Tasting, Really Tasting Honey

The Sensory Evaluation of Honey Training at UC Davis

by M.E.A. McNEIL

"One of the virtues of science is to defamiliarize what we thought we already knew."

Verlyn Klinkenborg

"Wow." Chef Mani Niall described his discovery of the varieties of honey. "I thought, isn't it just sweet? How did I not know?"

Indeed, how does anyone know? "For many people, all honey tastes the same — the sweet syrup found in the grocery store plastic bear," said Amina Harris, Director of the Honey and Pollination Center at the University of California, Davis, sponsor of the event.

Harris and Niall were among the presenters at the three-day training at Davis' Robert Mondavi Institute: Sensory Evaluation of Honey. A group of apiarists, honey processors and packers, teachers, educators and researchers had come from across the U.S., Canada and even Korea to the course. They settled in at their desks where organizer Liz Luu's team had placed three mysteriously numbered tasting cups of honey and a small notebook marked Honey Journal. Although they all knew a fair amount when they arrived, they had no idea how broad and how deep it would go and how, at the end of three days, they'd find taste intensified and their perceptions transformed as they re-tasted the same three samples.

The honey course was designed not only to train the participants as tasters but to teach a wider scope: research methodology, and pollen and chemical analysis — areas where UC Davis research is at the forefront. Beyond that, issues of adulteration, allergies and nutrition were covered.

To understand what happened in that indoor amphitheater where they were gathered, a brief history of the place is in order. The UC Davis Mondavi Institute has been at the forefront in a long process of putting words to tastes. It has played a role in the evolution of public discernment in wine, with production more than doubled over the last 25 years. It has promoted awareness of olive oil, which has grown remarkably in the last decade. Next is a focus on honey, which is just as generically perceived by the public as wine and olive oil once were.

Harris had already been evaluating honeys professionally for decades when she became director of the Honey and Pollination Center with the mission to promote the use of "authentic, high-quality honey." To help develop sensory criteria, Harris recruited a tasting panel to create words for tastes in the form of the Honey Flavor Wheel. The grandparent of such wheels was designed at Davis for wine, a chart with radii expanding from the most generic terms to more specific around the rim. Before that, wheels were created for beer and Scotch, and of course, tasters of tea or chocolate and sniffers of perfume have used descriptors as long as those products have been traded.

Monetary value has been created through sensory appreciation, so one way domestic honey can pay its way is through marketing varietals — wherever the consumer understands the differences. Case in point is one attendee, a beekeeper who could not sell his bulk honey for a price to cover its production. His plight, and that of a nation of honey producers, has prompted the training of tasters to spread the word about "authentic, high-quality honey" to be sold, and enjoyed, at a premium.

Human Sensors

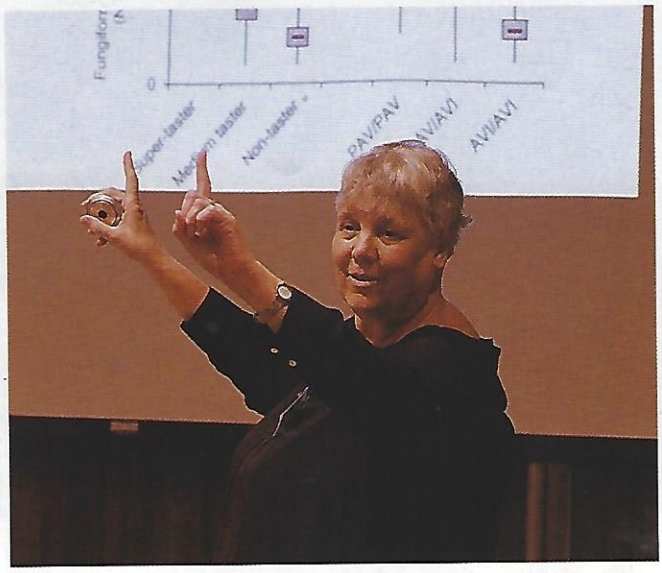
"Sensory evaluation," said Dr. Hildegarde Heymann, Professor of Sensory Science at UC Davis Department of Viticulture and Enology, "is a scientific discipline using humans as sensors to analyze characteristics perceived by sight, smell, taste, touch and hearing." But, "we are all living in our own sensory world." Individual differences in physiology mean that even simple aromas and flavors are not similarly processed. For example, sight is quite literally in the eye of the beholder; the arrangements of rods, cones or opsin molecules can make color seen very differently. That belies the common belief that people may appear different but perceive the same.

