PHARMACOGNOSY AND PHYTOCHEMISTRY

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Week 9

Lecture 42

Resins containing drugs

Hello everyone, and welcome to week 9 of the NPTEL course in pharmacognosy and phytochemistry. In the previous session, we saw what resins are. So just to recollect, resins are substances produced by plants. Sometimes physiologically, sometimes as a result of injury, they differ from gums and mucilages in that they are not carbohydrates but more complex polar compounds, which are generally polymerized from terpenes and are often oxidative degradation products of the same. So let's see some examples of resins in this session. In this session, we will discuss two resins: colophony, which comes from pine, and benzoin, which comes from the Styrax species. Now, colophony is a resinous compound that does not contain a combination, whereas benzoin is categorized as a balsam—that is, it is rich in balsamic acids. So let's start with colophony. Colophony is actually a residue. As you can see here, it's a nice transparent to translucent solid, depending on how old the sample is. It's a yellow-amber-colored solid, which is transparent to translucent and is obtained from pine trees.

So, basically, when you say colophony, initially it's an oleoresin obtained from pine trees. And then, when you distill the oil from the oleoresin, once the oil is removed, you are left with the plain resin. That is precisely what colophony is. The oleoresin is often referred to as rosin. Now, all of this is obtained from the pine species belonging to the Pinaceae family, but the majority of the resin comes from Pinus palustris. Now, coniferous or pine forests geographically occur in North America, Northern Europe, and in the Himalayan belt of India and Pakistan. So that's chiefly where you get your pine resin from. Now, you get two types of pine resin.

One resin which is called wood rosin. So, what is done is you might have seen sometimes during the Christmas season when the coniferous trees are cut off; you get a stump. There is some resin which is exuded from the wood part of it and that is what is referred to as wood rosin Wood rosin is mostly obtained from southern pine stems, whereas gum rosin is generally obtained when you make external incisions—when the tree is not cut directly, but tiny incisions are made on but tiny incisions are made on the external surface and then from that continually you keep on Eluting what is called the resinous exudate from this plant. So mostly, this is done from pine species such as Pinus palustris and Pinus caribaea trees. Now, let's see how we prepare it.

Now, for pine trees, generally mature trees are taken. And these mature trees are often injured. Now, you will ask, if colophony or pine resin is a normal physiological resin, why are the trees injured? It is said that when you injure a pine tree more and more or the resin yield goes on increasing.

So injury increases the amount of resin which is present and in order to get a good yield people often injure the tree. So the trees are injured enhancing the resin content which is already been present and then you make a slight slit or what is called a sloping cavity. So say for example this is your tree. A sloping cavity is made.

And as it slopes, what is done is it's slightly put in or made slightly more deeper so that all those resinous ducts are exposed. Now what happens is when the cut is made on a tree trunk, the oleoresin starts exuding out. Now once it starts exuding out, it will stick to the tree. So what people do is imagine something like a blade. So they take a copper or a metal plate and fix inside it.

Now what is going to happen is this is something like a tray. So whatever resin is exuding out will get exuded and will flow down. So you generally keep a vessel or something to collect it if it is in the liquid stage which is initially it happens and later on it solidifies. So you need not keep anything there.

So it solidifies and you get on this metal plates solidified. amount or good amount of oleoresin being accumulated now. This process is continued, and oleoresin is extracted until the autumn season. So, right from winter to autumn season, for many weeks, this resin keeps on exuding and is extracted. Once extracted, what is done is this resin is taken and put in water.

Now, this resin is almost a little bit heavier than water. So it sinks, and then the water is heated. So when the water is heated, as we saw, this process is called hydro distillation. Do you recollect volatile oil? Hydro distillation was one of the methods used to extract the volatiles.

So this oleoresin now is heated in water undergoes hydro distillation distillation. As a result, whatever volatile oil it contains—like turpentine, pinene, terpenol, and so on—

distills off along with the water. What you get in the end is what is called pure resin. So these impurities also, as they loosen up, start floating because they are wood particles.

They don't; wood particles don't sink in. So impurities are skimmed off, and this, on heating, forms a very sticky, adherent mass. So this sticky, adherent mass is separated, dried, and used as what is called colophony. So this colophony, upon preparation or drying, appears as pale yellow to amber, as we just saw, translucent fragments. Now, if you go on heating it, you will see that these are solids which are polymeric in nature, something like plastic.

