Basics of Wine Tasting:
Wine Sensory Evaluation - Aroma

CORY: Hi, everyone. I'm Cory, and in behalf of Global Connections I'd like to welcome you to our webinar today on wine sensory evaluation. Please feel free to use the chat box for any questions or comments throughout the presentation, and if you have any problems hearing or seeing anything, please feel free to send us a message, and I can help you out with that. So here is Dr. Ross.

CAROLYN ROSS: Hi, everyone. I'm pretty excited. Sorry about that. Let's put the video on so you can see me. I'm excited that we have two live participants. So that's great. If you have any questions, just write them in the chat box as Cory mentioned, and I'm really happy to answer them as we go along, just to allow to have some interaction.

So the first webinar-- this is a three series webinar-- the first one was about just general production of sensory evaluation, and then I talked about appearance and color. The second webinar is going to be focused on wine on aromas-- detection of them, how we detect them, positive aromas, negative aromas, one or two wine salts. So there's going to be a lot of information, but it's just going to be focused on aroma. And then webinar three, we're going to be talking about taste and mouthfeel.

So just as a review, what we did last time was the appearance, so, when you got a wine in front of you, hey, what do you do? You look at it, you take into account the color, and if there's any clarity issue, if there's any crystals, so you look at it and make that decision at least at that point if you're going to drink it.

There can be some no go-s at that point, so if you see any ropiness, you probably don't want to drink that one because it's got some microbial issues. Tartrate crystals are fine, and again taking into account the colors-- the color appropriate for the type of wine you're drinking. So if it's a young table wine and the fact that it's a deep yellow, that might make you think hey, this might be oxidized. So you may make some decisions at that point whether you're going to actually consume it or not, but I mean, nothing hurts about at least giving it a smell. So that today's webinar talk that is aroma.

So my name's Carolyn Ross. I'm an associate professor here at the School of Food Science at WSU. I have been here for nine years, and the research in my lab brings together sensory evaluation-- so people tasting, smelling, feeling, hearing different products; foods and wines-- and that I've got another piece where I do instrumental analysis. So analytical measures-- measures of flavors and aromas and textures-- and then bringing those two sets of data together. So having the people evaluate something, having the instruments evaluate some aspects about that food, and then bringing those data together.

So today, as I mentioned several times, we're going to be doing aroma and odor. So I'm going to start off with just talking generally about odor perception-- how we perceive it-- and then the importance different techniques, wine odor identification, and the influences on odor identification. So what influences our ability to tell if certain odors are present or being able to identify them?

We're then going talk a little bit about the process of how that's actually done. I'm going to be talking about the wine aroma wheel a little bit, and then finally wine aroma faults. So I'm going to go over several of those. It's not an exhaustive list. There are a lot of them that we can talk about, but I just kind of picked the big ones that we're going to hit on.

So, odor perception. This first slide just demonstrates the importance of why we need to aggressively sniff. So after just sitting in the room, only a small fraction of the air that you're breathing it actually reaches the olfactory epithelium. That is located right here in the upper part of your nose. So only 2% to 3% of the air that we're breathing in right now reached the olfactory epithelium, and that's where the receptors are. So, a small percentage are being fired and reaches the area where we can actually perceive aromas.

And the way that you can drive air up over this olfactory epithelium is by aggressively sniffing. So, really aggressively sniffing; driving the air up over that olfactory epithelium. It increases the perception to about 20%.

So, you can see that there is a lot more air, and a lot more of those aromas that theoretically can then reach that olfactory epithelium for detection. You do have those receptors located there.

So, it really is the power of the sniff. You do really need to rapidly sniff. We'll talk a little bit about the technique. You can't aggressively sniff for too long, otherwise you have a point of diminishing returns. Two to three short, sharp sniffs, followed by a rest.

There are two types of detection that I'll talk about-- orthonasal detection and retronasal. Now, you can look in the little diagram. It looks like he's smoking a cigarette and a little puff of smoke. But it's a good illustration. It's a good cross-section.

So the orthonasal olfaction-- those are the aromas that come right up the front of your nostrils. So when you've just got a glass of wine in front of you, and you just stick your nose in the glass of wine and sniff, those are the aromas that come out of that wine up to the front of your nose. So that's orthonasal detection.

Retronasal detection-- you can look in the figure below-- those are aromas that come out of the product; come out of the wine once the product is in the mouth. And so those aromas travel up to the same area for detection as do the orthonasal olfaction, but it just goes by a different route.

So it still gets to the olfactory epithelium-- you can just see in the diagram-- but it goes via a different route. So if you have a cold and you're not able to smell things, you're probably not able to get those flavors either, because that area is blocked off. So that's why you can't experience a lot of flavors when you have a cold.

You can experience taste. You can experience sweet, sour, salty, bitter, umami, because those are on the tongue. Those receptors are located on the tongue. So you can still perceive those things. But if you've got a cold or if you block or nose, you're not able to get strawberry or lemon or vanilla.

So there's an activity I do with my students in class where they all block their nose, and then they pop in a Lifesaver, and they're not be able to see the color otherwise that might influence their perception. But with their nose blocked, all they can detect is sweet. Then they unblock their nose, and then bang, then they get whether it's strawberry or lemon or orange or whatever it is.

So the importance of being of being healthy, and understanding that if you're not healthy-- if you have a cold and that region is blocked up you're not able to perceive a lot of those in mouth aromas-- is another way of looking at them, which are really flavors. So importance of odor perception-- take home message from this-- two to three short, sharp sniffs drive the air up over this olfactory epithelium for detection. Otherwise, a smaller percentage of air is reaching that area for detection.

OK. And so this diagram illustrates that as well. So along the x-axis we have by nose, and along the y-axis we have by mouth. And then what I've done is I've highlighted the line right through the middle. So this is a publication in 1999. The contents that are below the line-- those were more likely to be detected by the nose, whereas the contents above the line were more likely to be detected by the mouth.

And so what you can see from here is that some compounds-- at least to the people who participated in this study-- were more likely to be detected by the mouth, meaning that the wine had to be in the mouth. Things such as vanilla and [INAUDIBLE]. Those were more likely-- and kirsch, which is kind of the cherry-- those are more likely to be detected in the mouth. But if you look below the line, there is the nose. Those were compounds that were more likely to be detected by the nose.