Amina Harris, Director of the Honey and Pollination Center at UC Davis, has decades of experience with honey and is on the Center's mission to create awareness of "authentic, high-quality honey." She taught several sessions of the course. Photo by Kathy Keatley Garvey

Taste, Dr. Heymann explained, is separate from taste plus smell. "Hold your nose as you taste a jelly bean," she directed as she pointed to the candy. "Let go and taste again." It was surprisingly difficult without smell, and it is nearly impossible for a taster to determine whiskey, garlic, chocolate, coffee or wine with the nose blocked. Two different ways to smell, she said, are retronasal from the mouth, with the nose open, and orthonasal from outside the nose.

Discrediting yet another common assumption, Dr. Heymann traced the belief in a "tongue map" to a disproven 1901 dissertation. What's true is that the five basic tastes — sweet, sour, bitter, salty, and umami — can be tasted everywhere on the tongue, mediated by taste receptor cells in the taste buds. Other aural sensations are astringency, temperature, irritation, viscosity — all mediated by free nerve endings. She concluded with another thwack at unsubstantiated belief: "Humans can smell ten million odors. We are as good as any dog." We just don't hone our ability.

Orietta Gianjorio was on a mission to begin to change that. "Like people come to a wine shop and ask for wine by a specific description, people can be educated to ask for honey." She is a certified sommelier, olive oil and chocolate taster, and part of the Italian Registry of honey sensory experts. "It's relatively new, this American obsession with food, but I come from a country where this is normal." She is one of only two Americans with the demanding Italian certification that requires blind identification of 22 varietals. She chafes at being called "a honey sommelier," explaining that the word sommelier is for expertise in wine; cicerone for beer; and, she proposes, a mieleur would be a honey sensory expert. Then she set about to create a room full of mieleurs. "I want you to become analytical tools."



Professor of Sensory Science Dr. Hildegarde Heymann gave the group an informative physiology lesson that demonstrated the limits and advantages of ways to taste. Photo by Kathy Keatley Garvey

As she guided the Davis participants to start tasting, she tilted a honey sample toward the light to see the color. "Look," she said, holding it to the Pfund Honey Guide, a color scale determined by the number of millimeters away from the lightest end of the scale, from water white to dark amber. "Is it extra white? Light amber?" she asked, indicating the place in their notebooks to record color.

"Keep your cup covered," she said, rubbing hers on her palm, warming it to release the volatiles. She stirred the honey and inhaled the aroma, recapping it while she paused to be present with what she had smelled, a moment of intense presence with her senses. The tasters repeated the orthonasal exercise several times, turning their flavor wheels to find words to describe their experience.

"Now," she said, "Take a small amount of honey, place it on your tongue, distribute it through the whole oral cavity — tongue, gums and roof. With your mouth closed, breathe out your nose as the honey melts. Hold it until you finally swallow the honey."

"Give me just one specific — visual, olfactory, gustatory, retronasal. Find a hook to identify, remember this honey." The responses were various, and a profile emerged — white; cinnamon, almond, spicy in the nose; taste of dried fruit, apricots, figs, prunes; slightly acidic with a retronasal scent of vanilla, cherry. "Sweet clover," she said.

Before the end of the course, tens of honeys would be tasted and many more offered in the foyer. But sweet clover, orange blossom and buckwheat are the three honeys being studied every whichway at Davis — en route to an ambitious goal of creating both sensory and analytical profiles for monofloral honeys from the entire U.S.

Tasters and Testers

That work had begun with Sensory Science Consultant Hanne Silversten, who explained that she had assembled a trained honey tasting panel that met over six weeks "to help identify sensory characteristics within a variety of fingerprints." In order to test multiple examples of the same varietal from various sources, she used an analytical discipline that determines the shuffling of blind samples in a study. Not only did the panelists use words to describe the honeys, but they marked the intensity of each word on a scale. In each session, hundreds of samples of clover, orange blossom, and buckwheat honeys were tasted.

Think, *directed sensory expert Orietta Gianjorio, as she taught course participants to associate words with smells and tastes. Gianjorio is one of only two Americans certified by the Italian Registry of Honey Sensory Experts.* Photo by Kathy Keatley Garvey

"As a food scientist, I'm not even tasting them," said Katie Uhl, Davis Food Science PhD candidate. Her objective was to characterize the chemical markers of the three honeys. To separate, identify, and quantify each sugar, she used high-performance liquid chromatography with refractive index detection. To analyze amino acid and headspace volatiles, she used gas chromatography. To study compounds such as acids, alcohols, esters and aldehydes, she used solid-phase microextraction with detection by mass spectrometry. The reader will have to take it on faith that Uhl managed to explain these processes with diagrams.