So what happens when you heat plastic? It kind of melts and fuses. You will see a very similar behavior with colophony. Now, because it is a what to call it as a polypropanoidal compound or it's a resinous compound, it eventually burns at 100 degrees Celsius, initially melts, fuses and burns with a very smoky carbonaceous film. So this is very typical of resinous compounds and what happens is if at all you tend to heat it in presence of water.

In the presence of water because of the oil content or because of the resinous content which is insoluble in water it forms a little milky white solution. So this is also something which is very typical to pine resin. Now when you take crude rosin Crude rosin is already containing oil.

Now, this oil imparts more softness to the rosin. Now, because of this more soft as compared to your colophony, it melts to a very soft, nice mass, very soft like your dough and fuses and forms a sticky mass like a film. So you can actually take a spatula and spread it across. So it forms that soft kind of mass and because of presence of oil it has a turpentine like odor.

Now this colophony is rich in acids. Basically your turpinaceous acids or when we classified it we called it as resin acids. So colophony is very rich in resin acids and as a result if you titrate it you will get a very high acid number. So for this particular resin the acid number should not be less than 150. If the acid number is less than 150 that indicates colophony.

The resin acids are missing and something else which might be more synthetic is added and that might be an indicative of adulteration. In terms of its density it is just little heavier than that of water and as a result it sinks. Now, taking into account its polymeric nature, you will see that this is more towards the lipophilic side, not towards the water soluble or to the polar side.

And as a result, it dissolves properly in your ethanol, benzene, ether, that is your diethyl ether. Glacial acetic acid which is organic in nature compared to your acetic acid. It disperses very well in oils and it dissolves nicely in caustic alkalis. The reason caustic alkalis are aqueous but they are basic in nature. When you see this particular component of resin it is rich in acids.

So these acids react with bases to form salt and that imparts a very nice solubility in caustic alkalis. But when you take an example of glacial acetic acid, the solubility is predominantly due to the organic nature of glacial acetic acid and not due to its acidity. Now coming to the chemical composition, the chemical composition of your pine resin that is your colophony is mainly attributed to acids

or often referred to as resin acids. A good example of resin acid is your abietic acid. Now you will see a few other acids which are very similar here. So if you see abietic acid, If you see your palustric acid and if you see your neoabietic acid, they are very similar in structure.

But what is the little or subtle difference between the two is the placement of the double bonds, which is slightly different in all three, whereas the functionalities or functional group remains nearly the same. So it's an interesting phenomenon to be observed. So what happens is, so you have what is called as pimeric acid and palustric acid.

So pimeric acid and palustric acid are chief acids which are present in the raw resin. We often refer to that as rosin or oleoresin. So but when you heat it, remember in the processing we heated it. So when you heat it for the process of removal of oil, it is said they undergo rearrangement. So your pimeric, levopimaric acid, palustric acid all undergo rearrangement.

Now why am I emphasizing on this? So if you see the abietic acid content of raw resin. That is rosin, abietic acid is present just to the extent of 7%. Whereas if you see a pimeric, levopimaric or palustric acid, together they make up more than like 50% of the resin. Now after steam distillation, this undergoes rearrangement.

They are structurally very similar. So what has to change there is just the placement of double bonds. So after steam distillation, there's a lot of rearrangement happening and after steam distillation, all your pimeric acid, leopimaric acid, palustric acid interchange and what is going to happen is your abietic acid. concentration changes from 7% to 40% whereas your pimaric acid concentration changes from 40%

and goes down to as low as 5%. So, abietic acid is born during the process of steam distillation at the expense of pimeric acid. Apart from that, you have your saponic acid, dehydroabietic acid, dihydroabietic acid and other abietic acid derivatives. So all of these acids put together are classified or called as your resin acids and they make up more than 90% of the weight of resin.

Now apart from that the other part of resin is like a sticky matter or you know inert long chain polymerized matter which is generally thought to be very unreactive. Now not only that if you take just pure abietic acid if you heat it to 300 degree Celsius your abietic acid undergoes further rearrangement to form what is called as neobietic acid as shown here.

You can see a little transformation in the double bond. This switches to here and this switches to here. So it's like this is this goes here and this goes here. So this is what happens when you heat it and from your pimaric acid, first abietic acid is born, heat it further. From abietic acid, you will get your neoabietic acid.

