Natural Dyes

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Lecture No. # 12

Medicinal Properties of 6 Natural Dyes

We had learned about the toxicity of dye stuff and during that lecture I had mention that natural dyes are non toxic. But today lecture is related to the medicinal properties of some of the dyes which come under the category of natural dyes. So, instead of being toxic they are our friends and because they are from the herbal origin, and we know that the entire ayurveda is related to the herbal medicine therapy. Many of these dye molecules also have some therapeutic properties. And I have enlisted only 6 of them here, because otherwise the lecture will become very exhaustive, and it will not be so much for importance. But to give you in overview that medicinal properties do co-exist with the coloration in the natural dyes is what will be emphasize in this lecture.

If we take the example of indigo, now we also understand that if there is a molecule, be it is synthetic dye, be it natural dye, the toxicity or the non toxicity is all related to its structure. So, when we try to look at the medicinal property we should also look at the chemical structure and make a co-relation, because this is a scientific approach to understand any situation. If we take the example of indigo, indigo dyed fabric imparts many medicinal effects. It is known that dyed fabric with natural colors impart some or all the activities mention below due to close proximity of to the skin.

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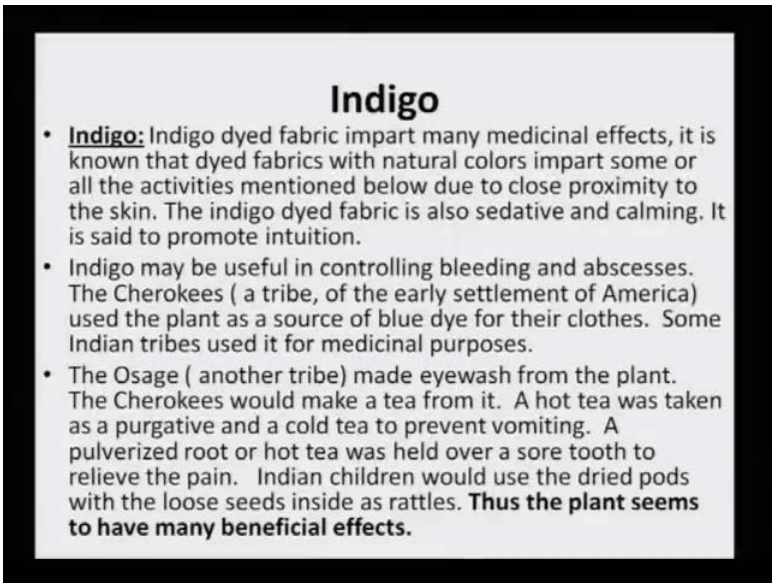

The indigo dyed fabric is also sedative and calming. It is said to promote intuition. Of course, these are a few things which are you know just an extension of what kind of medicinal effect it may have. But nevertheless, if you and I were an indigo dyed dress we definitely feel happy wearing it. It is a color which soothes our temperament. Indigo may be useful in controlling bleeding and abscesses. The Cherokees, a tribe of the early settlements of America, used the plant as a source of blue dye for their clothes. Some Indian tribes used it for medicinal purposes. So, these are all the information that I have collected from the folklore medicinal books or journals or some from the internet, but I have just compiled to make you understand that these medicinal properties are an attribute with the natural dyes.

The Osage, another tribe made eyewash from the plant. The Cherokees would make a tea from it. A hot tea was taken as a purgative and a cold tea to prevent vomiting. A pulverized root or hot tea was held over a sore tooth to relieve pain. Indian children would use the dried pods with loose seeds inside as rattles. Thus the plant seems to have many beneficial effects.

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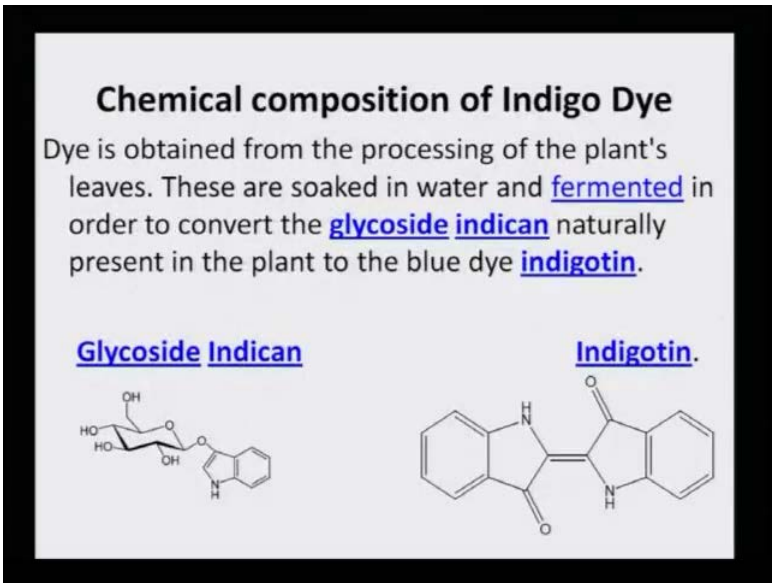

Now, if we try to look at the chemical composition of the glycoside indicant and the indigotin which is the final indigo molecule. Dye is obtained by from the processing of the plant's leaves. They are soaked in water and fermented in order to convert the glycoside indicant naturally present in the plant to blue dye indigotin. So, there is an oxidative process where the glucoside or the glycoside goes away and the two molecules join up at the C C bond. So, this is the structure of indigo dye.