So the kirsch is kind of a cherry liqueur, and then we just have cherry, which is more likely to be detected by the nose. Blackberry as well.

There are some compounds that are equally well protected by the nose and when the product is in the mouth. So if you look at it below the line, those are orthonasal compounds; and above the line, those are retronasal compounds. So some compounds are more easily detected in the nose when you're sniffing the wine, versus when the wine is in the mouth.

What that means practically is that you may have to descriptors when you're sniffing the wine. You may really get cherry. You may really get red currant. You may really get kind of a hummus. But when you put the product in your mouth, you think, wow, what happened to that cherry? And that's just because some compounds are easier or not as easy to detect in the mouth, and then you may get different compounds as well. So you might get a different profile of the wine if you're just sniffing it versus if you actually have it in your mouth.

So wine odor-- very complex. There's a lot of odors wine. And we've done a lot of different analyzes of wines, and you can find hundreds and hundreds and hundreds compounds. Whether or not they're important-- that's a different question. But you can find a couple hundred-- 300 compounds that are present in these wines.

So there are a lot of compounds that are present. Only a subset of those are we able to actually detect-- are they at a concentration that's high enough that we can perceive.

But when we're talking in terms of vocabulary, terms might range from simple to very complex. So simple might be if you just smell a wine, you think, wow, this is raspberry. That's it. End of story. That could be a simple wine, whereas very complex would be a number of descriptors that you smell it and you think, oh, this is fig, and it's got diesel, and it's got steak, and it's got cherry. So ranging from simple to very complex.

Intensity is a different aspect of aromas or odors. So this is the strength of those aromas. So whether or not they're strong or weak. So there's complexity, which is the number, and then intensity, which is how strong they are.

We do tend to smell a wine better once it's in the mouth than in the glass, but as you know from the previous slide, it does depend on the compound. Theoretically, because the mouth is warmer, and so you get a release of more of these aroma compounds that are present in the wine.

Terms for intensity can range from very aromatic, which means that there's a lot-- they're very intense. They're very strong. You get them, versus closed, which implies that there might be some present, but they're not very intense. So those are some terms that go along with wine odor.

Now, odor perception. Odors are grouped by origin or specific event. So the way we look at odors, they tend to refer to an object or experience, and that's because our sense of smell if more tightly tied in with our limbic system, which is associated with emotion and memory.

So when we smell something, we tend to think of an event. We tend to think of a good memory that we have. We might smell and think, wow, this smells like my grandma's kitchen. But we tend to think of an event. And we might not automatically think, wow, I smell this; oh, it's cinnamon. At some level you've got this emotional connection with cinnamon, and you think of that event. You think of your grandma's kitchen. You think of picking raspberries out in the

summer. And then you kind of have to deconvolute that event, and say, OK, what was going on there?

So it is hard for us to put our finger on what we're smelling, and that's a phenomenon known on the tip of your nose-- meaning you can smell something. You know it. You know what it is. You just can't actually name it. And that's where the wine aroma wheel comes into play-- is that you can have that in front of you and it can help you develop that vocabulary.

So it is difficult to use unfamiliar terms for familiar odors. So if you're used to calling something a certain smell or aroma, and then someone comes along and says, no, no, no, no-- we're going to use a different term; or how you've been using this term is incorrect, and you're going to use this other one. Very difficult to switch.

We do use a lot of verbal, visual, and contextual cues, meaning that we look at the color of something, and that kind of tricks us as to what aroma you might be able to associate with this. And I talked about that webinar one where I talked about the wines that were colored. So they took a white wine and they colored it red, and then they gave it to a number of experts, and a lot of those experts then used red terms to describe this wine. They didn't just sniff it and give terms that that they might really perceive in the wine. They took the cue that the wine was red, and they came up with red terms, which they may not have otherwise done.

So there are a lot of visual, verbal, and contextual cues that we take into account without even realizing it. So knowing, as I mentioned earlier, the oxidized wine-- if you have a young one that's oxidized-- that's kind of golden-- you might then have a perception of what you're going to smell.

So if you are doing a tasting, it's best to do it blind. Ideally, if you just want people to focus on the aromas and the flavors and the mouthfeel, and you don't want them to look at the color, what you'd want to use is dark colored glasses-- wine glasses or dark colored glasses glasses-- to disguise those color differences, because that can influence. The intensity-- the depth of the color-- people tend to associate it with deeper fruit.

So there are associations that have been made. They're very, very difficult to overcome, and it does take training to say, OK, ignore the color-- just focus on the aromas. So if you did want them to just focus on the aromas, I would encourage you to disguise any color differences that there may be.

Also a big thing-- odor perception is personal experience. If you've never smelled something, then you'd likely won't use the term to describe the wine. So I did a panel a number of years ago where I was looking at Lemberger, which is a red wine variety in Washington state. And previous studies have said, well, boysenberry is how you describe it. And if my panelists didn't know what boysenberry was, why would they use that as a term? And it turned out most of them didn't know what it was.

So personal experience plays a huge role. I also used the example last time of an ice wine panel that I ran when I was working at the Cool Climate Oenology and Viticulture Institute in St. Catherines, Ontario. And we were studying ice wine and looking for markers of genuine Canadian ice wine. And so we were profiling a whole series of ice wines, and what we had was-- a couple of them-- we had a number of them out in front of people, and people were coming up with terms to describe differences among the wines. And honey came up. And then we had some people saying, well no, it's clover honey versus lavender honey. So then we had people who could distinguish between various-- distinguish, within the context of an ice wine, these different types of honey. And so personal experience-- if you don't like honey, or you've never had it, or you don't pay much attention of what kind of honey you've had, then you wouldn't be able to make that distinction.

So odor perception-- very much personal experience, and very much contextual cues.

And this is a copy of the wine aroma wheel. Here's a color version of that as well. So it's quite pretty. So if you haven't seen this, the way it works is you start with the innermost-- those are the most broad terms-- and as you work your way out, you get to more specific terms.