The result: 125 compounds were found in the three honeys, some significantly different among varieties. Most interesting was the sensory tasting vocabulary in comparison to the profiles of various found chemicals. For example, compounds found in sweet clover: The aroma of 3-hexanol is resin, floral; benzaldehyde is almond, cherry; 2-hydroxybenzaldehyde is spice, cinnamon; phenethyl alcohol is rose, honey, spice; cinnamaldehyde is cinnamon; coumarin is green, sweet.

Eight amino acids were analyzed, with buckwheat higher in several and orange blossom lower. Among Uhl's graphs was a remarkable 3D scatterplot chart that showed her analysis of each sample of the three honeys, not identical but clearly clustered by varietal – with the exception of one outlier. Interestingly, the tasters had also identified the same honey as an outlier, not clover as the jar was labeled.

For Real?

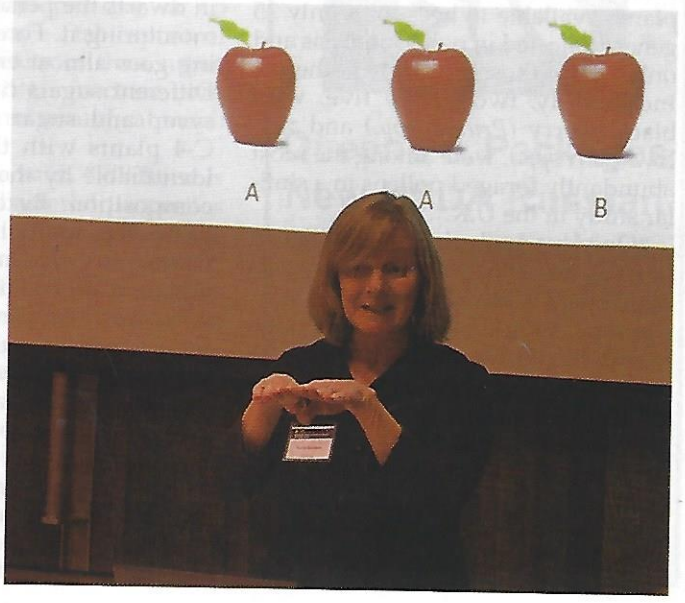
Misrepresented honey is a problem that was addressed by Amina Harris. To begin with, a honey labeled with a "chief floral source" would be assumed to be just that. But U.S. guidelines allow a varietal honey to be extensively blended. For example, orange blossom honey can be only 27% orange blossom, with the remainder made up of 23-25% portions of this and that. In the same way, a jar labeled clover honey can be just 27% clover, with the remainder a similarly lesser-portioned mix of other honeys. So the outlier honey in the study, labeled clover, could have been legally labeled by being just a little over a quarter clover; but it was not enough to be grouped with its varietal by either taste or chemical analysis. The labeling rule is among those that beg to be reexamined.

The Honey Flavor Wheel, developed at Davis as a device to offer descriptive language to tasters, was a useful tool as course participants put words to flavors. Photo by Kathy Keatley Garvey

In her opening remarks, Harris posed the question: What is honey? Definitions from USDA-CID (years in the editing and just issued) and the National Honey Board come up short for her: "The missing word in both is pollen — the fingerprint," she said, the way it can be identified.

Irina Delusina is a UC Davis palynologist, or pollen scientist, with an interest in pollens in honey — which makes her also a melissopalynologist. She said that "the presence of pollen in honey is evidence of the geographical location and genus of the plants that the bees visited." Different colors of pollen are primarily from different flavonoids (red, yellow, purple) and carotenoids (yellow, orange) which, besides being pigments, are also antioxidants. The accumulation of phytochemicals in pollen is dependent on climatic conditions such as sunlight and moisture as well as soil characteristics. "Each pollen has its own face," she said, showing electron microscope images of myriad shapes.

It was intriguing to learn that the pollen grains of some flowers are overrepresented in the honey, which



Hanne Sivertsen, a sensory scientist, explained the triangle test: Of three honeys, participants had to choose the one that was different — a means of honing their discernment. She is testing the sensory side of the ambitious Davis project to classify honeys by scientific testing as well. Photo by Kathy Keatley Garvey

Among many additional honeys available outside the sensory training course offered for tasting were several from attendees, such as this one provided by agroecologist Virginia Bolshakova from her Jennings Family Farm in Michigan.
Photo by Kathy Keatley Garvey

means that the percentage of pollen is greater than the percentage of the corresponding nectar, as in the forget-me-not *(Myosotis spp.)*. Conversely, with other pollen types the situation is reversed and the pollen is underrepresented, as in citrus *(Citrus spp.)*, rosemary *(Salvia rosmarinus)* and sage *(Salvia officinalis)*.

