TRUTH IN HONEY LABELING

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Truth In Labeling

Testing Honey

Vaughn **Bryant**

How much would you be willing to pay for premium honey? Once purchased can you be certain it matches the information on the label? Unfortunately, in most places there is no guarantee because most of us have no way to verify the origin or type of honey we purchase.

The most expensive honey in the world is Mad Honey, which comes from the Kars-Trabzon region of the Black Sea and sells for $166/lb. The hills of that region are filled with blooming *Rhododendron ponticum* & *R. luteum*, both of which are native to Eastern Turkey and both of which produce high levels of a toxic alkaloid called *Grayanotoxin*. The high price of the honey results from its scarcity and a high demand because of its purported ability to stimulate sexual arousal, cure arteriosclerosis, reduce cancer, increase good memory, prevent hair loss, reverse barrenness in women, and solve a long list of other problems. In small amounts Mad Honey can also cause a feeling of euphoria, but if too much is consumed it can result in excessive bradycardia (<50 low pulse rate), hypotension (<77/46 – low blood pressure), dizziness, vomiting, and disorientation. Death from Mad Honey is rare, but temporary hospitalization is often needed.

The second most expensive honey is Sidr honey, produced in Yemen from the flowers of *Ziziphus spina-christi*, known as the Jujube bush. That honey sells for about $100/lb. and is a favorite of those seeking its reported killing action on bacteria, which is claimed to be far superior to anti-microbial agents currently used in medicine. It is also reported that when pure Sidr honey is mixed with a combination of nuts, ginseng and herbs it works better than Viagra and leaves no side effects.

The third most expensive honey is Manuka honey, made from the nectar of tea tree flowers (*Leptospermum scoparium* and *L. polygalifolium*), which grow throughout New Zealand. Manuka honey currently sells for about $40/lb. and is sought after by those wanting to enjoy the reported healthful benefits from *Methylglyoxal*; one of the antibacterial agents in the honey. Application of Manuka honey on superficial burns is also reported to reduce infection and speed recovery.

Many other types of honey command premium prices and are popular with different groups of consumers willing to pay high prices for those products. A few of the premium types include: Lehua, Kiawe, and Christmas Berry honey from Hawaii; heather and ling honey from the United Kingdom; fireweed honey from Western Canada and Alaska; gallberry, citrus, and tupelo honey from Florida; sourwood honey from Appalachia; thyme honey from Greece; and buckwheat honey from Eastern Europe, China, New York, and Canada.

The biggest problem with all of these premium honey types is that in most countries the consumer is required to "believe" what is written on the label. Many nations, including the United States and Canada, do not have strict requirements for truthful labeling of honey products. This means that consumers rarely get what is written on the label. I know this because each year I am asked to test hundreds of honey samples sent to me mostly by beekeepers wanting to be accurate about the types of honey they sell and by importers wanting to confirm the types of honey they are purchasing. A few honey exporters also need to have their honey certified as to the floral contents and place of origin in order to export it to some countries with strict requirements.

What I have been finding in my studies of honey samples from all over the world has been reported in many different media sources and those reports highlight the importance of testing honey. Without those tests many importers would have paid high prices for expensive, premium honey types when in truth the product was very ordinary and inexpensive honey. Some people who purchased exotic types of honey, and sent me a small sample, are often shocked to discover they purchased a blend of inexpensive honey rather than the exotic type mentioned on the label. Beekeepers and honey producers selling their products to commercial stores or at roadside stands are frequently amazed to discover they have been selling types of honey that are completely different from what labels they were putting on their jars.

POLLEN

If this is true, then which testing methods are the least expensive and the fastest way to confirm what nectar sources are included and where the honey originated? Most authorities will say that pollen testing, called melissopalynology, is the quickest and least inexpensive method when considered against all of the other testing alternatives. Nevertheless, pollen testing is not an exacting method because the technique is fraught with problems that can sometimes cause misinterpretations. I have discussed some of these aspects in the past, but they may need repeating. Essentially, the problems in melissopalynology focus on a number of variables that both beekeepers and the pollen analysts may not always anticipate, or recognize, when examining a honey sample. First, we know that not all honey bees are created equal. In any hive a portion of the workers will be very efficient at nectar collecting and very efficient at removing pollen from collected nectar sources while returning to the hive. Other workers are very inefficient and do not remove any of the pollen from the nectar they collect. That variable translates into some workers returning to the hive with nectar that is full of pollen while other bees will return from the same flowers with the same amount of nectar, but most or all of the pollen will have been filtered out during the return flight. This variation translates into high or low amounts of pollen present in the final honey product. Therefore, the pollen spectrum of a resulting honey may depend on what percentage of worker bees were efficient vs. those that were inefficient.