Apart from that, it also contains a little bit of what is called as unsaponifiable matter, which is rich in hydrocarbons and high molecular weight alcohols. Now coming to a chemical test, because it contains mostly a resin acid, it gives you a test very peculiar to this resin. Now when we previously sought examples of different class of compounds such as alkaloids, flavonoids or anthraquinones, We had typical distinguishing tests like Borntragers test for anthraquinones or dragendorff test for alkaloids.

If you see resins, there is no specific test or there is no test which can be generalized to all resin classes. So here, depending upon what class they contain, what functionalities they contain, every resin example will have its own unique characteristic chemical test. So for pine resin, what you can do is take the colophony resin, just triturate it, powder it, and dissolve it in acetic anhydride and sulfuric acid.

You will see a good purple coloration because of the presence of terpenoidal compounds. Not only that, because of the presence of resin acids, if you take this colophony powder, disperse it, and nicely dissolve it in alcohol, it solubilizes. Treat it with your normal litmus paper; you will see that your litmus, that is your blue litmus, will get converted into red, indicating its acidity.

Now, there's one test which is very specific for colophony, and that is what is called your cupric acetate test. Now, what is done in this case is you take your colophony and extract it with your pet ether. Most of your resin acids get extracted in your petroleum ether. Generally, the 60-80 fraction, that is the fraction of petroleum ether which boils between 60 degrees Celsius to 80 degrees Celsius, is what is taken.

Now, solubilize it well. and if you want it gently warm it but don't heat it because it's a very low boiling organic solvent that you're taking okay if you're heating, don't use direct flame; just use a mild water bath or gentle heat. So once you've done this, you can filter it, take the petroleum ether layer, and to that, you will add your 0.1 percent aqueous cupric acetate solution.

Now when you add that what is going to happen is the copper in that solution is going to react with abietic acid and resin acids, and as a result, this copper is absorbed by this to form what are called cupric salts. So you will get your cupric salt of abietic acid, which shows a typical emerald green color, unlike cupric acetate, which has more of a bluish coloration.

So, the presence of an emerald green coloration indicates the presence of abietic acid, and that is how you confirm the sample given to you is colophony. Now, where do you apply all this? Colophony, being a very piceous resin, forms nice films—stiff films, to be more precise. And as a result, it is used in plasters.

It is used in ointments wherever you want adhesion; you get it there. So even in your wax-based depilatory, where you want a good adhesive effect. Or even in adhesive plasters, it is used. It is used in printing inks where you want to have low viscosity, varnishes, sealants, linoleum, or even as an interesting ingredient in soldering flux where you want to

clean the other debris and wash it out. So the soldering flux formula also contains a little bit of your pine resin. Apart from that when you want water repellent thermoplastic floor tiles this resin has been molted, dissolved in solvent it gives you a nice film over the tiles to create your thermoplastic floor. Not only that, it's used in cements and soaps because we saw its acid reacts with alkali to give you soap.

Wood polishes for its film-forming properties. It's used in paper sizing solutions. It's used in plastics and even fireworks because it gives you a waterproof and a very tight binding for the plastic. material or the explosive material it is used to even waterproof your papers or paperwork such as cardboards and in a pharmacy it is more used as a stimulant and diuretic even for the people those who are interested in music

if you know the violin strings they are made uh those they are made up of or especially the bow if you go to see they are made up of horse hair So for that horsehair to give it a good friction so that the metal wire can nicely make sound with it. It is often treated with your rosin. So even your violin people treat the horsehair bow with rosin and use it for playing instruments.

Now let's move on to the second drug and that's your balsamic drug and that's your benzoin. Now there are two type of samples which are available in market when it comes to benzoin. One is the Sumatra benzoin and one is the Siam benzoin. As the name indicates Sumatra benzoin comes from the Sumatra province which is located more in Indonesia. Whereas Siam is located in Thailand.

So there is a little species difference between these two plants. So Sumatra Benzoin is obtained from the trees that is from *Styrex Benzoin* and from *Styrex Paralynonaris*. Whereas your Siam benzoin is obtained from your Styrax tonkinensis. Both of them are Styresia family member. But the difference is the speciation that has occurred between your Indonesian plants as well as the Thai plants.

So geographically, Sumatra benzoin is found in the Indonesian belt. That is your Sumatra, your Java, and Borneo islands. Whereas Siam benzoin occurs in the little Thai area that is Thailand, Vietnam and some cases even in Laos. So if you see both of these benzoins, you actually have what are called benzoin forests. That means the benzoin trees are specifically cultivated to get this balsam.