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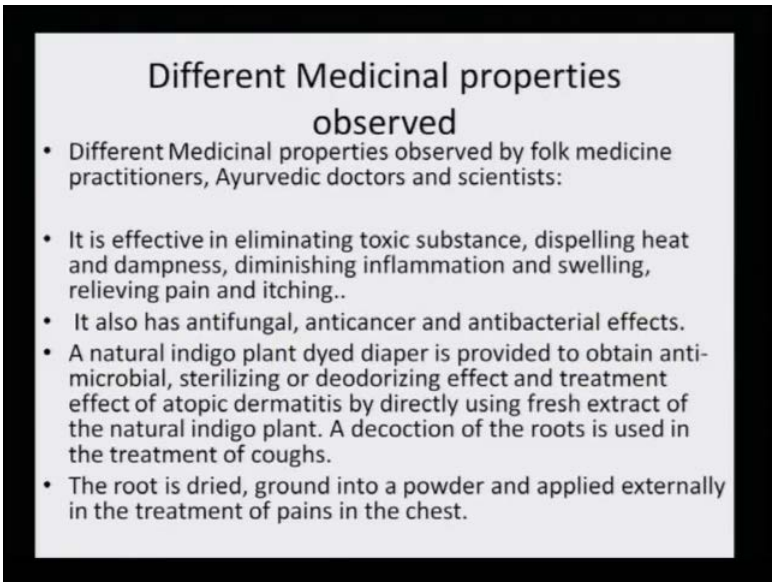

Different medicinal properties that were observed by various people all over the world have been the different medicinal properties observed by folk medicine practitioners, ayurvedic doctors and scientists have been. It is effective in eliminating toxic substances, dispelling heat and dampness, diminishing inflammation and swelling also relieves pain and itching. So, these are some of the very, very you know common effects of using indigo dye. It has its antifungal, anticancer and antibacterial effect. And natural indigo plant dyed diaper is provided to obtain antimicrobial, sterilizing and deodorizing effect and treatment effect of atopic dermatitis by directly using fresh extract of the natural dye plant. A in a decoction of the root is used in the treatment of coughs.

So, you see it is also good for cough, it is used for you know a smearing it on the diapers of the children, why because it has an antibacterial and antifungal and is very good for atopic dermatitis. The root is dried, ground into powder and applied externally in the treatment of pain in the chest. So, it was also done by some of the ayurvedic practitioners or folk medicine practitioners that this kind of application helped in the chest pain as well.

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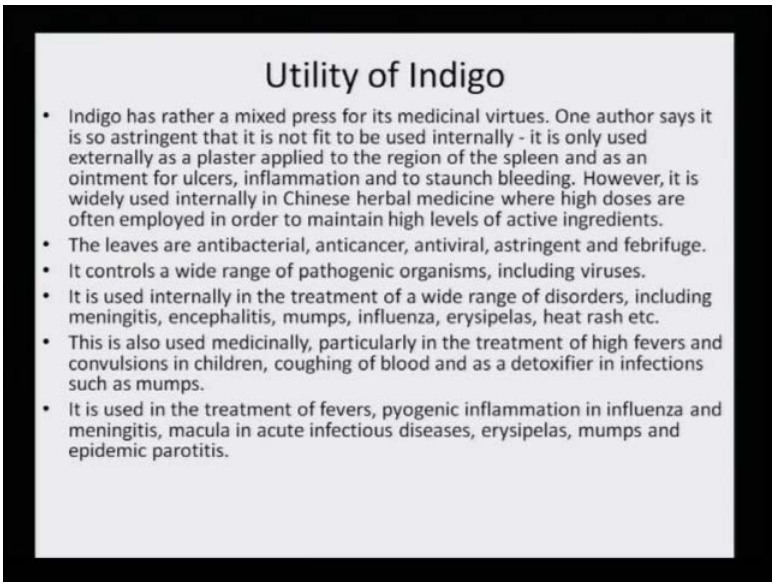

Indigo has rather a mixed press for its medicinal virtues. One author says it is so astringent that it is not fit to be used internally - it is only use externally as a plaster applied to the region of the spleen and as an ointment for ulcers, inflammation and to staunch bleeding. However, it is widely used internally in Chinese herbal medicine

therapy; we know Chinese have a very enriching traditional herbal therapy just like our ayurveda; where high doses are often employed in order to maintain high levels of active ingredients. So, indigo was applied both in ayurvedic that is the Indian herbal medicine system as well as Chinese herbal medicine system.

The leaves are antibacterial, anticancerus, antiviral, astringent and febrifuge. It controls a wide range of pathogenic organisms including viruses. It is used internally in the treatment of wide range of disorders including meningitis, encephalitis, mumps, influenza, erysipelas, heat rash etcetera. This is also used medicinally, particularly in the treatment of high fevers and conventions in children, coughing of blood and as a detoxifier in infections such as mumps. It is used in the treatment of fevers, phylogenic inflammation in influenza and meningitis, macula in acute infectious, diseases and mumps and epidemic parotids. So, you see many, many diseases have been treated by indigo. It not only has the antifungal, antibacterial, anticancerus, antiviral effect, but also for internal and external applications for bleeding spleens spleens and so on. They have been used extensively. So obviously, the people have got benefitted because of its medicinal property.

