PHARMACOGNOSY AND PHYTOCHEMISTRY

Dr.Galvina Pereira

Department Of Pharmaceutical Science and Technology

Institute Of Chemical Technology Mumbai

Week 1

Lecture1

Week 1: Lecture 1: Introduction to Pharmacognosy and Phytochemistry

Hello everyone, and welcome to the NPTEL course on Pharmacognosy and Phytochemistry. I, Galvina Pareira, Assistant Professor at the Institute of Chemical Technology, Mumbai, will guide you deeply through the intricacies of pharmacognosy and phytochemistry. In this particular session, I'll introduce you to the concept of pharmacognosy and phytochemistry, and we'll learn about the scope of it.

But first, let's understand the course. This course is designed with the objective that when you study it, you will be able to understand, appreciate, and evaluate various drugs of natural origin. You will be able to understand them with respect to their sources, with respect to the compounds they contain, which are called phytochemicals, and how to apply these drugs, as well as where these drugs find their applications. That's the main objective. After completing this course, you will be able to classify drugs of natural origin based on the compounds they contain. You will also understand their sources, properties of compounds, applications, and different classes of phytochemicals found in these plants. Towards the end of the course, we will also study the methods to evaluate them, which is very essential.

Ensure the quality of the drug. So, evaluation methods, understanding of the plants, and classification of drugs based on the phytoconstituents is what we basically focus this course on. To start with, what is pharmacognosy? Now, let's start with a little historic time.

Pharmacognosy didn't start on a particular date. So, if you see us as Homo sapiens, as humans, we started exploring nature for our food and our needs. And that's where we started consuming plants. Now, definitely many of these plants make up for our food needs.

But while consuming some of these plants, some proved fatal. That is, they took the lives of people. But some of these plants, humans observed, were able to change lives. Their physiology changed something in them or gave some reaction. Some of these plants were hallucinogens; some caused you to go to sleep.

We call them sedatives, and some of these plants help to kill the pain. We call them analgesics. So, man in his search for food also came across or stumbled upon different plants with different therapeutic applications. And this was slowly monitored as evolution happened. And this bank of plants, which humans knew had medicinal applications, grew.

So we study them in this field. We call it pharmacognosy. So pharmacognosy basically is derived from a Greek word, which is 'pharmakon,' meaning a drug, and 'Gignosco,' meaning to gain knowledge. So you gain knowledge of a drug.

This was attributed as early as 1815 by C.A. Seydler, who gave us the word 'Pharmacognosy.' But, as I said, the evolution or that bank of plants or products with medicinal applications has been happening since time immemorial. You know, time immemorial, you can say.

So Wallace explained pharmacognosy as a distinct department of pharmaceutical sciences. Which deals with the study of structural, physical, chemical, or sensory attributes or characteristics. Now this could be of crude drugs which are of animal origin, vegetable, mineral, or nowadays even microbial origin. And this includes the whole process, including their history, cultivation, collection, as well as application. A recent definition of pharmacognosy is given by the American Society of Pharmacognosy,

which defines pharmacognosy as the study of physical, chemical, biochemical, or even biological properties of drugs or drug substances which are obtained from them, as well

as potential drugs. They might not have been right now categorized as drugs or drug substances of natural origin which have been used to alleviate disease disorders or which have been used to search for new drugs from natural sources.

So, not sounding verbatim, but what you need to know is pharmacognosy is basically all the studies that you need to do for understanding drugs of natural origin, including their physical, chemical, structural properties, attributes, origin, history—everything included. Now, when we go to phytochemistry, phytochemistry deals with the molecules present in plants. So, if you specifically say phytochemistry, it means the chemicals that are present in plants.

So phytochemistry will focus more on isolation, what structures this compound have, from where they have been biosynthesized, what function or what role they play in plants and And this phytochemicals can be your primary metabolites that may help you in the build up or gaining normal physiological functions or they might have some secondary defensive functions.