So in the Indonesia or even in the Siam province in Thailand, these trees are abundantly cultivated. Now they are cultivated, and right from the age of 8 years till, you know, like 20-25 years, they give you a good amount of resin. So these plants are allowed to grow to more than 8 years old, and once they are more than 8 years old, what is done is, you know, a small triangular deep incision is made into the bark.

Now we saw earlier that the pine resin was an example of physiological resin whereas when we come to this example benzoin is not a physiological resin—it's a pathological resin. What does it mean? That if the plant is not injured, you will not get the resin. So if you just cut the tree the same day, you will not get it, but if you injure the plant, gradually the

plant will start the process of producing resin. So this plant produces traumatic resiniferous ducts only after you produce an injury to it. So injuries are made in a small triangular formation. Once a triangular formation is done, the little bark is removed off, and then you will see that the plant starts exuding this over a period of time.

Now the initial amount of resin that comes out is a little yellow. So the first crop is yellow. not really white or pristine white. It's a little yellow in color and it appears as a tiny teary material. So it forms blobs or tears.

Now, when you do a second tapping of this plant, one more incision is made. This time, rather than a yellow resin, you will get a milky white resin coming out. That's more of a resin of your comers. Now it is said that throughout its age right from you know like 7 years till as long as you are tapping it on an average a plant might yield somewhere between 1 to even 10 kg of drug.

So that's really profitable and that's the reason this forest are kept. So they go on tapping till the resin no longer is white. So in fact it is said that after multiple tappings the resin starts appearing darker or yellow. So Because it is not a physiological resin, it's pathological resin.

Every time you want to get the resin out of the plant, you have to injure it. So injure it once, then after 5 cm another triangular incision is made. From that you are removing the resin. So once one side of the tree is covered completely with the bruises, they start making bruises on the other side. And once both the sides are covered that plant is left alone.

So that is the time it ceases to produce or produces a really dark color resin which is no longer useful. But more or less it is a habit that all of this resinous material is pulled together, mixed and then dried. Once dried you get in market what is called commercial or balsamic resin. So if you see the Sumatra benzoin, Sumatra benzoin distinctly is more grayish in color. And if you see the internal side, the internal side is little grayish or milky white as compared to the external side.

So they are like variable sizes. They might be big, they might be small. They are translucent, brittle, irregular masses. internally whitish in color externally grayish and a little gritty texture so when you consuming it they are little gritty and little acidous because they contain balsamic acids

so that balsamic taste is very close to that of storax and a very aromatic like a organic taste you get of those balsamic acids now coming to your Siam benzoin Siam benzoin is the one which occurs in the Thai province It is said that as compared to the Indonesian or the Sumatra one, Siam benzoin is more of yellowish brown in color, but internally that's also whitish. If you see the smaller tears, they are much, much darker than the larger chunks.

You know, like if you take them and you start chewing them, they form a little plastic like or chewing gum like masses. So they have a good amount of, you know, what is called as resins or resins that makes it more chewy. As compared to your Sumatra, Siam Benzoin has more nice aromatic or vanilla like fragrance. Now coming down to the chemical constituents. If you see Sumatra Benzoin, Sumatra Benzoin is rich in free balsamic acids.

That is your cinnamic acid and benzoic acid. So cinnamic acid is your phenylpropanoid derivative. You can see here, this is your cinnamic acid. And instead of this, if a COH is attached here, we call it as benzoic acid. So cinnamic acid, benzoic acid totally make up to almost 16%.

And along with them, their ester derivatives make up to little more. Now, going to the major component of Sumatra benzoin, it is said that the major components of Sumatra benzoin come in from terpenes, especially triterpenes belonging to the beta amyrin category. So much so that if you put total terpene put together, the terpenoidal content of benzoin goes to as high as 90%.

So it contains triterpenes such as oleanolic acid derivatives. So you have 19-hydroxyoleanolic acid, 6-hydroxyoleanolic acid. You have esters like cinnamylcinnamate or phenylpropylcinnamate or even the phenylethylene derivatives. Now, coming down to your Siam benzoin, which is the thigh variant, you will see more of esters coming here. So, one particular ester, which is your coniferyl benzoate.

So, what is coniferyl benzoate? So, it is benzoic acid. You can see B. This is the benzoic acid which has formed ester with coniferous alcohol. So coniferous alcohol is now a phenylpropane derivative.

But this time it's not an acid. It's an alcohol. So. Coniferous alcohol plus benzoic acid gives what is called as coniferous benzoate and is the major component of your Siam benzoate.