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How good is the indigo dye? Both the leaves and the roots are use in the treatment of pneumonia. The root and the whole plant have anticancerus properties whilst extracts of the plant have shown bactericidal properties. A decoction of the root is used in the

treatment of coughs. The root is dried, ground as a powder and applied externally in the treatment of pain of the chest; wild indigo, a decoction of the root being used as an antiseptic wash for wounds and skin complaints. Modern research has shown that this acrid bitter herb stimulates the immune system and is particularly effective against bacterial infection. So, that works what is making it as an antibacterial agent.

Tea made from the roots is cholagogue and emetic, febrifuge and purgative. The fresh root is also considered to be antiseptic, astringent and laxative. The infusion is used in the treatment of upper respiratory infections such as tonsillitis, pharyngitis, and is also known in treating infections of the chest and gastro-intestinal tract and skin. So, practically it has a very enriching medicinal property as what we have learnt through these few slides.

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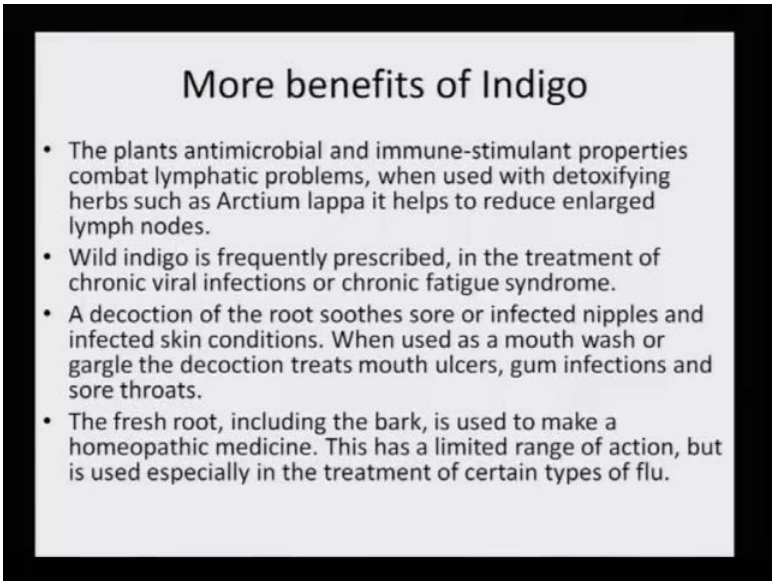

More benefits from indigo: The plant antimicrobial immune-stimulated properties combat lymphatic problems, when used with detoxifying herbs such as Arctium lappa. It helps to reduce enlarged lymph nodes. Wild indigo is frequently prescribed in the treatment of chronic viral infections or chronic fatigue syndrome. A decoction of the root soothes sore or infected nipples and infected skin conditions. When used as a mouth wash or gargle the decoction treats mouth ulcer, gum infections and sore throats. So, it is even good for mouth wash. So therefore, it can be taken internally as well. The fresh root, including the bark, is used to make a homeopathic medicine. This has a limited

range of action, but is used especially in the treatment of certain types of flues. So, from the ranging from flues to chest pain to all kinds of antibacterial, antiviral, anticancer kind of diseases, one can see that it has a wide spectrum of affectivity on different types of a elements.

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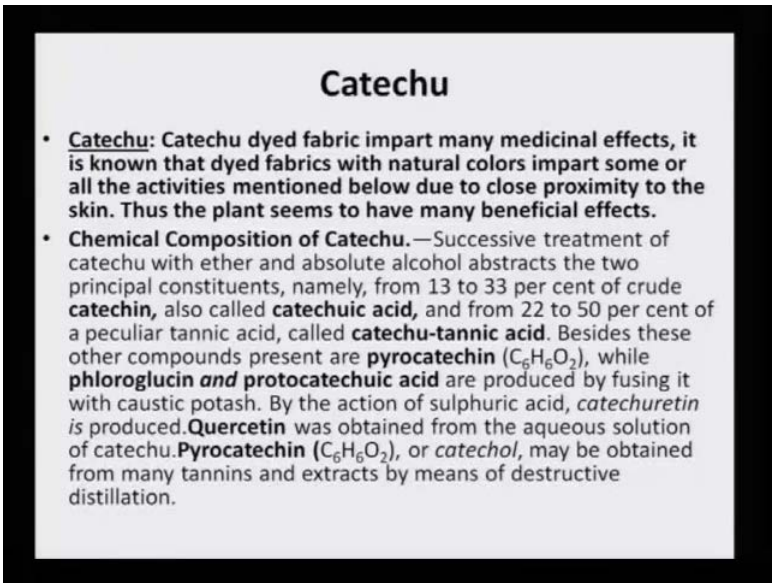

