR to Differentiate Adulterated Honey from Natural Honey

Sponsored Content by [Bruker BioSpin - NMR, EPR and Imaging](#)

Jun 11 2020



Image Credit: Shutterstock/ Subbotina Anna

**Honey is the most popular natural sweetener worldwide, with a wide range of consumers relying on its sweet taste to add sweetness to baked goods or to improve tea's palatability. While honey is a widely available product, many honey products' authenticity has been called into question over recent years.**

Commonly used methods for detecting [sugar-based adulterated honey](#) are not generally effective. This is because of similarities in the chemical compositions of authentic honey and sugar-based adulterants.

Honey is made up of around 70% to 80% carbohydrates. These include glucose and fructose alongside minor components such as enzymes, organic acids, amino acids, polysaccharides, lipids, minerals, vitamins, proteins, volatile chemicals, and phenolic acids.

## **Adulterated honey: A widespread problem requiring a solution**

Honey is one such food that is reported to be incredibly vulnerable to food fraud, accounting for approximately 90% of all sweetener-related adulterations across Europe.

People facilitating this fraud are often based in China, a country that is a major producer of honey as well as one of the world's leading global honey providers. It is estimated that 200,000 or more tons of honey are produced in China every year, with around half of the Chinese honey output being exported to the global market.

The need for accurate, sensitive tools to detect adulterated honey has increased, because many existing methods are unable to produce optimal findings. Adulteration of honey lowers the product quality, as well as potentially downgrading the region's market credit rate.

Adulterants also pose a prospective health risk, partially resulting from its increased levels of low-density lipoprotein and cholesterol.

The nature of the contemporary food industry poses additional challenges in the tracing of products' origins, as well as in the identification of these products' components. Analytical techniques, like thin-layer chromatography, tend to be limited due to their high detection rate of false positives.

## **The role of nuclear magnetic resonance for identifying adulterated honey**

One of the most promising tools in the detection of food adulteration is nuclear magnetic resonance (NMR) imaging. This technique can measure differing compounds and allow thorough examination of the structural information of compounds contained in a mixture.

Bruker's NMR Food-Screener includes a Honey-Profiling Module, and this is just one example of the range of NMR commercial tools specifically designed for the identification of adulterated honey. Through the use of spectral libraries of a known mixture, NMR spectra for a test sample can identify whether a food's components are either added or missing.



Bruker's Food-Screener offers an NMR fingerprint that is specific to a sample – for example a honey sample – and this can be compared to a sizeable database of honey samples to ascertain if there is a discrepancy or a match. The platform provides an innovative tool, capable of improving quality control monitoring across the honey production industry.

A single NMR experiment can produce reproducible, repeatable findings. The NMR experiment is generally only five minutes long, as well as being high-throughput, and generally considered to be non-destructive to the sample. Spectroscopic methods are also highly cost-effective, an attractive quality in many research labs.

## **Study accurately differentiates between natural and adulterated honey**

In a recent study, researchers from China utilized an advanced NMR technique to analyze major and minor components in Chinese honey, in order to ascertain whether or not the technique was able to identify adulteration.

The researchers employed a 600 MHz Bruker Ascend™ NMR spectrometer to acquire the <sup>1</sup>H NMR spectra of 75 adulterated and 90 authentic Chinese honey samples. The NMR spectrometer was set at 600.38 MHz and 298 K with no sample rotation in place.

A principal component analysis (PCA) score scatter plot revealed a metabolically similar cluster of total honey samples. The researchers believe that this was a result of the tailoring of adulterated honey samples to mimic natural honey's carbohydrate profile.

A PCA/linear discriminate analysis model that utilized <sup>1</sup>H NMR spectral data was able to accurately classify adulterated honey and true honey by 94.0% and 98.3% in the training set, respectively. The test set displayed similar results.

The researchers were also able to use NMR data to 'screen out' contributing components that discriminated adulterated honey from true honey samples. A large number of these contributing components included xylobiose, proline, turanose, uridine, melezitose, β-glucose, and lysine.

The researchers were able to conclude that these markers, when examined in combination with NMR analysis, may aid scientists in establishing a rapid tool

suitable for the identification of authentic honey. This tool can then be employed prior to the honey entering the Chinese and world markets.

## **NMR: The future of food monitoring**

As research around the applications of NMR technologies in nutritional sciences continues to expand, consumers will likely be more confident in the quality of testing procedures applied to their honey products.

Not only does testing using an accurate system guarantee a better quality end product, it has the potential to mitigate the possible negative health effects that have been linked to adulterated honey.

Additional research may be required to fully validate this study's findings; but, these promising results do indicate that NMR can be effectively and safely employed for honey analysis in Chinese honey exports.

## **Reference**

Hea C, Liub Y, Liu H, et al. Compositional identification and authentication of Chinese honeys by <sup>1</sup>H T NMR combined with multivariate analysis. Food Research International. doi: 10.1016/j.foodres.2019.108936.