So if you sniff a wine, and you think, wow, it smells fruity, you go to the fruity spoke, and then you can look down within fruity. There's citrus, there's berry, there's tropical. And then once you're within that category, you can even subdivide it further.

So even if you just get to tropical fruit, that may be enough-- may be sufficient. But you can subdivide it into pineapple, melon, or banana. So it's a way of putting your finger on what you're actually smelling.

With my students, I just ask them to come up with a couple of terms-- at least, say, three aromas that you're smelling in this wine, even if it's sort of fruity, vegetative, and chemical. Even if it's sort of broad categories, that's a really good place to start. You don't want to make this a frustrating experience.

So just smell the wine, get a few aromas out of it, write them down. It's not expected that you be able to list 12 aromas that you're getting from a particular wine, but this does certainly help in that it removes that sort of emotional-- or helps minimize the effects of that emotional and that memory connection that you have, and actually enables you to put a name to that aroma that you're smelling.

A lot of differences in sensitivity-- genders, ages-- and a lot of them in that there's a great deal of variation within all of those categories. This is looking at differences in sensitivities to different aromas among males and females. So along the bottom we have the number of sessions, and then the number of correct is on the y-axis. Females are the open circles, and what the triggers are showing is that women are more sensitive than men.

And that's been shown in a number of different studies on the whole. Of course there's variation. You're going to have men that are very sensitive, and some women that are not very sensitive. But if you take the population as a whole, you'll find that women are generally more sensitive.

They also become more sensitive to aromas with repeat exposure, and they've also done some studies where they've shown that women are more sensitive to certain types of aromas. So women tend to be more sensitive to floral and food related aromas, whereas men are more sensitive to petroleum related aromas. I'm just reciting the study. No value [INAUDIBLE] on that. But that there are differences among genders, and again, you're going to find differences with individuals.

This looks at identification of odors in a mixture. And this is why I was saying previously not to kind of get hung up on coming up with too many terms, because it is very difficult to do. So on this figure, we have along the x-axis the number of odorants ranging from one to five. So there was either one odorant present-- two, three, four, or five. So the final solution had five different aromas present in the wine. And then along the y-axis, we have percent correct. The expert tasters are shown in the open circle, and then the novice tasters are shown in the squares, and then the semi experienced tasters are shown in the middle with the open squares.

So when we look at one odor-- if one odorant is present, what you can see is that expert tasters-- they can pick it out. They know what's going on. 100% correct or so. Our novice tasters are about 80% correct, so it just depends who you ask.

As we go up to two aromas, we see a big change in the novice tasters. Now we're down to about 40%. So it's a lot more difficult for these novice tasters, when there's another competing aroma present, to be able to tell what those two aromas are. It's a little bit more difficult for the experts, but they're still able to do it. They're about 80% correct. And then you can follow the trends. By the time we hit four aromas, our novice tasters are just-- few of them are getting it. And then our expert tasters are a little bit under 20%.

So we're seeing the same trends for all of them. By the time we hit five aromas that are present in that wine, it's very difficult to get them all correct. Of course, you're going to have some people who do get them all correct. So our experts are maybe around 5%, and then almost none of the novice tasters were able to pick them out.

So what this shows is that it's difficult to pick out aromas. Not saying that can't do it, but it's difficult to do. And it also of course depends on the intensity of these different aromas.

This is looking at different aromas, and how some are easier or harder than others to identify. So you can see along the bottom we've got the different aromas, and then along the side axis, we have the percentage of people who were correct. And what you can see is some aromas are easier. Lemon's easier for people to get. Black pepper is easier for people to get. So it's easier

for some-- Cinnamon-- but it's easier for some of these very distinctive aromas for people to be able to successfully identify them.

Some other aromas are harder. Guava's harder for people. Lilies-- the aroma of floral is harder for people. Black currant. So some of these aromas-- they're harder to pick out because of the concentration that may be present because of the background that's present in the wine, and they outcompete. So it's hard to pick out maybe raspberry unless it's at a high enough concentration, because of the matrix of the wine. What else is going on in the wine.

So it's going to be more or less difficult, depending on the aroma, and depending on the concentration, and depending on the person. So if someone has never smelled orange blossom before. Well, they're not going be able to identify that in the wine, because they never smelled it before. They have to learn to identify it. So there's certainly a learning effect that goes along with being able to identify these aromas.

Now, this is looking at the detection of compounds alone and in a mixture. So it kinds of goes similarly. So we've got three compounds along the x-axis, and then alone is in the black box, and then when it's kind of stripy, that's in the mixture. So when it's present in a mixture with other compounds. And what we see for all of these compounds is that alone it takes a lot lower concentration for the person to be able to identify the compound is there, while on the mixture, it increases. So say for 1-butynol-- alone, it's about 0.5 parts per million to be able to tell if the compound is present; whereas in a mixture, you need a higher concentration of it to be present.

So it depends on the complexity of these wines-- the concentrations that are going to be impactful. There's a lot of compounds. You might need a higher concentration of some of these compounds in order to tell that they're there-- in order to outcompete-- in order to really tell if they're there. So let's say raspberry.

But then there's the point of that it might be raspberry present, and just kind of contributing to the overall background and the overall complexity of the wine, but you may not be able to pick it out exactly. And that's also another issue-- it's whether you can pick it out and tell, hey, this is present, versus hey, it's just there contributing to the background nature.

And that's the idea of threshold. And so I'll talk about this now. This is the concentration below which a compound is not detectable, and above which you can really detect it's presence. So the way that we test this is we give-- we have people come in. They sit down. We give them three glasses of wine. Glass one had no compound in it, and then the other two glasses have a lower concentration of that particular compound. Sorry-- two of them have no compounds; one of them has the test compound in a low concentration.

You switch up those three glasses, give them to someone, and say, hey, can you pick out which one is different? And so the person sniffs or tastes. Goes through, sniffs one, sniffs two, sniffs three. Hey, I think this one is different. And they may or may not be correct.

Those wines are taken away, and then they're presented with the next step. It's a slightly higher concentration of that same compound. Now can you tell which one is different? And you think, oh, I still can't really tell, but I'll guess this one.