Coming to the second dye which is catechu or cutch; catechu dyed fabric impart many medicinal effects, it is not only the dyed, but even the dyed fabric also has lot of medicinal property. It is known the dyed fabric with natural colors impart some or all the activities mentioned below due to close proximity of the skin. Thus the plant seems to have many beneficial effects. But before we understand the effects of this molecule, we need to understand the structure as what I said it is all related to the structure. Be it is dyeing property, be it is medicinal property, be it is any property; it has to do with the structure of the molecule. Chemical composition of catechu - successive treatment of catechu with ether and absolute alcohol abstracts the two principle constituent namely, a from 13 to 33 percent of crude catechin also called as catechuic acid, and from 22 to 50 percent of a peculiar tannic acid called the catechu-tannic acid

Besides these other compounds present are pyrocatechin while phloroglucin and protocatechuic acid are produced by fusing it with the caustic potash. By the action of sulphuric acid, catechuretin is produced. Quercetin was obtained from the aqueous solution of catechin. Pyrocatechin or catechol may be obtained from many tannins and

extract by means of destructive distillation. So, the main component is the catechin, quercitin and catechuic acid and catechu-tannic acid. These are the main components of catechu.

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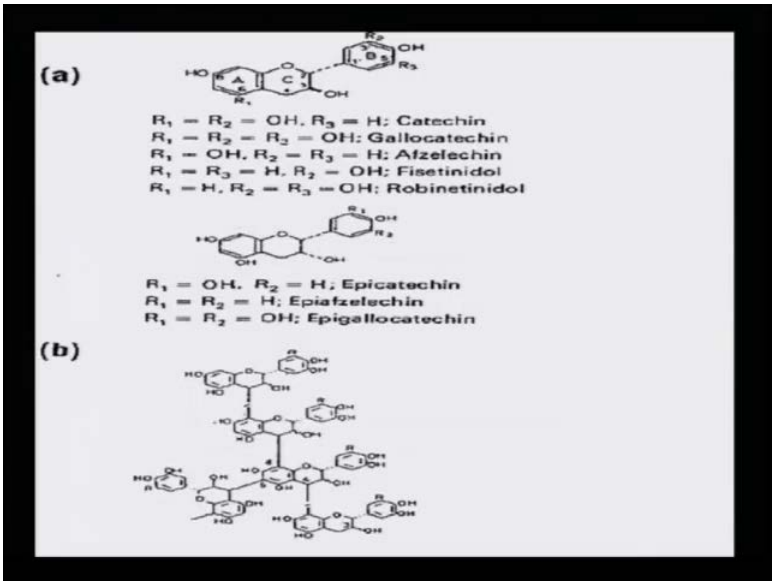

And the structures here are as you would see it has a typical flavonoid come flavon kind of structure with lot of hydroxy groups all gathered epicatechin and epigallocatechin. If these are all condense tannins and whereas, these are catechin and fisetinidol, these are all just single, single molecules.

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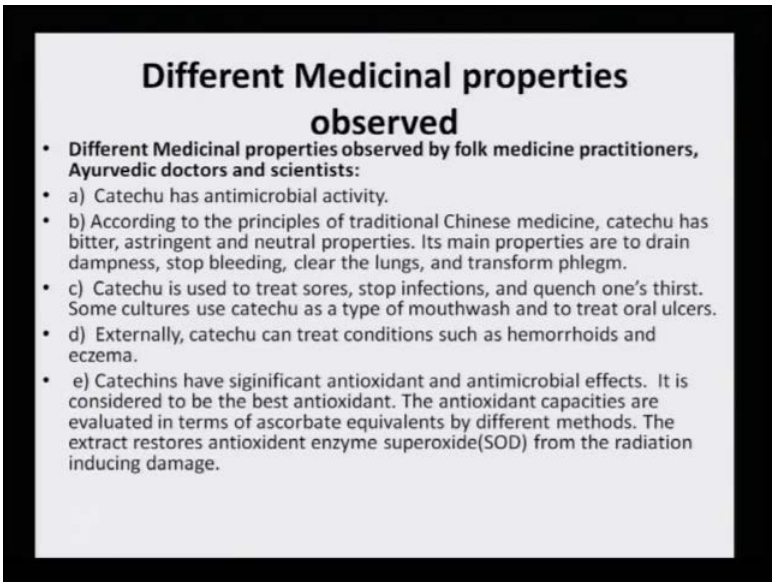

Different medicinal properties that have been observed in catechu by the folk medicine practitioners, ayurvedic doctors and scientists that catechu has antimicrobial activity. According to the principle of traditional Chinese medicine, catechu has bitter, astringent and neutral properties; its main properties are to drain dampness, stop bleeding, clear the lungs, and transform phlegm. Catechu is used to treat sores, stop infections and quench one's thirst. Some culture use catechu as a type of mouthwash and to treat oral ulcers. Externally, catechu can treat conditions such as hemorrhoids and eczema. Catechins have significant antioxidant and antimicrobial effects. It is considered to be most one of the best antioxidants. The antioxidant capabilities are evaluated in terms of ascorbate equivalents by different methods. The extract restores antioxidant enzyme superoxide that is SOD from the radiation including damage.

