Fire and wine were the topic of an open access article in the March 2022 issue of the Journal of Natural Products entitled “Natural Product Phenolic Diglycosides Created from Wildfires, Defining Their Impact on California and Oregon Grapes and Wines.” Authors from the University of California Santa Cruz (UCSC), the SC Laboratories, and the University of California Cooperative Extension collaborated to study the impact that smoke from increasingly intense and frequent wildfires in the western United States is having on grapes and wine in the country’s most revered wine regions. Their research focused on forecasting wine quality using UHPLC and MS/MS to directly measure and quantify the bound phenolic diglycosides in grapes and wines that are indicators for smoke taint. In May 2022, we interviewed lead authors Dr. Phil Crews (UCSC) and Mr. Paul Dorenbach (SC Laboratories), who attribute the success of their research to both solid natural products chemistry and workflows but also to the tremendous support and inspiration from their regional winemaking community. The transcript of this interview has been edited for length and clarity.

How did you get involved in measuring smoke taint and working with SC Laboratories?

CREWS: I got involved in this about five years ago, when all these fires were occurring. The situation was that growers and wineries were trying to collect, in some regards, insurance money to cover the loss [from the fires] and the potential loss of the crop. Some wines sell for a couple hundred dollars a bottle, so they don’t want to take a chance. If there has been smoke damage, releasing a wine could subsequently ruin their reputation. So, I was approached by some insurance companies to evaluate packages of data and give them an opinion as to whether the claims for damage to grapes and wines was valid.

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Dorenbach: At SC Laboratories, we do mainly cannabis testing, but Phil came to us with this wine project. We have all the instrumentation, so it was the perfect match.

Could you summarize the main concepts of your research project and contributions of your research for the understanding of smoke taint in wine?

Crews: I discovered that the analytics that was going on in the US [about smoke taint], up until about a year ago, simply measured the presence of volatile phenols in the grape juice or the wines. There are volatile phenols when a fire happens in a forest. If you smell and taste these, they’re awful from a standpoint of the aromas and flavors, smokey, bitter, ashy, etc. The major compounds include guaiacol and 4-methyl-guaiacol. These are standard compounds that people would perhaps look for in a sensory evaluation and analytical experiment. You can have as many as 500 volatile phenols. So, these compounds [have been used] as markers to give us a sense as to whether there is potential damage to grapes or wine. During the fire, these compounds are created from the burning trees, and they’re sequestered by the smoke. The smoke lands on the grapes and you have glycosyl-transferases that can take these compounds of the smoke and essentially form a glycosidic bond to the disaccharide. They can be sequestered in terms of parts per billion (ppb), 100 ppb of these compounds. And that’s what Paul was able to do in terms of the magic of using the triple quad with the standards to get data.

As we can’t measure all 500 [bound phenolic] compounds, we’re just taking the six [biomarkers] to give us a sense of a projection. We accumulated several hundred samples, and I came up with the proposal that if you had the total ppb of the [representative] six bound phenolic compounds in Cabernet Sauvignon, if that is less than 6 ppb, you weren’t going to have a smoke impact. This number meshed very well with samples we got from people that have not been impacted by a fire. Mild smoke impact is around 30 ppb and really heavy impact is greater than 800 ppb. We were able to take paired samples of, for example, 2019 Santa Cruz Mountains Cabernet Sauvignon (no fires) vs 2020 Santa Cruz Mountains Cabernet Sauvignon (impacted by the massive CZU fires). Paul and I have learned how to sample grapes, quickly make a measurement, and be able to forecast to a grower what’s going to happen. The Australian Wine Research Institute has been doing this for quite a while. But the thing is, you can’t send grapes to Australia, and so there was really no lab until a year ago that could do this.

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Now here’s an interesting thing: it’s the amount of smoke. It’s the phenols in the smoke that have the impact, and they were able to drift [with the wind]. Two vineyards equidistant from a fire, one was not impacted by smoke taint, while the other one was heavily impacted because the wind was probably blowing that way.

What was the most surprising or interesting finding that you took away from this project?

DORENBACH: I think it is interesting to have a good sense of how much smoke is really affecting your grapes. Someone might think that their crop is affected and they send it in and [the level of phenols] isn’t super high. As our database grows, we’ll start to get a better sense of that. One surprising thing was that the range could be really high. For a while, the maximum that we had seen was about 300 ppb, and then we got these other fire samples and they were closer to 800 ppb. So that gave us a sense of what the possible range is that we’re looking at here.