Those are taken away, and then you present them with the third set of concentration. Now it's an even higher concentration. Now you smell them, and you say, wow, I can really tell. I think it's this one right here.

And then those are taken away, and now you're getting even higher concentrations. You're presented with another three glasses. You sniff through them, and now you can say, wow, I can tell it's this one, and I can tell it's raspberry.

So what that is is you're transitioning through your threshold levels. At the very bottom at that very first step that you're given, you can say, wow, I can't tell the difference between these three. They all taste just like the blank. Nothing. Can't pick up anything.

As you're presented with higher concentrations, you transition over the sensation threshold where you're saying, OK, there's something there, but I just can't put my finger on it. But I can tell which one is different. I just can't actually name what it is.

As you continue on to the higher concentrations, you exceed the perception threshold, and now you can say, yes, there is definitely a raspberry aroma to this wine.

So those are different questions. I'll show you other definitions. We've got the absolute threshold, which is the lowest concentration is capable of stimulating a response. It's the lowest concentration at which point you say there's something there. Recognition threshold-- that's the concentration at which you can actually identify what the aroma is, and this is always higher than the absolute. So the absolute-- you're just saying that something's there. Recognition-- now you're saying, OK, this is what's there. And then finally terminal threshold-- this is the concentration above which there is no increase in perceived intensity.

So there's a point at which we're done responding. We can only respond so much. So there's a point at which you're not going to be able to respond anymore, and that's the terminal threshold.

So these are all terms that are important to understand and at least keep in mind, especially when we're talking about wine faults. Because it does depend on the concentration present. Some of these wine faults, at low concentrations they confer x the wine, but when they go up to higher concentration-- when they get into the recognition threshold-- they're dreadful, and they make the wine undrinkable.

So there's a concentration part to it as well. So we'll talk about that when we talk about Brettanomyces. Maybe at a small concentration, some people are OK with it-- it adds

complexity to the wine. But if it's high enough, it's not pleasant. Most people don't find it a pleasant experience. So those are some terms to remember when we talk about threshold.

So what influences threshold? Well, a lot of different things. I guess leading off, we have genetic differences among all of us. And this is related to our olfactory receptor genes. So that's a big difference, regardless. We've got these genetic differences.

Other variables that they've being able to identify are age differences. So younger folks tend to be more sensitive. Also as we get older, there tend to be more issues with short term memory. There's also a lot of variation here.

Generally-- we've covered that a little bit with the male and the female. Consumption frequency-- so how frequently you're consuming wine. And that helps build up your experience. How experienced are you with wine, and perceiving different aromas. And if you really-- each time you try wine, you deconstruct it and see what compounds-- what are the overwhelming aromas in there. And you're studying it a little bit, and you get better at it.

Sensory panel experience. This is an issue when you're actually running the sensory panel, is that people who've done sensory panels in the past-- they tend to be more experienced. They know what to expect, and so they tend to give higher results.

Now, wine itself-- what you're actually testing the threshold in is also very important, and we'll see that when we talk about some of these wine s. Wine style, wine composition, the tannin level, the ethanol level, how many other compounds are present in the wine, and then wine presentation-- so the serving temperature of the wine. And I'll talk about the effect of that in webinar three.

Also in the previous webinar, we talked about the effect of wine glass shape. So we want have a tulip shaped glass that is bulbous at the bottom and tends to close in at the top in order to try to funnel those aromas to our nose. And there was a figure that I showed that there was a wine glass that sort of flared out like this, and the odor perception was decreased. So wine presentation does make a difference, whether it's what type of wine glass you have, and then of course also the serving temperature makes a big difference too.

So a lot of these-- it is very particular to how the study is conducted-- the threshold that is determined.

Now, this is looking at threshold values of 2,4,6-trichloroanisole in Sauvignon blanc. So this is the compound that contributes to [INAUDIBLE], and Sauvignon blanc was the matrix that they used. And what we see-- these are just people plotted along on the bottom. So this is just how many people fell into each of these different categories.

And as you look at the far left-- as you work your way to the right-- so the people on the far left with one or 2.5-- that's how much concentration had to be present before they could tell that

the compound was there. So the people on the left hand side are much more sensitive; people on the right hand side are less sensitive to the compound.

You'll always find that when you're running threshold studies-- some people are more or less sensitive. You can have right tailing, meaning that you have a greater population who are less sensitive.

And this is just for individual compounds, so you may be super sensitive to one compound, but not sensitive to another compound. It depends on the compound. So there's a lot of individual variation.

And this is looking at the development of wine fragrance. So this is [INAUDIBLE] to beyond threshold. But this is kind of a way that you can look at how-- or this is a plot of how wine has opened up, or how it changes or evolves over time. So on the x-axis we have the time, and then we've got the intensity.

So initially you've got an opening. It takes a little bit. And then you start getting these floral aromas. It'll hint of kerosene. You start to develop more of the complexity, and then how long the wine takes to sort of fade out.

And so we're actually doing studies on wine finish, and I'll show that you in webinar three-- how different aromas linger longer. And how some of them tend to open up earlier. And that has to do with the structure of the compound, and also has to do with the matrix of the wine.

So some compounds-- some aromas you're going to get early, like sort of the floral notes. Some of them may tend to linger, and some of them may not come out later until after a number of minutes. So that tends to be the development of wine fragrance. So as I mentioned before, this is another snippet of the tasting process. So this is determination of odor in glass.

Now, when we're looking at color of the wines, what we want to do is turn that wine at a 45 degree angle to create a gradation of color, have it against a white background, and look at the color, and then make decisions from there and evaluations from there.

Once you've done that, you can take your wine glass, and what you want to do is swirl the wine. And we're swirling the wine for a number of reasons. One is that we want to release those small [INAUDIBLE] aroma compounds that are trapped within the wine. By swirling it, you're allowing them to release. Ideally, you'd have a cap on the top of your wine glass. We use Petri dishes, but you can also use an inverted glass. By inverting that glass and by swirling, you're allowing those aroma compounds to volatize-- to come out of the wine-- but then sit in the headspace above it. And then this is the top of the wine glass. So they get kind of trapped in this space here, and when you pull the lid off, you're hit with a nice big concentration of aromas.