So, it has its own difference spectrum of reactivity and medicinal property. It is not the same as what we saw in the case of indigo. But in this class of compound that is the flavon class of flavonoid class of compounds. The condensed tannin types of compounds have a very common kind of antioxidant, antimicrobial activity, and therefore, these are very good substrate for medicinal property.

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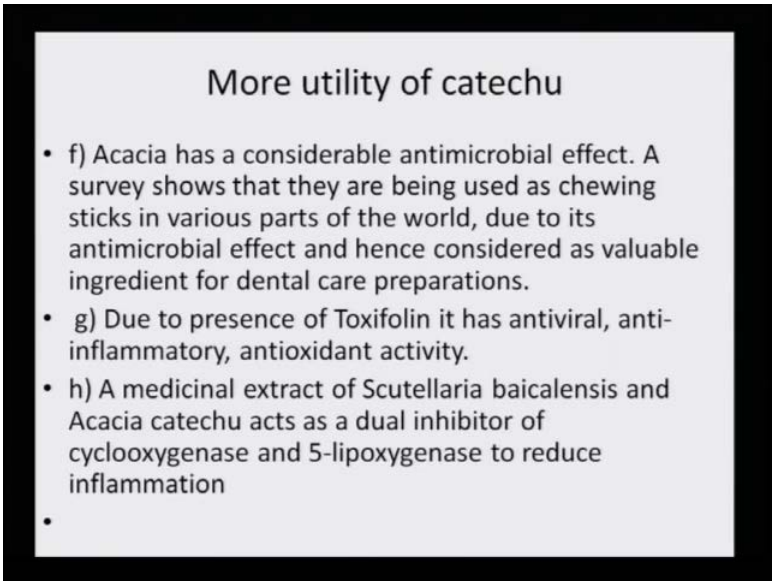

More utility of catechin: Acacia which is the botanical name of catechu has a considerable antimicrobial effect. A survey shows that they are used as chewing sticks in various parts of the world, due to its antimicrobial effect and hence considered as

valuable ingredient for dental care preparation. Due to the presence of toxifolins, it has antiviral, anti-inflammatory and antioxidant activity. A medicinal extract of scutellaria baicalensis and catechu acts as a dual inhibitor of the cyclooxigenase and 5-lipooxygenase to reduce inflammation. So, in conjunction with another plant the catechu plant shows very different kind of activity also.

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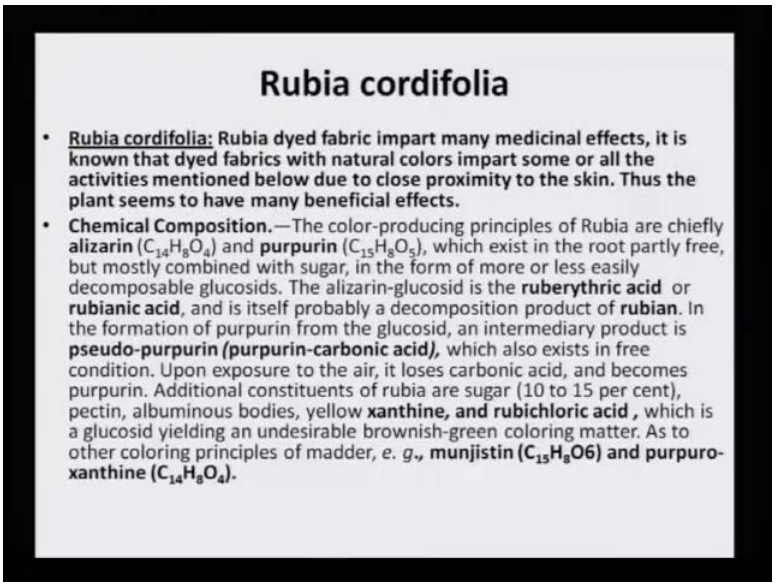

Now, coming to the third plant that is rubia cordifolia; I have taken chosen these very important common natural dyes - that is indigo, catechu and now munjistin which is called rubia cordifolia, why because they are being used most popularly from ancient times to the present time. Rubia dyed fabric impart many medicinal effect. It is known the dyed fabric with natural colors impart some or all the activities that are mentioned. But before we go on to understand the activity part we will try to look at the chemical composition as I have what I have mentioned that the medicinal properties are direct reflection of the chemical moieties that are present.

Now, we have also learnt by now that rubia is chiefly made up of 6 dyes of which alizarin and purpurin are the two main color producing principles, which exists in the root partly free, but mostly combined with sugar, in the form of more or less easily decomposable glucosids. The alizarin-glucosid is ruberythric acid or rubianic acid, and it itself probably is a decomposition product of rubian. In the formation of purpurin from the glucosid, an intermediary product is pseudo-purpurin or purpurin-carbonic acid

which also exists in free condition. Upon exposure to the air, it loses carbonic acid and becomes purpurin. Additional constituents of rubia are sugar 10 to 15 percent, pectin, aluminous bodies like yellow xanthine, and rubichloric acid which is a glucosid yielding an undesirable brownish-green coloring matter. And as to the other color coloring principle of munjistin is munjistin and purpuro-xanthine. So, these are the various components which make the munjistin dye or the madder dye, the rubia dye as the red orange colored dye.