Second, depending on the temperature, available moisture, and sunlight, the same plants may produce more or less flowers from one year to the next and each flower might contain more or less pollen and nectar

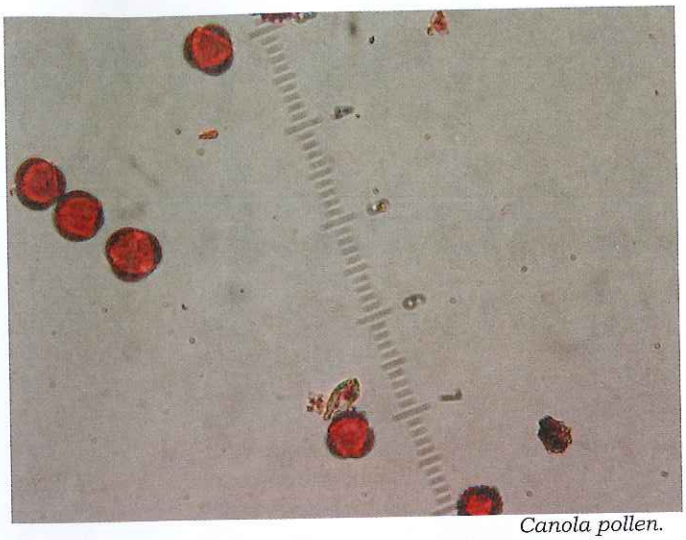
depending on those same climatic variables. Those conditions translate into heavy or light utilization of those floral sources by the bees in a hive, which then results in a heavier or lighter emphasis on that type of nectar in the produced honey.

Third, some plants produce flowers containing nectar with tens of thousands of pollen grains, such as the nectar from sweet clover, forget-me-nots, rapeseed, and blueweed. Other flowers, such as fireweed, sourwood, thyme, alfalfa, croton, evening primrose, and cotton produce nectar containing very few pollen grains. This difference is then translated into honey containing very few pollen grains from some nectar sources or thousands of pollen grains from other nectar sources. Those differences mean that some unifloral honey should contain thousands of pollen grains from their primary nectar source while other unifloral honey samples might contain only minor traces of pollen from their dominant nectar sources. Finally, experiments have shown that plants that produce large pollen grains, those over 50 micrometers (1,000 micrometers = 1 millimeter) in diameter, such as magnolia, hibiscus, tulip poplar, and onionweed, are generally highly underrepresented in honey samples even when those flowers provide the primary nectar source for the honey. These many variables make the accurate identification of primary nectar sources in any honey sample a major challenge. Those analysts who examine honey, but fail to recognize the many potential problems caused by these variables can create mistakes in their identification of both the primary nectar sources and mistakes about the potential geographical origin of the honey.

ISOTOPES

If pollen studies of honey have so many problems, then why not use a different type of testing method, such as isotopes? For years we have known that various types of honey adulteration can be detected using carbon stable isotopic ratio analysis (SIRA). For example, we know that the ^{13}C content of the carbon used by different plants will vary depending on the photosynthetic pathway the plant uses. Most fruits and many flowers use what is known as the less efficient C3 photosynthetic pathway that produces sugar with a ^{13}C value near -25°/$_{oo}$. However, sugar cane and maize use the more efficient C4 pathway that yields a $\delta^{13}C$ sugar value near -10°/$_{oo}$. Because honey is produced from the nectar of C3 plants, normal honey should yield an isotopic signature, called $\delta^{13}C$, of about -23.2 to -24.6°/$_{oo}$. Variations from those levels often suggest some degree of adulteration created by the addition of high fructose corn syrup or the addition of cane syrup. Nevertheless, using the $\delta^{13}C$ isotopic signature of honey does not ensure it has not been adulterated. Sugar beet and rice syrup, which are produced by C3 plants, could be added to honey and not be detected using only stable isotope testing.