So swirling the glass is good. Two to three short, sharp sniffs. You remember to drive that air over the olfactory epithelium. So 2% to 3% of the air as normally sitting-- just sitting right now breathing in-- about 20% when you really take big sniffs and drive the air over that area. And then you want to rest for about 30 seconds, and maybe take some notes, and then return for more sniffs.

Sensitivity does diminish with repeated sniffing. By repeated I mean if you sniff 8, ten, 12 times-- you're not going to get new information. A couple of reasons for that. One is that our olfactory receptors become adapted, and as before, the adaptation means that we get used to a new level of something, and we fail to respond to increasing concentration. So from a simple standpoint, if you go to someone's house who is cooking onions or cooking garlic-- you walk in, and you think, wow, this is garlicky. But then in a few minutes, you becomes adapted to it, and it doesn't register anymore.

Same case is when you're actually smelling wine. So you don't want to become adapted. You want to take a break, and de-adapt, and kind of let everything come back down; let your background reset, and then go back.

It also gives time for the wine headspace to build up again. Because you've just-- you've pulled off the lid; you've pulled out all those aroma compounds that were in there. And so you leave a little bit of time. Swirl it again and let those aroma compounds leave the wine and come back into that headspace, because you do have an equilibrium between the wine and the space above it.

So two reasons why you want to wait-- and important to remember that sensitivity diminishes with repeated sniffing. And then we've got little cartoon on the right that's just-- "I detect blackberries, currants, and just a hint of tobacco." And you can see that the waiter's smoking. So that's kind of fun.

This is a nice little chart that I found. It's talking about smellable faults. So when we're actually smelling aromas, we're more likely to detect these aromas on our nose and on the palate. Even though-- OK, so our mouth is warmer, and we do get the release of some of these-- we tend to get more compounds that we might perceive, and we also perceive less depending on the compound.

But there is a complexity that comes when you've got a product in your mouth. You've got the tannins, you've got alcohol-- you have all these other things that are in there, whether it's sweet or if it's sour. So you do tend to have all this extra noise that is added or contributing and making it difficult to pick up some of these aromas.

So the fault I'm going to talk to you about today are smellable, meaning that you can actually smell them in the wine glass. Some of them that I'll talk to you about next webinar are ones that you would perceive once the product's in your mouth.

What I wanted to show here is that it's all kind of relative what you consider to be a flaw. So this is the good, the bad, the ugly, and it depends. It depends what kind of wine you're having it in.

So looking under the it depends. If we've got cat pee-- it's under vegetative, but that is described as an attribute in Sauvignon blanc, which isn't necessarily bad. But if you had it in another wine-- if you had it in a Semillon, yeah, it probably wouldn't be that great. So depends on the wine. It depends on the context in which you are having it.

Barnyard and Brettanomyces-- maybe a small concentration in a big red wine. But if you find it in another type of wine, it is not cool. So it does depend.

And there's work that I did with the diesel [INAUDIBLE]. And that is a compound-- TDN-- that's found in Riesling. And so I was on research sabbatical in New Zealand about two years ago, and so I did work there where I determine determined the threshold value of this compound. And so at what point can people tell from not being able to tell presence to being able to tell something's up with this wine. And so I determined that concentration in New Zealand.

I also determined the point at which people liked the wine, or would reject the wine. That's a different question. One question is saying, can you tell if there's a difference? The other question is, do you like one or the other? Different question.

So we did research on both of those topics. Came back here and did the same thing back in Poland. And what I found was the threshold value-- it was the same. New Zealand population and the Poland population. Threshold concentration was not significantly different, but the preference was. People in New Zealand prefer-- they would accept a wine that had this sort of diesel aroma in it up to a higher concentration than those in Poland would-- than those in the US population. So there are differences among populations too.

And then you can look at the other things that are found in this little wheel as we have. So there's the bad that tend to be bad. They're just bad. It's really hard to put a different spin on them. Then we've got the good ones, and then we've got the ugly ones. So it's just kind of a fun little wheel that there is.

Now, looking at detection of odors in wine-- these are off aromas-- what this figure is meant to convey is that it varies based on whether it's white wine or a red wine. So we've got our off aromas along the bottom. We have ethyl acetate, which is nail polish remover, oxidation, we have vinegar, we have buttery, which isn't bad in small concentrations-- like in a Chardonnay-- but it is off putting at high concentration; and then we've got TCA, which is cork taint.

And so what we find generally is that it's harder for people to tell that these aromas are present in white wine. So you can see here that there's a smaller percentage of people who were correct when they were identifying it in the red wine. It's just harder, because it's a lot more difficult. There's a lot of other things that are outcompeting in the red wine. So it's more

difficult to tell if there's a fault in the red wine versus the white wine if you're comparing the same faults along the bottom.

And some of the faults-- I just see a comment there-- some of these faults I will be going over later on in a couple more slides. I hope to touch on them a little bit. And if you have further questions, I really am happy to answer. You email and then I can-- either we can do this offline or I can do it at the start of webinar three. I want to answer your questions.

Now this is a figure looking at detection of faults in wine. So it's looking at how easy or how difficult some things are. And some of the faults are harder or easier to detect, and that's really what it's showing here-- is that it is sometimes hard to pick up flaws, so not to be too hard on yourself; that it depends on the flaw that you're looking at.

And I just got this in the mail two days ago. It's the defects wheel. So it's a lot of information. It's got two sides. It's got the red side, which is kind of pink, and then it's got the white side, which is kind of a light green. And what it does is if you work the wheel-- and I would put a copy in, but I just received it.

So the outermost part of the wheel, you have-- let's go to the mouse urine spoke. So we've got mouse urine and rancid but. So that's one of the spokes. It tells you the molecule responsible, what it looks like, where it comes from, how does this compound end up in the wine, and then typical concentrations in the wine, and then threshold values. And now you all understand what threshold values are. So that's kind of interesting. So if you've got a wine that you smell and you think, wow, this completely smells like rotten egg, you can go to the rotten egg spoke, and then get some more information about that particular flaw.