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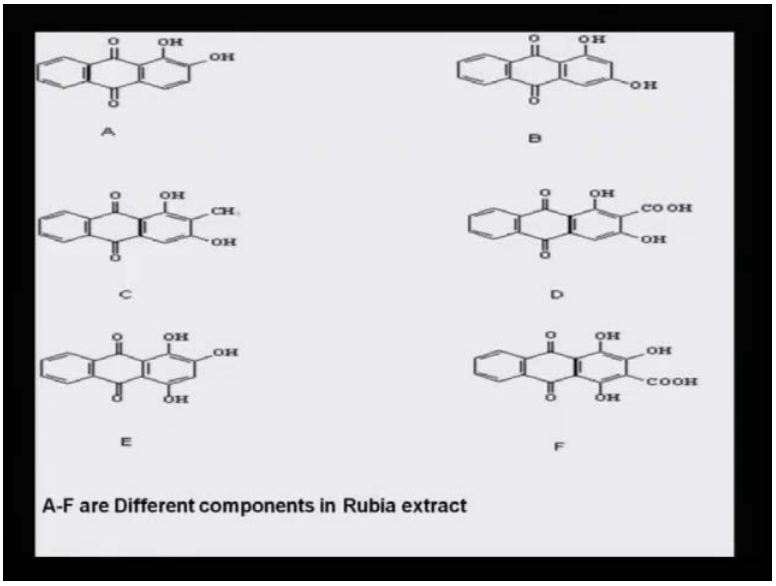

And these are the various structures you will see that they only differ in the functional groups that are present on the ring on the right hand side; one has ortho hydroxy, the other one has meta hydroxy, then the third one has meta hydroxy, but there is a methyl in between, the fourth one has meta hydroxy, but you know at the ortho position is the carboxylic acid, the fifth one has 3 hydroxy, groups 2 para and 1 ortho, and the four sixth molecule has 3 hydroxy and 1 carboxylic group. So, all these functionalities actually make them different moieties altogether.

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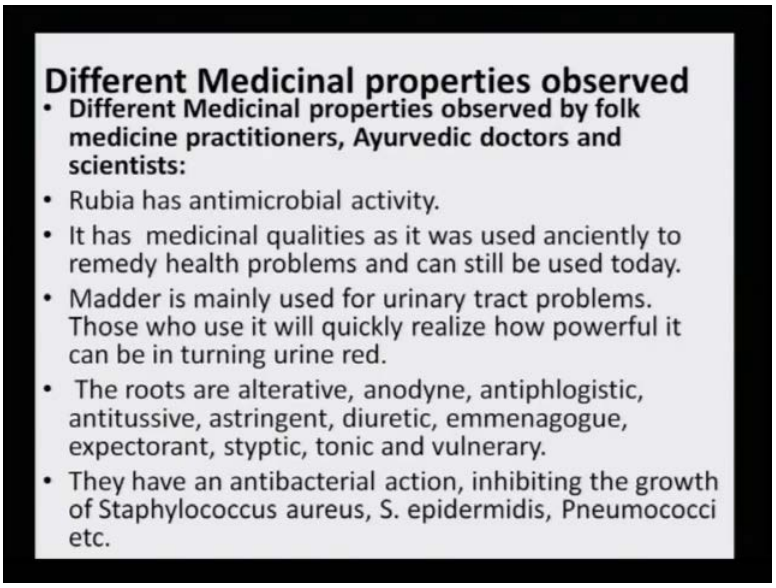

Now, because of these medicinal properties also vary. Rubia has antimicrobial activity, it has medicinal qualities as it was used anciently to remed to remediate health problems and can be still used today. Madder is mainly used for urinary tract problems. Those who use it will quickly realize how powerful it can be in turning urine red. The roots are alternate alterative, anodyne antiphlogistic, antitussive, astringent, diuretic, expectorant styptic, tonic and vulnerary. They have an antibacterial action inhibiting the growth of the bacteria such as staphylococcus and various species of staphylococcus as well as pneumococci also.

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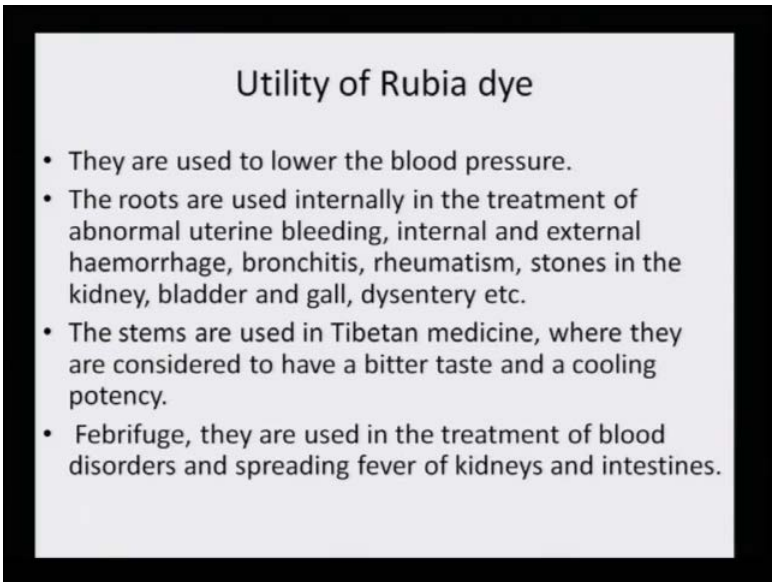