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# Collaborative approaches to honey adulteration detection

Sponsored Content by [Bruker BioSpin - NMR, EPR and Imaging](#)

Jan 10 2022

## Thought Leaders

Javier Nascel

Marisa Amadei

Professor Norberto Luis Garcia



*Honey fraud remains one of the global food industry's biggest threats, with NMR technology at the forefront of detecting, characterizing, and cataloging occurrences of honey fraud across a range of markets.*

*We recently spoke to two of Nexco's leading experts in honey fraud - Marisa Amadei and Professor Norberto Luis Garcia - to explore the impact of honey fraud on global food supply chains and ecosystems.*

*The aim was also to discover how a robust analysis program with [Bruker's NMR FoodScreener](#) at its core can help ensure authenticity, protect companies' reputations, and meet stringent quality and regulatory standards.*

## Marisa Amadei, Please could you start by giving our readers an introduction to your experience and role at Nexco?

I am a biochemist and the Quality Manager at Nexco, with almost 20 years of experience working with honey.

Nexco's honey testing laboratory has been ISO 17025 accredited since 2008, and the company has supported vital work against global honey fraud since that time.

Nexco consistently tests all the bee feeds available in Argentina, trains beekeepers on good beekeeping practices, and continues to update its knowledge and testing capacity.

## **What approach does Nexco take to detect potential honey adulteration and how does the NMR FoodScreener from Bruker factor into this?**

Detection of foreign sugars in honey is traditionally performed via a range of techniques. The whole sugar profiles of honey can be tested using HPLC with a refractive index detector.

Microscopic pollen analysis is also a valuable part of our authenticity testing toolkit, while the evidential presence of C4 type sugar is tested using a combination of isotopic analysis with elemental analysis, liquid chromatography, and isotopic ratio mass spectrometry.

Last year, Nexco decided to incorporate the latest NMR FoodScreener from Bruker as a core component of the company's quality assurance program.

We consider the NMR-based honey profiling from Bruker's FoodScreener to be one of the most comprehensive tests available as it is able to confidently detect the presence of foreign sugar syrups from C4 and C3 plant types.

Installation of the NMR FoodScreener technology was streamlined and straightforward. The setup of the honey methodology, the training of our professionals, and the acquisition of the initial NMR report was efficient and simple.

Bruker has also continued to support Nexco throughout the ISO 17025 accreditation process.



Collaborative approaches to honey adulteration detection - Nexco

*The impact of honey fraud on producers and consumers from [AZoNetwork](#) on [Vimeo](#)*

## Could you outline a typical honey fraud detection workflow?

Sample preparation follows a standard operating procedure, making this incredibly simple and fast. NMR handling is also straightforward, with the whole honey analysis being fully automated and completed within just 20 minutes.

No NMR expertise is required to operate the instrument, and once the analysis is complete, a PDF report is generated, which contains all of the information.

## How has the FoodScreener been utilized thus far, and how is this being developed?

Over the past month, we have tested a significant number of Argentinian honey samples. These tests have revealed excellent reproducibility and reliable results.

As the NMR spectrum highlights the fingerprint of the tested honey, it allows both non-targeted detection and targeted quantification of specific marker components.

A total of 36 different constituents of honey are quantified, including sugars, acids, amino acids, and other parameters regulated by the European Directive and related standards.

The non-targeted tests have allowed us to observe any deviation in the spectra compared to the reference dataset, which can give us an indication of adulteration or any other quality issues.

This can also reveal new forms of adulteration, as well as identifying the botanical variety of the honey and its geographical region of origin. The instrument's honey profiling method provides us with a complete approach to authenticity testing.

We are now beginning a collaborative project with Bruker to characterize our premium honey varieties and build a fingerprinting database of the different types of Argentinian honey.

Having this information available will allow us to inform our customers and consumers of this information, ultimately helping boost our sales.

So far, our experience with the Bruker NMR FoodScreener has been positive, and we have already come to trust the enormous utility and value of this powerful tool.

## **Professor Norberto Luis Garcia, Could you give us a brief introduction to your role at Nexco?**

I am a Senior Consultant at Nexco and also a Professor of Beekeeping in Argentina. I normally deal with honey quality and international honey markets.

## **Honey is a natural healthy food, requiring a bee colony to visit 2 million flowers to release 1 lb of honey. What are some of the benefits of incorporating honey into consumers' diets?**

A great deal of literature details the properties of honey and its benefits for human health, but it is also important to recognize that when a consumer eats honey, it is much more than a sweet product – bees are vitally important

pollinators and essential in maintaining environments and ecosystems.

**Over the last few decades, there has been an increase in food fraud, and in particular, honey. Could you provide an overview of food fraud and why honey has seen an increase in its adulteration?**

When a product like honey becomes difficult to produce, demand increases more quickly than supply. This directly affects the price of a product, and when a certain food becomes more expensive, this often results in food fraud.

Honey production has increased in recent years, but not at the same rate as the demand for honey. This has led to increasing honey prices, and over the past ten years, we have witnessed increasing numbers of fraudulent honey products flooding into the market.