It also contains benzoic acid, triterpenes, majority your CRS in all and traces of vanillin. Now one point to be noted is both of them contain vanillin that is your aromatic principles of vanilla but in Sumatra benzoin the free acids especially the balsamic acids contain Their aroma and taste is more spicy and as a result it completely masks the vanilla odor. Whereas Siam since most of the balsamic acids are esterified the vanilla aroma becomes more predominant

and as a result your Siam benzoin gives you more of a vanilla like fragrance. A little difference between the two, if you see your biological sources, Sumatra comes from your Styrex benzoin or Styrex paranoeris, whereas your Siam comes from your Styrex tonkinensis. Geographically, this is more predominant, that is Sumatra is more predominant in the Indonesian region, whereas Siam is more predominant in the Thai Vietnam Laos region.

If you see chemical composition, Sumatra is more rich in balsamic acid, especially free balsamic acid and contains your triterpenoidal compounds. Whereas if you see your Siam benzoin, it contains chiefly your esters such as your coniferol benzoate. Now, if you see the alcohol soluble extractive value, it contains. It is little less for Sumatra that is not less than 75% in terms of limits.

Whereas if you see your Siam because it contains coniferol benzoate as a chief one and some other esters on the alcohol soluble content goes to as high as 90%. In terms of appearance, this is a little grayish brown whereas your Siam appears to be yellowish brown. Coming to the chemical test, your simatra benzoin because it is rich in benzoic acids. So when you see your Sumatra benzoin,

what happens is Sumatra benzoin contains chiefly your benzoic acid and cinnamic acid. Now this cinnamic acid will get oxidized in presence of potassium permanganate. Now this will kind of cut it and oxidize it to produce your benzaldeyde. Now benzaldehyde is the compound which is responsible for giving aroma of almonds. So if you get that, you know, like beta almond aroma or benzidehyde aroma,

it is chiefly due to the presence of free cinnamic acid reacting with your potassium permanganate. On the other hand, because your Siam benzoin has your coniferous benzoate as compared to a cinnamic acid, the aroma is hardly there or not so significant. But there's another test that can be used there. So if you take your Siam benzoin and digest it like for five minutes with ether

so that the complete extraction happens, filter it and put the filtrate if you treat it with sulfuric acid. A deep purplish color immediately develops. Now, in Sumatra benzoin, instead of deep purplish, it is more of a red-brown color. So that color change can significantly tell you whether it's Siam or Sumatra. One more test that can be used is something to detect your coniferol benzoate and that's your ferric chloride Now, if you take your benzoin treated with ferric chloride, a green coloration is produced, especially with cyan benzoin, because it's rich in coniferyl benzoate, which reacts with ferric chloride to give a green color complex. Now, Sumatra doesn't have coniferyl benzoate, and as a result, this test is absent or negative for this drug.

Now, one more thing you can try is if you know this balsamic acid, cinnamic acid, or even benzoic acid. They have a good tendency to heat up, sublime, and then, when exposed to a cooler surface, they cool down and crystallize. So if you take your Sumatra benzoin powder, heat it gradually, and keep an inverted funnel that is slightly cooled down, what will happen is the fumes containing cinnamic and benzoic acid will heat up.

They will gradually condense on the inverted funnel, and you will observe tiny crystals on the cool surface. So this is also one thing which you can observe in your Sumatra which will be seen missing in your Siam. Now, coming to the applications, chiefly because of its benzoic acid content, if you see benzoic acid, especially when converted into sodium benzoate, it is a good preservative. So this is an antibacterial agent.

It is used as a topical protectant. In some cases, it is even used in gargles and mouthwashes. Not only that, inhaling the fumes, which contain traces of cinnamic and benzoic acid, is thought to be a good expectorant. So even a gentle whiff of benzoin is given to people suffering from cough and cold to be used as an expectorant.

Not only that, cinnamic acid derivatives have been used as protectants, sunscreen agents, and antimicrobial agents. So they have very good applications as organic sunscreen agent derivatives. Not only that, they also have topical protectants. And yes, definitely, sodium benzoate is abundantly used. And plant-based sodium benzoate is something we look for in most of our cosmetic preparations.

So these are a few applications of benzoin. So today we studied two drugs: colophony and benzoin. Colophony, a good example of resin whereas if you see benzoin, it's a good example of balsam-containing drugs. So if you wish to know more about these two plants, you can refer to these references.

And thank you, everyone, for your patient listening.