Other utility of rubia dye: They are used to lower blood pressure. The roots are used internally in the treatment of abnormal uterine bleeding, internal and external haemorrhage, bronchitis, haemostasis, rheumatism, stones in the kidney, bladder and gall, as well as in dysentery. Stems are used in Tibetan medicine where they are considered to have bitter taste and a cooling potency. Febrifuge, they are used in the treatment of blood disorder and spreading fever of kidneys and intestines. So, that is what the rubia dye can extend if taken orally, because as I told you these dyes are not only non toxic, but have very pronounce medicinal effects.

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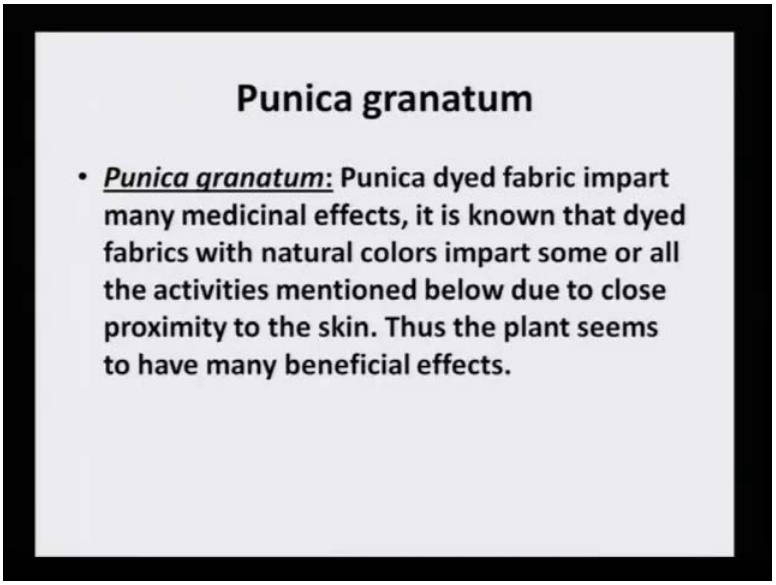

Coming to the fourth dye which is yellow in color which is obtained from the rind of the fruit called punica granatum or anarkachilka This dye also a has lot of medicinal property, because it a it is of very soothing color yellow color, it is very popularly used.

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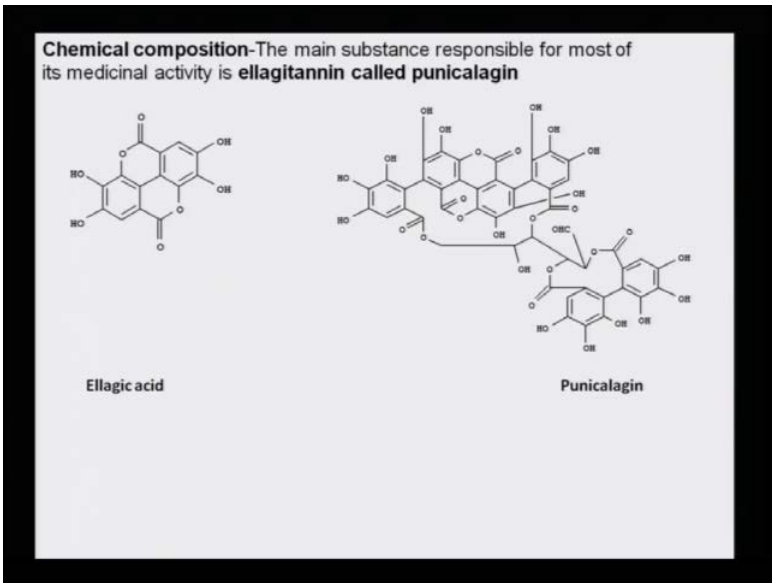

What are the structures of the chemicals that are comprising in this yellow dyed material. The main substances responsible for the medicinal property are the ellagitannin and also the punicalagin. So, this ellaginic acid and puna punicalagin are the two condensed kind of molecules with several, several hydroxy groups and that is what imparts the medicinal property to the dye.

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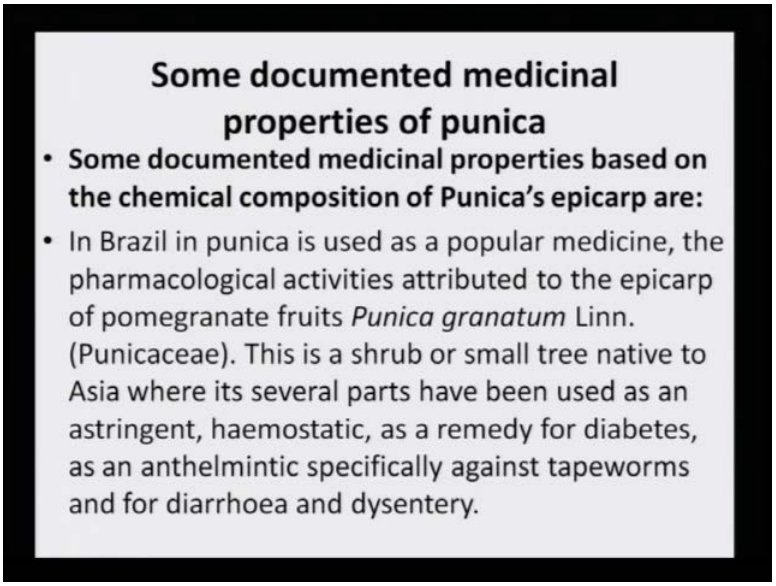