We call them as your secondary metabolites. So depending upon the role they play in plants, your phytochemistry will classify them into primary and secondary metabolites and study all these attributes. is totally summed up in the branch of what we call it as phytochemistry. So this is something which will help us in development of newer molecules herein.

so what is the scope of this subject why are we learning this subject or what is pharmacognosy and phytochemistry helping me out with so once i learn this subject i'll understand different different things first thing what i learned is when i take a drug like a plant drug animal drug or a mineral based drug i understand the sources of this drug and slowly how this drug contributed to drug discovery Now, I'll just give you a WHO report which says that despite all the modern allopathic advancement,

80% of the global population still uses plant based medicine or some form of traditional medicine. A still bigger eye opener is whatever molecules or drugs we have in the market right now of which approximately 60% are either natural or nature derived or nature inspired molecules from which more potent molecules have been prepared. So definitely

your pharmacognosy and phytochemistry knowledge is going to help you understand the sources and is going to provide you leads for the drug discovery. The next thing this knowledge will help you is whenever you have a herbal drug with you or whenever in your prescription you have anything to do with drugs of natural origin, you will understand the process of quality control, standardization and authentication. Are they genuine?

Are they not? Are they of good quality or are they of a poor quality? Are they adulterated, substituted by any means? So we will understand the quality parameters of this drug. Next is numerous drugs so far that we have seen have been used in the traditional system of medicine and the traditional system of medicine has its own logic. Now, we don't apply that to pharmacognosy and phytochemistry, but the pharmacognosy and phytochemistry knowledge, the knowledge of molecules, the knowledge of plants will make us understand different steps that have been involved in the traditional processing of this drug. herbs or how these herbs are being used in traditional medicine.

Now going to a little modern version of it, you will see numerous plants, animal based products or microbial based products have now come in market as nutraceuticals, natural excipients and cosmeceuticals. So our knowledge of this subject is also going to help us understand nutraceuticals, natural excipients and cosmeceuticals better. Now, let's try to learn them one by one. So take, for example, sources of drugs as leads.

So when you say historically, when people tried a traditional herbal medicine, you will say a willow bark which contains salicin. Now, salicin, which is there in willow bark, people used to consume for its analgesic effect. Slowly, more and more research started into the analgesic effect of Willow bark and they came across a molecule called salicin.

This was isolated, purified, and converted into a more potent and more, what you might call, a pharmacokinetically and dynamically better moiety—and that was aspirin. Now, this was still a long journey. But after that journey, you will see that even better molecules were discovered. As a result, the demand for aspirin declined.

Now, again, aspirin was discovered as a molecule that helped in what is called blood thinning. So now, it is not used for fevers, nor for its analgesic effect. It is primarily used for blood thinning.

So, Willow Bark gradually gave rise to a modern drug. Similarly, *Artemisia annua*, which contains artemisinin, an anti-malarial molecule. But when extracted from the plant, it had bioavailability issues due to its lipophilicity. This could be made more polar—if you observe carefully, what changed here is

This particular ketone is made into hydroxy, and a diacid has been added just to esterify it. And that artemisinin was converted into artesinoids, which was much, much more hydrophilic and more bioavailable. Now, moving to the next molecule, you will see that from rhubarb, there was a molecule called rhein. And rhein is known to irritate the gut. That is, you know, like a purgative, we call them.

Now, this purgative effect is what your anthraquinones were mostly known for. Again, this was chemically modified just by a simple acetylation process. And this acetylation led to a molecule which is called diacerin. Now, diacerin has a completely different set of moieties. It is used in arthritis, and it is used to prevent degradation of cartilage that happens in joints.

So people take diacerin as an anti-arthritic agent or something that prevents cartilage damage. So definitely, nature is inspiring, and here you come across the fourth example, and that is opium. Now, you will see opium is a kind of different molecule in a way; it can be a hallucinogen, it can be an analgesic also, and it has numerous activities.

Yes, the effects of morphine were observed, but just see carefully what is done here. Now, what is done here is if you take this hydroxy, convert it into a ketone, and if you take this methyl and attach an allyl out here, you get what is called an antagonist. So, if you had morphine and if you are having morphine poisoning because of morphine binding to an opioid receptor, then This drug, which was very structurally similar, was prepared, inspired by morphine, to inhibit the effect of morphine.