So white wine is a little bit different. So you go to the rotten egg section there. It had the possible causes and it has the possible treatments. So this is more of sort of an interest-- say if you're a wine maker, how you can possibly treat the wine-- and then possible prevention. So things a bit more theoretical, but kind of an interesting wheel. So I'll put that over here.

But it's kind of interesting in that if you smell it, it provides that information. The wine aroma wheel as it stands now does not have a spoke for flaws. I mean, there's a chemical area, but it's not-- there isn't a specific area for flaws. There is a wine flavor wheel that was put out by a research group in Australia, and that does have a spoke for flaws, which I quite like. That you have-- I'll bring a copy of that for next time to show if you're interested too.

So there's an awful lot of wheels out there. I think that what we're coming too now. And there's a lot of information. It's meant to help you, but it can get overwhelming.

So now let's talk about some of these wine faults. So these are some of the aromas you might smell. The positive aromas-- those are in the wine aroma wheel that you can look at, and you've got a copy on the slide, but now we're going to talk about flaws. These are the negative things that you might smell in wine.

So first you've got cork taint. This is often described as corked. You might just hear that term. It's described as wet cardboard, musty, or mushroom. And at low concentrations, in confers sort of a flatness. It dulls the typical aromas and the flavor intensity of the wine. So you may not actually be able to put your finger on what it is, but it might just suppress how good the wine could have been. And so you may not actually want to order this wine again. Not that you knew it was corked, but it just wasn't as good as you expected it to be.

So watch out for the low concentration. It dulls the typical aromas, and the flavor intensities that might already be present in that wine. It's a common wine fault-- 2% to 10% of all wine bottles bottled with natural cork, and if you have a screw cap, it's not an issue. So that's one of the big pushes for going to screw caps-- is to do away with this flaw. Do away with the cork taste.

So what happens is that the TCA-- the compound trichloroanisole-- is formed in the cork, and then it migrates into the wine after bottling. And then you've got a little bit of the chemistry here. It develops as a consequence of conversion of chlorophenols to chloroanisole. So you do get the fungal growth on or in the cork. And the conversion could be use of the pentachlorophenol as a wood preservative, or the presence of chlorine-- presence of chlorine being more of a cleaning issue in the winery. Same as the wood preservative-- that compound.

So it can be something that is preventable, but again it's also a compound that we adapt to extremely quickly. So if you're brought or if you order a really good bottle of wine-- or just a bottle of wine in the restaurant-- they bring it out to you, they let you sniff it, and that's what you're selling for here. You're smelling for cork taint. You don't actually need to taste it. You can just sniff it, and you get sufficient information.

It's a compound that again we become adapted to. We become used to it at very low concentrations. So sniff the wine-- two to three short, sharp sniffs, [? then a ?] big swirl-- and then if you smell it, that's it. You might go back and if you sniff it again, you may not think, oh, I didn't smell it. Which may be the case, but more than likely, you've become adapted to this compound-- we become adapted to it extremely quickly. It's a big problem. So if you think you smell it, you likely did. And so send the wine back and then get another bottle.

Now, there was a study that was conducted, and this was done in Australia. And what this person did was looked at cork taint. What he wanted to do was look at consumer rejection threshold-- so the point at which the consumer will reject the wine. And this is the same thing that I did with that diesel compound in Riesling. And then there's a detection threshold-- the point at which the individual could actually detect it was there.

And so what they found was the consumer rejection threshold was 3.1 parts per trillion. That's what [AUDIO OUT]-- parts per trillion, which is one drop of water in 20 Olympic sized swimming pools. That's how much needs to be present before you can tell it was there-- sorry, before you reject the wine.

A detection threshold is even lower, meaning that people-- at 2.1 parts per trillion, they could tell something was wrong with the wine. Couldn't put their finger on it; they could tell something was wrong. At 3.1, then they rejected the wine.

So if maybe you're delivered a wine that has a concentration of 2.5 or right around 2.1, you can tell something's there, but you may not actually reject the wine. And then that's kind of the little grey area that's a bit problematic, because that's the point at which the wine just isn't as good as it should be or could be-- that you're suppressing some of those other positive aromas that might be just kind of doling it and not making it is as good.

So that's looking at cork taint. So something very-- it's a compound that you adapt to very, very quickly. That's the thing to remember there. Very little of it needs to be present for the us to tell that it's there. 3.1 parts per trillion. We We're very, very sensitive to it.

Now let's move on to oxidized. This can be described as a bruised apple or a nutty acetaldehyde off odor. At low concentrations, the wine will have a decreased varietal character. It will just be kind of a flat. So again, you're not getting the best of the wine. You may not be able to tell what's wrong, but it's just not as good as it could have been if it wasn't oxidized.

At high concentrations, it's bitter. It also darkens the color of the wine. And so in white wines, it looks a lot deeper. In red wines, you get a sort of brickish color tint.

You can get an idea of whether the wine is oxidized at that appearance stage. Corked you can't. You do have to smell it. Oxidized, you can look at the wine and get some information, and then confirm it by actually smelling the wine.

You do need to know the style and the vintage of the wine before you come up with the diagnosis of oxidation if you're just looking at the color of the wine. So it depends what wine you're actually trying. So it is part of the complexity of some wines. So if you're having a sherry or Madeira, you would expect it to have some of those oxidized notes, and you'd expect that color. But if you were having a different kind of wine-- if you were having a Sirrah or if you were having a young, white table wine, you wouldn't expect it to have those sort of notes and perhaps that color as well.

So in young table wines it's considered a fault, but as I just said, it is part of the complexity of some wine styles which are intentionally oxidized, like sherry or Madeira. It is part of the typicity of some wines, too-- so some cool climate Chardonnay. So if you don't like oxidized notes, you probably want to stay away from those cool climate Chardonnays.

And that's something we had looked at in the first webinar-- was color differences between cool climate Chardonnays and Chardonnays that were grown in warmer climates. So I guess just something of interest.