"Knowing which plants honey bees forage upon is critical to understanding the link between floral availability, honey bee nutrition and health," said Delusina. She cited a study in Kentucky that found 125 pollinating plants available to bees with only 25 genera detected in pollen analysis and only five of those regularly gathered. Incidentally, two of the five, wild black cherry *(Prunus spp.)* and willow *(Salix spp.)*, were among the most abundantly foraged pollens in a similar study in the U.K.

"Only by analyzing the pollen in honey can it be reliably differentiated from [illegal] foreign honey," she said. A high percentage of pollen in tested commercial honey samples has revealed dubious authenticity. A photo of Vaughn Bryant, "the father of melissopalynology," lecturing on the situation from his hospital bed, emphasized her point.

"With too few pollen grains, the possible reason is that it is filtered honey or fraudulent," she said. "Pellets by color can show fidelity — normally the same color palette contains the same pollen, up to 90%." For example, the annual production of New Zealand manuka honey is 1700 tons, but as much as 10,000 tons is sold globally each year. "There is a strong demand from the beekeeping community for the analytical study of honey. But there are not enough qualified palynologists to work on these problems."

Honey Cunning

Honey fraud is rampant, as reported by Joyce Schlacter, Director of Food Safety and Quality, Crockett Honey. Of the top foods that are fraudulently sold, honey is third, after seafood and olive oil. She said that at the recent Apimondia in Montréal, 41% of samples of honey submitted for competition were disqualified for adulteration or overheating.

Schlacter was instrumental in uncovering the nation's largest honey fraud at Groeb Farms. As in that case, she said fraudulent honey enters the U.S. primarily by mislabeling Chinese honey transshipped from Taiwan, Thailand, Indonesia, India and Malaysia. She visited fake Asian suppliers, discovering no processing plants but only barrels of illegal Chinese honey.

She reported that honey is cut with cheaper sugars — malt syrup, rice syrup, corn syrup. But also, bees are sometimes intentionally fed sugar for harvesting. Pollen can be filtered out to destroy the identifying "fingerprint" and pollen from a different geographic source can be added back to escape identification.

Detection is difficult, mostly because the volume of honey coming in dwarfs the personnel dedicated to monitoring it. Foreign organic labeling goes almost entirely unchecked. Different sugars can be tested: Corn syrup and sugar are sourced from C-4 plants with the refined sugars identifiable by their carbon isotopic composition. By contrast, bees collect nectar and pollen primarily from flowers of C-3 plants. But, "Criminals are good at cheating," said Schlecter, who found ads on Alibaba advertising a Chinese company that can supply a syrup that passes the tests. The impacts, she said, are loss of both revenue for honest producers and consumer trust.

Industry, academia and government are contributing to combat the problem. Schlecter cited a white paper on fraud and global effects on long-term food security by Michael T. Roberts at UCLA. The Global Food Safety initiative addresses fraud with standards. True Source is an effort toward industry self-regulation. She described new laboratory testing methods that are developed to stay a step ahead of the cheats. But, she said, a distributer can be wary of honey that is white or clear, without pollen, tasting sweet like cotton candy without honey notes, showing unusual separation, and *too cheap to be true*.

Labeling, Harris explained, affects consumer perception. The word "honey" must be visible, although the name of the floral source is optional, and the serious problem with percentages has been mentioned. The label needs to include weight, contact information and, for large producers (10 employees or 10,000 units in sales), nutrition facts. Nutrition labels are available in designated font types from beekeeping suppliers. Heating or filtering beyond the removal of dirt, wax and bee parts varies significantly, so undefined terms are common: pure, naked, unheated, unfiltered, artisan, natural. Well, she pointed out, "All honey is natural."

No honey produced in the continental United States is certified organic, said Harris, explaining the difficulty of formally verifying vast foraging acreage as organic — although some comes from Hawaii. As for genetically modified organisms (GMOs), "The USDA has linked non-GMO with organic. Therefore no honey produced in the continental United States is certified non-GMO. But honey is not a plant. It does not have genes. It is not genetically modified."

She advocates for removing the word honey from products that are not honey such as "bee-free honey" and "honey crystals," which are made of sugar.