Now, the same thing can also be abused. So, this was antagonizing it. Imagine something potentiating it. So, people, what they did is they took this hydroxy and kind of acetylated it. Now, diacetylmorphine is called heroin.

So, heroin is again a substance of abuse. So, you can use it, or you can abuse it. It's a double-edged sword. But in the pharmaceutical industry, if you look at the positive side, these molecules have always helped us to develop better drugs for therapy.

I'm going to the second case where you can use it. So, say, for example, tomorrow I'm preparing for Brahmi or from Adulsa, or how do I know that I have genuine Brahmi with me? Or a vendor has given me a genuine sample because nowadays, even if you go to buy coriander in the market, you will see that there are numerous other adulterants or

other twigs which have been added deliberately or indeliberately. And the same thing happens in your drug market. So, quality control is very important. So, in this particular course, we will study the methods of how people authenticate their drugs. What methods of quality control do we say? Qualitative and quantitative methods.

So, we'll check authenticity. Some botanical methods, like microscopic methods, will be studied so that we can evaluate that. Whether you know, this arrangement of tissues is very fixed for a particular plant species. So, if the same kind of arrangement is observed, there are some values called leaf constants. So, are these values really similar for the drug which is given and for the sample which is provided?

In some cases, what people do is exhaust the drug and give it to you. So you might have come across clove, which is almost devoid of oil. There is absolutely no oil. There is absolutely no flavor in that. So you can check the presence of chemical constituents by doing something called phytochemical evaluation.

So what classes of compounds are there? How are we going to evaluate those classes by using chemical tests? We will see that in this particular course, and you will be able to evaluate that as well. And then there are methods to quantify if clove oil is present, maybe a compound like eugenol, which is present in clove oil.

How much is actually present? So you will come to know: is the clove of good quality? Is the clove processed well, or has it been stored or processed in a very substandard way and is no longer fit for medicinal use? So, quality control, standardization, and authentication are Something we will be studying in our pharmacognosy and phytochemistry course. The next thing this course will help us with is the validation of traditional medicine systems. Now, once we understand what plants are, what compounds they contain, the physical and chemical attributes of these plants, and some therapeutic effects of these plants, we can revisit our traditional medicines which use these plants. So maybe when you study alkaloids, you will study vasicin.

Vasicin is present in Vasaka. So if you extract Vasaka, in which solvent will the vasicin be high? Why use Asava and aristas? So imagine the compounds that are water-insoluble. Traditional methods used ghee to extract them if they were lipophilic.

Traditional methods use hydroalcoholic solutions. So whenever they wanted a combination of alcohol and water to get those compounds out of the plant, they used Asavas or aristas. So Asavas or aristas use hydroalcoholic solutions. Ghee preparations use lipophilic compounds, as well as your Kadhas when you boil them, used as a

Very hydrophilic preparations to take out the actives from the plant. Similarly, if you look at another procedure in traditional medicine called Sodhan prakriya. Now, shodhan prakriya is often referred to as detoxification or potentiation. For detoxification, we need to understand what is poisonous in the plant. If I say the poisonous compound in my plant is an alkaloid, take for example, aconite, it is aconitin.

So if it is poisonous, how do I remove this poison? Then I study that if my compound is an alkaloid, I can use a slightly basic pH. Basic pH can be imparted by lime, tuna, cow urine, or any alkaline substances, and then extracting it in oil or a lipophilic solvent. So we understand what these traditional methods did during the Shodhan Prakriya for detoxification as well as potentiation.

The potentiation approach was generally to improve the drug's bioavailability. Then you can even try to understand bhasma preparation. See, when you try to consume iron, mercury, or lead, for that matter, they can prove very fatal to us. But if you see some

traditional medicines, they still use metal preparations and these metal preparations were in the form of bhasmas.

What exactly happened to those metals to render them non-toxic? What exactly these metals were processed and chemically what happened to them is something we can understand during the mineral processing. And then, once you know what the actives are, once you know their mechanism of action, your dose and efficacy validation becomes much, much simpler for the traditional system of medicine. Going to the next part.

