

## Grapes: Diabetes and Grapes

(Number 45 in a series of highly opinionated articles about growing grapes and making wine in Fair Play. Note—the subject of this article was suggested by Susan Smith, who has endured 36 years of listening to highly opinionated whinings from her husband, John)

In the previous article I mentioned that I was going to take some time to re-enter the world of medical devices and try to help those who suffer from diabetes. Just as glucose is the main sugar in grapes, it is also central to diabetes, and my own connection to measuring glucose in people preceded my interest in grapes by a number of years. From a hospital laboratory position in the 1960's, through participation in designing blood glucose laboratory systems and then meters for home use, to the search for a device that might one day make this vital measurement without drawing blood, many facets of this challenge have altered the path of my life. While winemaking evolved from a hobby to a passion and then to a living, measuring glucose moved from a livelihood to a sideline activity, but has now come back as a primary focus. If this most recent twist proves successful, I'm hopeful I can make one more of these shifts *back* to grapes in the future.

People with diabetes can manage their disease, if they can control their blood sugar levels, and research shows that if people just measure the level of sugar (glucose) in their blood, they'll usually do the right things to stay healthy. What's the problem? In order to measure blood glucose, you have to stick a needle into your finger, often several times a day, to obtain a drop of blood to make the measurement. Only a few, very "special" people really enjoy painful experiences, and for the rest of us, any excuse to avoid pain is a good one. It may seem like a small thing to those who aren't faced with the problem, but people who need daily insulin injections almost uniformly report that they much prefer the injection (smaller needle, used where there aren't as many pain-sensing nerves as the fingertip) to the "fingerstick" required to measure glucose.

### **Why Does It Have To Hurt?**

In spite of how universal it is, glucose in blood is not an easy measurement to make. In the old days, people used simple "dipsticks" to test for glucose in urine (a relatively simple chemical mixture) instead of blood. The only problem was, glucose only shows up in urine when it's at dangerously high levels, so when you do find it there, you may well be on the way to the doctor's office or to the hospital. In the late 1970s, crude tests became available for use in home measurement of glucose levels in blood. The user would apply a drop of blood to a test strip, rinse the blood off after 60 seconds, blot the strip dry, and insert it into a device the size of a large shoebox to get a reading. During the next twenty-five years, several companies, led by my former employer, the LifeScan division of Johnson & Johnson, made major advances in the convenience and accuracy of blood glucose measurements, to the point that currently-available meters are only about as big as the remote-entry key for your car, but the major obstacle remained: you still had to stick your finger to get a drop of blood!

### **Noninvasive or Non-Invasive?**

During my active participation in the field, starting in about 1982, the most challenging goal was to find a way to measure blood glucose without the pain of drawing a drop of blood. After learning that the other simple approaches, such as measuring glucose in saliva, sweat or tears didn't work, we looked at over a hundred different and varied technical approaches, from a very sophisticated-sounding "photo-acoustic spectroscopy" project in Scotland, to attempts to measure trans-dermally (across the skin) in Japan. In spite of years of effort, nothing worked! However, I did get to meet some very interesting (and very colorful) characters who populated the field. One such was a researcher in the West, who has been absolutely sure for over twenty years that the right combination of microwave energy and sophisticated computation could yield the right answer (it hasn't yet), and another investigator on the East Coast who came to this field from a very different perspective.

### **Near the Infrared**

This individual, who was one of the most dramatic figures in this field, had begun his investigations by making noninvasive measurements of agricultural commodities like fruits and nuts (no slight intended). It's a pretty simple task to grab a piece of fruit, cut out part of it, and use it to measure the sugar content to indicate if it's ripe, but it's a little hard to sell the remaining piece of fruit after you've cut part out of it off. Light in the "near-infrared" region (the part of the light spectrum just above red light and below that used for heat-sensing night vision goggles featured in spy thrillers and middle-eastern conflicts), passes easily through the flesh of most fruits and, with a lot of calibration and computing, will make a pretty good measurement of sugar (as well as protein, fat and moisture) content without cutting into anything.

### **The Great "Grape Glove" Escapade**

This discovery led rapidly to an entire generation of instruments that could scan natural products at the rate of several thousand per minute, make accurate measurements, and even remove individual items that were below acceptable standards (including the inevitable small brown rocks that find their way into each bin of harvested walnuts). "Wait a minute," they said, "if we could put this technology out into the farm fields, we could pick only the fruit that's really ready to be picked, and not have to throw away the culls." And so was born a new breed of devices for use in the field, among them the "melon wand." A device was constructed that could be held by someone walking through the field, pointed at a melon, and if the fruit was ripe enough to pick, it would yield a satisfying "beep" (and mark it with a small spray of food dye). A disappointing "boop" was heard if it didn't meet ripeness standards (this, like many inventions, intensified the stratification of society, since the foremen could walk upright as they strolled through the field making executive decisions, while the real workers had to spend most of their days in hard labor picking the marked fruit).

Table grapes, like wine grapes, are picked according to ripeness (sugar content). In the old days, a single cluster on a vine, or even an entire block of vines, might be measured

with the grapegrower's standard tool, a hand-held refractometer, and the other clusters would be picked if the sample was ripe enough. The problem is, just like any other fruit, one cluster may be very sweet, while the one next to it is not. So the next device in this new high-tech family was a system, mounted in a glove, where a worker could gently squeeze a cluster of grapes between thumb and fingers to make a measurement of their readiness for market, and without damaging the grapes in the process. A problem arose when the growers recognized that every cluster could be measured before picking (to insure uniformity *and* increase the grower's profit at the farmstand or supermarket), but the workers were quick to figure out that they were able to pick fewer clusters per hour when they had to test each one (many farm workers are still paid on a piece-work basis, so the less they pick, the less they make each day). The result? All the devices began to mysteriously suffer severe damage from the razor-sharp knives the workers used to separate the grapes from the vine, until the cost of repairs exceeded the savings to the grower, at which time the "grape glove" was eliminated and the previous system was reinstated.

### **The Real Test**

Buoyed by the technical (if not always the economic) success of the agricultural devices, several companies began serious investigations into using this technique to measure glucose in people without causing discomfort, and at least a dozen groups around the world have now looked into the possibility of measuring glucose using near-infrared light. This light can penetrate body tissue as well as fruit (everyone has at one time held a flashlight beneath their fingers in the dark and seen the deep red light that passes through), and because glucose has a small but measurable signal in the region, it seemed that this approach might yield the long-sought noninvasive glucose measurement device for people. One researcher even began to tout his new device as the "Dream Beam" that would end the pain of glucose testing forever. Some devices were small, some occupied an entire tabletop, but all eventually ran into the same problems: there's a lot less sugar in people than in fruit (about one one-hundredth the amount), and the variability of tissue (skin, hair, sweat glands, blood vessels, collagen, adipose deposits, etc., etc.) gave these optical methods fits when trying to get an accurate measurement. To date, no one has succeeded, due to these and other technical complications, in spite of the hundreds of million of dollars that have been spent around the world in its pursuit. It's kind of a sad technical saga, one that might someday have a sweet ending, but today is a little more reminiscent of "sour grapes."