Now, oxidation can occur at bottling. You can have bottle thickness-- two big ways. First is bottle thickness. This is due to the introduction of oxygen during the bottling process. So this is a reversible process, but it does leave the wine kind of tasting flat and dull, and that's why you want to leave these newly bottled wines left for about four to six weeks before you drink them. And usually they won't actually put them on the market place anyway.

Secondly, if you store a wine bottle upright, what can happen is that the cork can dry out and then retract back and then allow for the ingress of oxygen, and then you can have oxidation that way too. So if the wine isn't stored correctly on its side-- and what that does is it keeps the cork moist, and so it keeps it expanded into the full neck of the bottle of wine. If it does get dried out it tends to regress and then allows for the ingress of oxygen, and then you can have oxidation.

Now, moving on to rotten eggs. So this is a smell of rotten eggs and sewer, so you wouldn't think it would be positive, but they have found that at low concentrations it can contribute some fruity character. So again, it becomes a question or becomes a point of what is the threshold of this compound. How much of it needs to be present? Can a little bit be there and it be OK? And some of these faults-- that's the case. Is it can be present in small concentrations. However, how do you control that? Especially for Brettanomyces. And we'll talk about that in a couple more slides. But that's very real issue.

So rotten eggs-- these sulfur compounds-- again they can contribute to a fruity if it's present in little concentrations. High concentrations-- you've got rotten eggs and sewer, and that's not something people want to smell.

Due to the presence of hydrogen sulfide. So as I said, at very low concentrations it can be positive. And then we've got the threshold level at 0.9-3 parts per billion. And just relating parts per billion now, one part per billion is a drop of water in 250 chemical drums. Or, if you want to look at it a different way, it's three seconds in one century. That's the concentration that this compound needs to be present before we can tell that it's there.

So these compounds, my goodness-- we're very sensitive to them. Very, very sensitive. And so it's always a challenge coming up with an instrumental way of detecting these compounds, because nothing is more sensitive to the complexities of wine or any aromas than our human nose.

We do adapt out to these compounds very quickly, meaning that we get-- we stopped responding to it. We get a decrease in sensitivity over time. Same as with the cork. You can smell it and think, hey, something's off, but then you go back and smell it again and you've become adapted to it. It can dissipate with mild aeration, meaning kind of swirling the compounds, you can actually have it dissipate.

Some wines are more prone to it than others. So Sirrah, Chardonnay and Riesling are more prone to the aroma than others. Yeast tend to produce it during fermentation if there's an

adequate nitrogen and other yeast nutrients. So it's something that can be addressed at that stage, but definitely the H2S-- hydrogen sulfide-- is produced by the yeast during the fermentation.

So as we move on, now we're talking about sulfur dioxide. This is described as kind of a burnt match, and you have a slight prickling sensation inside your nose. That's called trigeminal stimulation, which will come off in webinar three. But you do kind of get that little tickling inside your nose. At low concentrations-- familiar story-- it masks the varietal aroma and flavor. Your wine just isn't as good as it could be, so at subthreshold concentration. At higher levels, which is above threshold, that's when you get the acid and the chemical character, and you know what's there.

It is widely used in the wine industry as an antimicrobial and an antioxidant, and so it does help prevent other faults. Geranium taint, oxidized, ethyl acetate, vinegar. And we'll talk about ethyl acetate in a moment. But if you use too much, then you have a problem. So bottles may be bottled with excessive amounts.

It can be dissipated by allowing the bottle to air, as I mentioned. You can also have bleaching of red wine. So your red wine might look differently as well. It tends to be a problem in off drying sweeter wines, which may be bottled with more of the sulfur dioxide. What they want to prevent there is any spontaneous fermentation that may occur. Because there is extra sugar-- because it's sweet-- there's a little bit of sugar that still in the wine. Bacteria and yeast can use that as energy and grow. So they want to make sure that they minimize, they limit, they eliminate any microbial growth, and so they may use a little bit too much of the sulfur dioxide. So it may be more of a problem in off dry and sweeter wines.

OK. Acetic acid. I just mentioned this one. Acetic acid is vinegar, so it's very sharply acidic. some irritating odor. It also has a trigeminal stimulation, which means that it provides a little bit of prickling in the nose. So if you've ever just smelled vinegar, or balsamic vinegar, or any type of vinegar , you might get that little prickle in your nose that may make you sneeze. That's because it is a trigeminal stimulate. And so you may get that when you're sniffing a wine that has a lot of accidents acetic acid in it.

It is a component of volatile acidity, along with ethyl acetate, which I'll talk about next. There are established legal limits, which is based on the threshold of this compound. So in the presence of oxygen-- so if there's oxygen present in the system in the wine-- the acetic acid bacteria takes the alcohol that's in the wine, they convert it to acetic acid, which smells like vinegar, and ethyl acetate, which smells like nail polish remover. So you don't want to have the presence of oxygen in your wine. You want to have an airtight environment. So if you have a leaky cork-- you're allowing oxygen to ingress in-- then you have a lot of problems, because otherwise you wouldn't have oxygen there.

The detection and recognition threshold are a lot higher than ethyl acetate. That means it requires a higher concentration of acetic acid in order for us to tell it's present compared to

ethyl acetate. So the concentration is about 0.6 grams per liter, and then you're starting to get to that [INAUDIBLE] sharply acidic.

There is of course variation among individuals, but some people are going to smell and be able to tell it's present out lower concentrations; some people it may take a lot higher concentration. But it certainly is detectable. So it's that kind of vinegar, robust-- and you get the stimulation in your nose; kind of a prickling in your nose as you sniff it.

Now, ethyl acetate is the other half of this. This is nail polish remover. It's a component of volatile acidity along with acetic acid. At low concentrations, this is one of those other ones that may enhance the fruitiness and may lend itself to a little bit of overall complexity. But you're walking a fine line between that and nail polish remover. So at high concentrations it generates an acetone like off odor-- nail polish remover-- and it detracts from the wine. So it's a problem. It's not something you really want to have in your wine.

And there is a lot of variation in the sensitivity of individuals. Some people are not able to smell this, but they're able to smell acetic acid. And then opposite is true. So you've got these two components of volatile acidity, and some people may respond to both of them-- they're really lucky-- and some people may be more or less sensitive to one over the other.