The modern ones you will see in the market or you will see on the e-retail site. There are numerous herbal supplements. Natural supplements people claim numerous things as antioxidants, tonics, brain boosters. All these boosters are categorized as nutraceuticals, so nutraceuticals are nutrition plus pharmaceuticals, a combination of both, and that helps you gain health benefits.

They cannot claim to cure your disease, but definitely they do offer a good variety of health benefits. This includes your dietary fibers. You know, you will see your oats, your brands, your isabgol. They've been categorized as basically polysaccharides as dietary fibers. Somewhere they help you decrease the glycemic index in your diabetic patients and cholesterol in hypercholesterolemic patients.

Whereas if you're suffering from disease such as cancer, you will require more of antioxidants. So polyphenols or carotenoids, polyphenols are little hydrophilic, whereas carotenoids are little lipophilic. So your diet or products which are rich nowadays in markets, you have supplements such as lutevit for your eyes. You have zeaxanthin or in polyphenols, you have ellagic acid, gallic acid derivatives, which are even helping you in cognitive health.

So all these antioxidants, immune boosters, ashwagandha, ginseng, what do they contain? How are they helping us and how should they be given to the patients or given to the market is what we see. Even when it comes to your microorganisms, your prebiotics, it's a huge market. Certain lactobacillus or if you do bacteria which is a part of your gut microbiome,

They've been sold out as products and your knowledge will definitely help in understanding what they are, how they are prepared, produced and used. Now when you are learning pharmacognosy and phytochemistry we will be dealing with a good set of drugs and some of these drugs can be used as excipients. So there is a need or a growing need of what is called as green

or eco-certified ingredients, so more green, more eco-certified, more safe, and more biocompatible. They are, so this is what your subject is going to help with. So, take for example, colorants: beetroot, chlorophyll, annatto, cochineal. They are all there in the market. How do you prepare these? How do you process them? How do you use them in your products so that they can be a very stable formulation? Coming to sweeteners, people nowadays, you know, resist the use of high-calorific diets and

they want to switch to something which is low-calorific or non-calorific. So sweeteners such as stevia, thaumatin, monk fruit, or mongoside are nowadays used as a substitute or a zero-calorie sweetener. Emulsifiers, natural emulsifiers like acacia, tragacanth, lecithin; gelling agents, agar, gelatin; even your flavor market. People don't want synthetic flavors. They want natural flavors because they are safer.

There are no process impurities in them. So mint, vanilla, your knowledge of pharmacognosy and phytochemistry will help you understand the application of all of these drugs as excipients also. Now, cosmeceuticals—we do not just restrict ourselves to drugs. We also venture into the cosmetic domain.

So you will see nowadays the market flooded with cosmetics which are of natural origin. Your algal marine ingredients are also coming into play, your brightening agents, kojic acid, which is obtained from fungus. Lemon extracts or even your hair oils are loaded with ingredients such as amla, hibiscus, brahmi. So all of these are obtained from nature.

We just need to use them, process them, and understand their phytochemistry so that they can be wisely applied. So emollients, take for example, your creams which you apply—you don't want the moisture to escape, you don't want dry skin. So you want to retain the moisture. Emollients help you with that. So you'll see your beeswax, jojoba or hohoba oil, almond oil,

All of these create a lipid barrier and prevent what is called transepidermal water loss. On the other hand, there are certain plants which will help you retain water in your skin, such as aloe vera. If you see the aloe vera mucilage, it is laden with water. Apply it to your skin, and your skin will get hydrated quickly. Your cucumber, in a similar manner—even if you see your perfumery market,

People are again wanting to go very green-label with more natural fragrant molecules. So your rose, citrus, musk, spices—all of these, which are obtained naturally—have been used here. So, all in all, if you look at pharmacognosy, there's a huge scope and a huge market. If you see the drug market, the CAGR is 5, but if you see the nutra and cosmeceutical market, the CAGR goes as high as 7. So there's good scope, absolutely good pricing, and value for money.

So definitely, pharmacognosy and phytochemistry knowledge will help you venture out and understand these markets better. So here are a few reference books I want you all to read thoroughly throughout this course so that you enjoy it. And thank you, everyone, for your patient listening. Thank you.