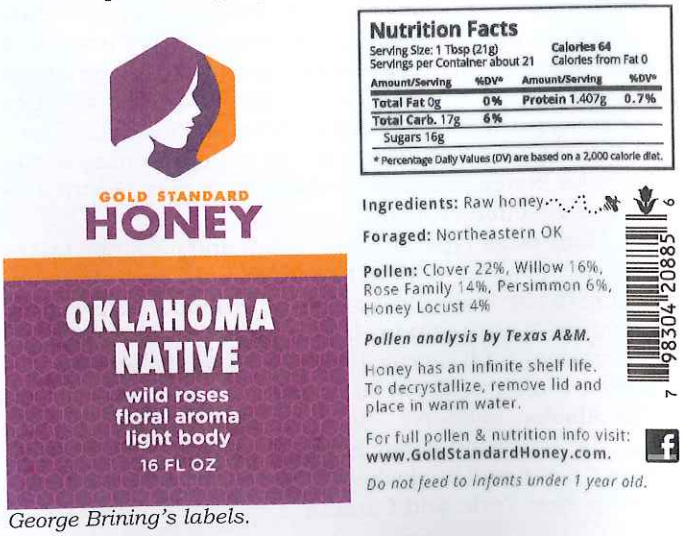
The isotopes of $\delta^{13}C$, $\delta^{2}H$, $\delta^{15}N$, and $\delta^{34}S$ in the honey proteins can be used to reveal the climate and environment where a honey sample is produced, and those data can then identify the geographical region where the honey originated. Although the amount of protein in honey is minimal, it comes mostly from the plant sources with small amounts introduced into the honey by the bees. The carbon and hydrogen isotopic ratios in honey



Canola pollen.

proteins are based on the water and carbon dioxide levels utilized by the plants that produce the nectar sources collected by bees. The $\delta^{13}C$ values in honey protein will increase slightly in hives located in areas of increasing amounts of sunshine, higher temperatures, and reduced humidity. The hydrogen or $\delta^{2}H$ value in honey protein will decrease in areas of reducing humidity, increasing elevation, and decreasing temperatures. The nitrogen isotopic composition of honey proteins comes from the plant's nectar, which is a reflection of the plant's ability to absorb nitrogen from the topsoil or fix nitrogen from the air. Therefore, slight differences in the $\delta^{15}N$ levels in honey proteins will reflect the nitrogen levels in the region where honey was produced. Finally, the sulfur isotopes found in plant nectar reflect the soil chemistry of the region. Clay soils tend to retain higher levels of sulfur than sandy soils. That results in different amounts of sulfur isotopes in a plant's nectar. When those nectar sources become part of a honey sample, the $\delta^{34}S$ ratios become a signature for the soils of a region.

None of the individual isotope values found in honey proteins is usually unique enough to identify a specific geographical region. However, when all of the isotope values in honey proteins are calculated it presents a multi-element evaluation often resulting in a precise geographical origin. Thus, the use of multivariate statistical analysis is essential to discriminate between different potential geographical locations.



George Brining's labels.

DNA

Some readers might ask why the analysis of the deoxyribonucleic acid (DNA) properties of honey has not been attempted. Recently, there has been progress in this area with the development of pyrosequencing and the use of barcoding strands of DNA. For plants, the ideal is to barcode selective DNA strands that have one or a few standard loci that can be sequenced easily and reliably in large sample sets. Comparisons of those sequenced data against available plant DNA databases will enable specific plant taxa to be distinguished from one another. The remaining problem, however, is that currently the DNA analysis can only provide ubiquity; in other words, it can identify the plant sources in a honey but it does not provide quantitative information on "how much" each nectar source contributed to the honey sample. Therefore, these types of DNA studies are useful for identifying blends of honey and they can help determine the possible origin of a honey sample. However, the drawbacks of DNA analyses are that they require a good plant DNA database for comparisons, the use of special DNA sequencing equipment, knowledgeable technicians, and at present the procedure remains a fairly expensive way to identify honey samples.

OTHER WAYS TO IDENTIFY HONEY

Liquid and gas chromatography have been used to identify the amino acids in honey. Patterns of the different amino acids present in the protein fraction of honey have been used statistically to show different patterns exist in different types of honey. Applying discriminant analysis to those data have shown that with a good database for comparisons, certain groups of honey samples can be distinguished from one another on the basis of free amino acids.

Volatiles contribute significantly to the flavor of honey and variations result from different floral origins and methods of handling the honey. The isolation and analysis of the volatile components in honey is difficult, but possible. Previous attempts confirm that a careful analysis of the volatiles in honey could become a useful tool for determining nectar sources, but note that such analyses should always be accompanied by pollen studies to confirm the results.