CREWS: Firstly, one surprising thing was how generous people were in the winemaking community to share samples, and so we got samples from lots of different places. What made the project work is that people were generous in sharing Cabernet Sauvignon samples. We looked at over 20 American viticultural areas (AVA) with eight different varietals. Two more surprising things: Cabernet didn’t vary from the baseline as a function of the AVA. In other words, the resident concentration of these compounds when there are no fires is the same no matter where the grape is planted, no matter what the cultivar is. People had wrestled with that question, but they didn’t have any answers to that. We generated a fantastic baseline for these eight varietals where we can now compare a fire year versus a non-fire year. Likewise, the baseline (grapes that are not impacted with smoke) from California Cabernet Sauvignon is different than the Australian baseline. That was a surprising thing. It was unexpected. The baseline for Australian Cabernet Sauvignon is about three times what the California baseline is, and there may be some other explanations to that. Third, people are still trying to learn how to use this information. That’s where I think these data sets will be helpful. A winery will be able to decide what they want to do: do they want to sell off some of the grapes for bulk wine or do they create a second label that may not have the high quality? They’ve got to be careful because they don’t want to ruin the quality of the label, but, up to this point, nobody was able to do this because they didn’t have this kind of data. I wouldn’t say it’s a surprise, but it’s been an interesting learning circumstance in terms of how to match the biomarker ppb with the sensory evaluation scores.

DORENBACH: I think the baseline we’ve generated is super valuable, and hopefully we’ll just continue to add to it. The more samples that are in the baseline, the more comprehensive the range is. We found that the ideal is to have the pair: the exact grape from a year that was unsmoked compared to a year that was smoked. That’s going to be the gold standard. If you can get those two sister samples, that’ll give you the best idea of how much smoke was affecting your grape. But comparing it to a baseline average of the varietal, I think over time it’ll be a good estimate as well.

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Did you get any big grants for this project? Or was this just made possible by wineries donating grapes, and your own labs? Was it entirely a community effort?

**CREWS:** No. We just pulled people in from other projects to do this. And I think SC Laboratories was confident that maybe there’d be a business opportunity down the road, which I think there is. I was convinced that we could make an important scientific contribution because I didn’t see this coming out of the other laboratories, commercial labs and other academic labs, because I was laser focused on looking at the direct measurement of these biomarkers.

**DORENBACH:** I would say that there definitely is a business opportunity, but there’s also the community aspect. We just had the big CZU fire here, and we were able to get some winemakers who are really interested in this because of that fire to donate some samples. And it’s been a mutually beneficial relationship where they get some free data, and we get to use their data to establish our baselines and increase our dataset and develop our method. It just worked really well.

**CREWS:** Let me also tell you a little story. I knew that the commercial labs were not doing it right, and I wanted to tell my friends here in Santa Cruz and other winemaker associations what the problems were. I wanted to try and get them to use their money wisely to get bioanalytics and using the money wisely was not measuring the free and the total. It was the bound compounds, the direct measurement. And I figured that if we could get that going, we could provide data that would be useful to people to help the small family wineries make the correct decisions. So, in fact, a lot of our samples came because people were grateful to the standpoint that two years ago when I gave them seminars, I pointed them in the right direction of what data to get and what data not to get. In fact, next month I’m going up to the Dry Creek Valley Wine Growers Association to give a talk.

That’s great. It sounds like your research has been really community driven. You started with community questions and you’re benefiting communities, small wineries, and now you’re disseminating that information through community talks.

**CREWS:** And one of the things you might know is that our paper is open access. The reason we did that is I wanted everybody to be able to get it.

**DORENBACH:** I hope people use it!

Mr. Dorenbach, since cannabis growers are having to deal with many of the same environmental issues as vineyard and winery owners, are you involved in any similar research looking at the effect of wildfire smoke on cannabis?

**DORENBACH:** Yes, we are in the development stage of that. We have our standards, and we know the instrumentation that we are going to use. So it’s a matter of developing that method, but it’ll be measuring the free phenols because obviously there is no natural process of fixing them to sugars.

Dr. Crews, do you have any advice for other people who are pursuing a career in science but perhaps have a very different passion that they also hope to blossom into a career, and how you can be successful on both ends?

**CREWS:** That’s hard. I don’t have any advice. What I’ve always done in terms of science is I pick what I’m interested in and follow my heart. Actually, there’s a parallel between the wines and sponge natural products chemistry. To do natural product chemistry, you have to be out in nature, so we’re always out on expeditions. And one of the things that made the expeditions work is that I would ask all the PhD students, the post-docs and staff as we’re going out to a tropical area to bring four bottles of wine in their wet suit, two in the arms and two in the legs. At the end of a long day of diving and then collecting and interrogating samples, we could then have a good meal with some vino. That would then set the stage for evening seminars. So, at any rate, I was lucky. I just found a way to combine, on many levels, our science, in terms of chemistry, biochemistry, enology and viticulture.