Crystalized honey is another matter, said Gianjorio. "All honeys crystallize because they are a supersaturated solution." Honeys with various types of crystals were sampled. The higher the glucose content, the faster crystallization sets in, like dandelion or canola honeys. Conversely, honeys with more fructose, such as acacia, sage and tupelo, will crystallize much more slowly, or even barely. "Crystals have a refreshing, cooling effect in the mouth, related to the absorption of heat by the small crystals of glucose," she said.

Crystalization processes and defects were discussed — with a distinction between improperly crystalized

Dr. Suzanne Teuber, a Davis professor specializing in allergies, put to rest some widely held beliefs about honey, adding both hope and humor.
Photo by Kathy Keatley Garvey

honey and the consumer misperception that crystalized honey is spoiled. Samples of other kinds of defects were passed around for sampling — fermentation, smoker and thymol contamination, burned flavors from overheating, mold, and rust.

Despite belief to the contrary, said Gianjorio, "Honey does have a shelf life. True-to-type sensory characteristics are degraded; it becomes darker in color with declining aroma, a smell and taste of caramel and bitterness, and the crystalline structure disintegrates. Once opened and kept in a protected atmosphere, it has a shelf life of three years."

The Sting of Truth

"An Allergist's View: Bees and Bee Products" was presented by UC Davis Allergist Dr. Suzanne Teuber. She noted that honey bee anaphylaxis tends to be more severe than that from most other stinging insects. An allergy most commonly manifests in initial years of beekeeping.

"Allergies to honey as food are very rare," she said. But one in six Americans has allergic rhinitis, which breaks down to 65% windblown pollens, followed by cat dander, then dog, dust, molds. "Flowers attractive to a bee are not a major source of allergens. Weed allergies, for example from ragweed and mugwort, are mainly wind pollinated." Although it is possible to get some wind pollens in honey, "local honey does not have enough protein in it to drive an immune response like allergy shots or sublingual allergy therapy." There goes the motivation for many local honey customers. But, "Placebo responses are huge, and wonderful and real. There is a mind-body connection with the nerve fibers literally ending at mast cells that contain histamine granules and other mediators."

Dr. Teuber said that bee pollen sold as an herbal remedy has poorly controlled manufacturing practices and widespread adulteration. Yet, "The most famous bee pollen success story of recent times occurred when Sen. Tom Harkin became convinced that bee pollen pills had cured his allergies. His enthusiasm motivated him to pursue the establishment of the NIH Office of Alternative Medicine. Even though the product he used was soon fined by the FTC for falsely claiming that the bee pollen products could cause consumers to lose weight, alleviate permanently their allergy symptoms, and reverse the aging process."

The Soul of Sweet Delight

Nutritionist Amy Miller said that Americans' added sugar consumption has increased by 30% over three decades. Public awareness of the link to an increase in serious health issues has led to half of adults reporting that they are checking sugar content on nutrition labels and trying to eat less sugar. However, most don't know the daily recommended amount of sugar.

Labels on products from manufacturers with over $10 million in sales must now have the percentage of daily value of sugars in their products. "The recommended daily maximum of added sugar is 10% of total calories," said Miller. "All sweeteners are the same from a metabolic standpoint," she said. "So why is honey better?" Considering honey, for a 2000 calorie diet, the guideline would suggest 2.5 tablespoons per day, or 7.5 teaspoons. "Although a tablespoon of honey has more calories than sugar, maple syrup or high fructose corn syrup, the consumer would eat much less honey."

In addition, she said, "All honeys have natural antibacterial properties and anti-inflammatory properties, depending on the type of honey." Methylglyoxal (MG) is an antibacterial compound found in most types of honey, with the higher the concentration, the stronger the antibiotic effect. Manuka, for example, contains significant amounts. A measure, called the unique Manuka factor (UMF) was developed by honey producers to rate the concentration of MG and other compounds. To be considered potent enough to be therapeutic, manuka honey needs a minimum rating of 10 UMF.

Manuka, as Schlecter pointed out, is more often fraudulent than genuine. Harris said that, in any case, it is illegal to claim that any food "prevents, treats or cures."

The three-day training ended with a cooking demonstration by chef Mani Niall, author of the honey cookbook "Covered in Honey." Pumpkin honey-butter on savory rosemary-chevre scones; black bean, corn and shrimp salad with honey chipotle vinaigrette; bourbon and honey chocolate truffles — all of it was bantered into a feast that the participants relished when he finished cooking for them.

Although this was an in-person experience that a reader can only sample, if not taste, the Sensory Evaluation of Honey is scheduled to again take place at the UC Davis Honey and Pollination Center October 23-25, 2020. Details will be posted at **honey.ucdavis.edu**, where it is also possible to order Honey Flavor Wheels and Honey Journals.

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