This fraudulent honey has caused an oversupply that has collapsed the market, placing the livelihoods of many beekeepers in jeopardy.



## **Why is origin determination important in the production and export of honey?**

There are multiple ways of committing honey fraud beyond diluting honey with syrup. Masking honey's geographical and botanical origin is also a common mode of adulteration. A country like Argentina is a traditional exporter of honey, so it is very important to be able to assure our clients that our products are 100% Argentine honey.

## **How has food fraud impacted the livelihood of beekeepers as well as the honey market financially?**

The price of honey has a direct impact on the livelihood of many beekeepers, as well as the consumer who has to pay in terms of price and quality.

Beekeepers are ultimately responsible for attending the beehives, which help maintain the environment and which are vital to the pollination of many other food crops.

## **How has Nexco helped address this aspect of honey supply?**

Since 2013, Nexco has worked to develop consumer and industry awareness of the problem of honey fraud via presentations and interviews around the world. In parallel, the company has worked to ensure the purity and authenticity of its honey.

This combination of technological innovation and the sharing of knowledge is a core part of Nexco's work.

## **What contribution is Nexco making to traceability in honey production and supply?**

Argentina has access to a comprehensive online traceability system, and Nexco is adhering to this to assure our clients of the traceability of honey from the



drum through to the beekeeper's honey extraction room and the exported product.

By ensuring robust traceability, we can trace any deviation in honey quality and ensure that the consumer is receiving the quality of honey purchased.



*The impact of honey fraud on producers and consumers from [AZoNetwork](#) on [Vimeo](#)*

## **Bee populations are in decline. How does Nexco's work help stop the numbers from decreasing?**

By assuring the purity and authenticity of honey, Nexco is able to play a central role in the combat against honey fraud. Simply by assuring honey quality and purity and communicating this to consumers, we can help safeguard the livelihood of many beekeepers, increasing their capacity to maintain sufficient beehives and helping to make the global honey market clearer and fairer.

Bee populations are essential to the pollination of many crops and the Earth's overall biodiversity of the planet. Essentially, safeguarding the livelihood of beekeepers and maintaining bee populations helps ensure the survival of vital ecosystems.

## **How does Bruker's FoodScreener and NMR technology help to build consumer trust with a brand?**

Honey is a very complex food, and the methods of its adulteration are increasingly sophisticated. NMR has led to significant changes in the market due to its two core capabilities: its ability to ensure the purity of honey and its ability to confirm honey's geographical and botanical origin.

NMR allows consumers to be confident that the honey they are consuming comes from the country and is of the botanical origin included on the label.

NMR is also able to detect purity deviations, which offers enormous potential for the future of honey production.

NMR offers the potential to characterize and document the thousands of honey varieties produced around the world – an important consideration as consumers are increasingly demanding details of honey's origin in terms of its geography, plant, and flowers of origin.

These factors each have a significant impact on consumer confidence and a brand's reputation.

## **How does NMR help detect honey fraud?**

Honey is a complex food with more than 200 components, so the methods used to detect honey fraud must constantly evolve and become increasingly sophisticated.

A single method cannot detect the different types of fraud for the different types of honey, so we typically try to select the best available combination of methods. NMR remains a central part of almost all our honey analysis workflows.

NMR can be used to quantify normal, natural honey components, but it can also be used to identify a diverse array of components and markers that are atypical and should not be present in honey.

NMR can detect the addition of serums to honey, as well as deviations in the declarations of the botanical or geographical origin of honey. There are at least five different methods of honey fraud, and NMR offers the unique possibility to detect all of these.



*Image Credit: Bruker*

## **What are some of the advantages of using Bruker's FoodScreener to detect adulteration in honey?**

We initially used the FoodScreener to ensure the purity of Argentine honey, but it is our intention to fully develop the potential of NMR for investigating honey. We are currently working with Bruker to explore the use of the FoodScreener to characterize the entire range of honey varieties that Argentina produces.

One of the main advantages of NMR as a screening method is that it is possible to see the whole spectrum of components in honey within a single test run, including potential adulterants and even non-target substances.

This allows the detection of new adulterants as well as honey components that are unique to particular honey varieties.

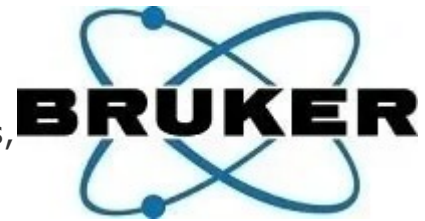
## What are the next steps in the fight against food fraud in honey?

Food fraud is an ongoing issue and while it is unlikely that this can ever be wholly eliminated, we continue to work to control and minimize honey fraud. New methods suitable for the detection of food fraud and new modes of adulteration are continually being developed and discovered.

I foresee a future where honey supply is scarce and food fraud remains a constant challenge, but powerful new screening technologies like NMR will guarantee positive outcomes for consumers, beekeepers, and the environment.

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