High performance liquid chromatography has been successfully used to characterize the flavonoid patterns in specific types of honey, such as citrus, sunflower, lavender, rosemary, and heather. Some believe that flavonoid patterns could become a useful tool for determining floral contents and geographical origins, provided the data were analyzed using multivariate statistics.

The mineral and trace elements in honey samples have been used to indicate types of environmental pollution that pinpoint certain geographical locations as being the origin of honey samples. Some analyses and experiments focusing on the composition of organic acids in honey have shown that those might also prove useful in providing additional ways to identify specific types of unifloral honey.

These are only some of the many ways that have been used to identify honey. There are numerous other ways, which have been used, or have been attempted in the pursuit of identifying the floral and/or geographical origin of honey.

All of the many identification methods mentioned thus far suffer from some type of problem. For some of the problems focus on the need for special and expensive laboratory equipment. Others are time-consuming and require developing an extensive database before the results can be determined. Some methods are costly to perform; others require skilled technicians or analysts with extensive training. In summary, there is no inexpensive, foolproof, or simple way to verify the floral and/or geographical origin of a honey sample. Many of the methods can provide generalized results and some of them can offer fairly reliable estimates, but much depends on the skills and experience of the people performing those tests.

ADDITIONAL PROBLEMS WITH HONEY IDENTIFICATION

In the United States and Canada we have inadequate laws needed to address the problem of proper identification of honey. Pollen studies of honey, as mentioned earlier, can correctly, or incorrectly, identify the probable floral and geographical origin of a honey sample depending on whether or not the pollen analyst understands the many potential problems that can affect a sample. Skilled pollen analysts normally understand these potential problems and consider them when writing the final report. A bigger problem, however, is that much of the honey sold in North

America no longer comes from only a single source, most are now blends. Many honey samples sold in stores or even at roadside stands are mixtures of different types of honey yet many carry the label of "Clover Honey." When I asked some beekeepers and honey producers why "all" of their honey was called clover, they replied, "because that is what customers want to buy!" In other words, for that group, it makes no difference what the actual floral sources might be. What mattered to them is putting something on the label that convinces customers to purchase it.

Another problem, which I have addressed before, is that the vast majority of honey sold in commercial food stores has no pollen because it was removed by filtering. Not only does that mask the true floral and geographical origin of honey, but it can also be used to hide transshipped and illegal honey. When I asked some honey producers why they removed the pollen, they replied "to prevent crystallization." They said that most customers avoid any honey that shows signs of crystallization. It is true that removing the pollen may slow the process of crystallization, but in reality the pollen content is one of the very minor causes of crystallization. As many of you know, the rate of crystallization in honey is most affected by the ratio of laevulose to dextrose (fructose to glucose). Honey containing higher percentages of dextrose will crystallize quickly while honey containing less than 30% dextrose rarely ever crystalizes. High dextrin contents will also delay crystallization, while storing honey at certain temperatures and stirring honey will often speed the rate of crystallization.

We have a significant problem in North America, which consumers are beginning to realize. The intentional or accidental mislabeling of premium grades of honey is cheating the customer and creating a climate of suspicion about the purchase of expensive grades of honey.

We have no federal laws requiring truth in labeling for honey products and attempts by some states to require honey labeling standards are not enforceable because state laws are trumped by federal laws that do not require truthful labels for honey. A few beekeepers, such as George Brining of Gold Standard Honey, are now putting the pollen contents of their honey on their labels to assure customers of the origin and floral sources. Other have stressed the need to establish some type of recognized testing system, run by beekeepers in the U.S. and Canada that could certify honey, especially the premium and expensive types. One example of how this might work is seen in New Zealand's efforts to protect the sale and distribution and their true Manuka Honey. Honey exporters and beekeepers in New Zealand have formed the *Unique Manuka Factor Honey Association* (UMF). The UMF strictly regulates and tests New Zealand manuka honey to ensure accuracy in labeling. Only honey that has been tested and certified as true manuka honey is permitted to use the UMF label. Because of the strict testing, the openness of their research efforts, and the association's published policies, consumers worldwide are willing to pay premium prices knowing that the UMF label on manuka honey ensures that the contents are 100% accurate. Perhaps this is the type of system that might work in the United States and Canada. Such a system could win back those honey customers who realize that any jar of honey carrying a label claiming it is a premium type, could easily be nothing more than a blend of inexpensive honey from some unknown region. BC

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