And then volatile acidity in general. So the major component is acetic acid, but you also have ethyl acetate that' present. There's also other acids that lend itself to this. It's due to the presence of wine spoilage yeast or acetic acid bacteria. And these vinegar notes, which you get with the acetic acid, often accompany nail polish notes. And as I've said before, ethyl acetate is detectable at lower concentrations, and some people may be more or less sensitive to one of those compounds over the other.

But, you know, generally seen as negative. Actually, completely seen as negative. Volatile acidity is seen as negative. Ethyl acetate at low concentrations again may add a little bit of that complexity.

I just got distracted by looking at the time.

So vegetative aromas or odors-- either green grassy, herbacious, stemmy, vegetative character-- it depends on the concentrations that are present, as it does. These are caused by the presence of leaf aldehydes, alcohols, and pyrazines. It may be desirable, these vegetative odors, in some Bordeaux red and Sauvignon blanc, and Semillon. Those are considered to be part of the typicity of the wine. Cabernet Sauvignon-- you want some vegetative odors.

You don't want too many of them, though. And there are some vineyards prevention tips there, and it has know increasing sun exposure, excessive watering, that type of thing. But really the thing to keep in mind here is that it depends on the wine that you're having it in. It depends on the context of the wine, and also depends on the concentration. And if you're not really keen

on that vegetative odors, you'd probably stay away from the ones that have higher concentration.

So it can be indicative of fruit not being ripe. There's a point at which it's considered to be a flaw. The exact concentration of that isn't really known, because there are so many factors that would influence that. But if it's something that you feel is detracting from the wine and not really contributing to it, at least to you individually, you would consider that to be a flaw.

And then finally we're going to finish up with Brettanomyces. This is described as sort of barnyard, Bandaid, fecal, mousy, wet dog. And very recently there's been a development of a Brettanomyces wheel, and I'll show you that in the next slide. It's a very controversial wine flaw.

So at low concentrations, someone make me feel that it adds complexity. So they feel like, oh, you know, it makes it a bit more interesting. It's associated with classic burgundy and Bordeaux red, and so you might have an expectation that there's going to be a little bit of the reddy character to it.

The compounds-- we've got a few compounds listed there. There's a huge host of compounds that are associated with it, and even if I took all those compounds and mixed them together, it still wouldn't be exactly Brettanomyces. It's very hard-- it's almost impossible to recreate this in the lab. It's very complex. There are a lot of compounds that contribute to this.

Why it's described differently under different cases depends on the strain of Brettanomyces that is present. It also depends on what else is going on in the wine-- depends on the other matrix components in the wine. It is associated with aromas and flavors that are contributed by wild yeasts from Brettanomyces and Dekkera genus, and it's been isolated from many sources within the winery. It's extremely difficult to get rid of once it's in the winery.

Why in red wine? Because the red wine contains a precursor that the Brettanomyces need to produce these compounds that are listed right there.

Now, the wine Brettanomyces wheel-- I just showed you a little spoke of it-- this is very recent. And so what they did to develop this wheel-- they had 83 strains inside of UC Davis-- they had 83 strains of Brettanomyces. Of those, 17 were considered to be positive. If they were positive, they were described as sort of floral and spicy. Five of them were considered to be negative, and they were described in the rotten putrid category, which you can kind of see there. And then some of them really had no sensory impact at all.

So that's how this Brettanomyces wheel was developed. So some of them, again, they had no sensory impact whatsoever.

So the wheel divides Brettanomyces into main categories such as animal, you've got the putrid, you've got the chemical solvent-- you can kind of take a look there. There are a lot of different categories, but it's all just for Brettanomyces.

And it works the same as the other wheels do in that the innermost part is the most general, and then it scoots it's way out-- as it gets further out in the wheel, it becomes more specific. And then the danger is that, oh, well maybe some people like this. Maybe we want to encourage this in the wine.

And I guess bottom line-- it's really hard to control Brettanomyces in the winery, so even if you say, OK, I'm going to have this little section devoted to wines that I'm going to encourage Brettanomyces character, it can easily be contaminated, and it can easily become a really big problem. So it may be something that you don't want to get into. It could just end up in a big old disaster. But understanding that some people do like a little bit of Brettanomyces. They do feel it adds some complexity to their wine.

So that is all for me for today. I'd like to thank you for your attention. This is has been introduction to wine tasting webinar two about aromas, and webinar three I'll be talking about flavors and mouthfeel and taste. Thank you very much.

OK, so just responding to some of the questions. The earlier one I'm going to have to look for faults when I go wine tasting. It's good to have some information, at least. I mean, something to kind of think about. If you smell something, you can kind of say now, wow, that really-- maybe that was this fault.

Does using an artificial cork prevent cork taint? Yes, it does. But what I've found is that some of these artificial corks-- they don't have the best feel, and I've had some issues with oxidation with some of the artificial corks.

So that is why I found a wine that made me think of-- is that-- wow. I don't know what to say about that. That sounds-- I was with you up to peppery bacon, but you kind of lost me at Bandaid. Yeah, , some of those compounds, they just contribute really interesting notes to the wine. And so it does depend on the concentration. And then what that slight about the aroma wheel-- the breadth of the wheel shows-- is it depends on the strain that's present; the compounds-- whether they're positive or negative, and then within the positive negative. I was just struck by how many were defined as positive within the Brettanomyces. 17 strains as opposed to five that were defined or described by the panel as negative. I would have thought it would be the other way around. But certainly Brettanomyces lends something.

OK, well thank you very much. I'm glad I had a live audience. It was really nice. So hopefully you can attend webinar three.

AUDIENCE: [INAUDIBLE]

CAROLYN ROSS: I'll have to check. I can email the wine aroma wheel because it was printed in a journal, but the other one you have to purchase, so I'm not able to do that. Otherwise I would love to. I can give information on how to order the other wheel if anyone's interested. Maybe I'll just do that.

AUDIENCE: [INAUDIBLE]

CAROLYN ROSS: Oh, you found it online. Good on you. Yeah.

CORY: One last time, thanks for joining us today, guys, and I hope you have a wonderful afternoon.