Some documented medicinal properties for punica are that in Brazil in punica is used as a popular medicine. The pharmacological activities attributed to the epicarp of the

pomegranate fruit Punica granatum Linn which belongs to punicaceae family. This is a shrub or small tree native to Asia, where it is several parts have been used as an astringent, haemostatic, as a remedy for diabetes and as an anthelmintic especially against tapeworms and for diarrhea and dysentery. So, these are the various uses of punica dye.

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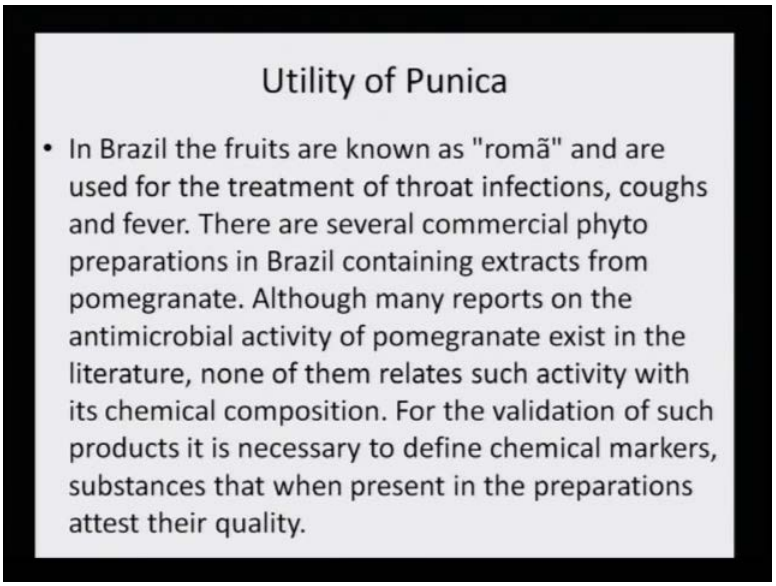

In Brazil the fruit also has been further used and is known as roma and are used for the treatment of throat infection, cough and fever. There are several commercial phyto preparations in Brazil containing extracts from pomegranate. Although many reports on the antimicrobial activity of pomegranate exist in the literature, none of them relates such activity with its chemical composition. For the validity of the product it is necessary to define chemical markers, substances that when present in the preparation actually have been attested for their quality, because it is very important to first understand what the dye contains and then only those compounds only must be contributing to these medicinal properties can be truly marked out.

But you know in Brazil there are some compositions available which do not give any chemical markers. So, that is a bit of a dissuading situation, because it does not give a clear picture, whether it is the same chemical or some other concoctions have been added to the so to call punica dye con decoctions.

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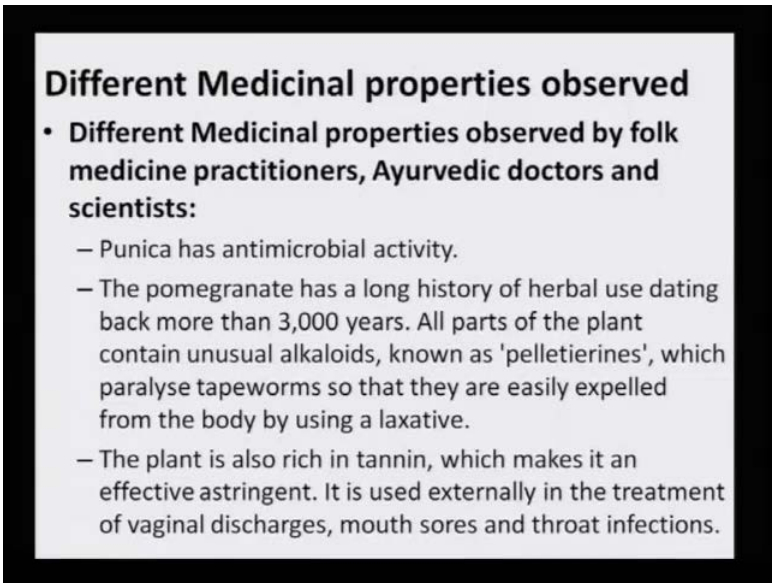

If we try to look at the medicinal properties punica is an antimicrobial activity. The pomegranate or punica has a long history of herbal use dating back even before 3000 years. All parts of the plants contain unusual alkaloids which is called as pelletierines, which paralyze tapeworms; so that they are easily expelled from the body by using a laxative. The plant is also rich in tannin, which makes it an effective astringent. It is used externally in the treatment of mouth scores sores and throat infections.

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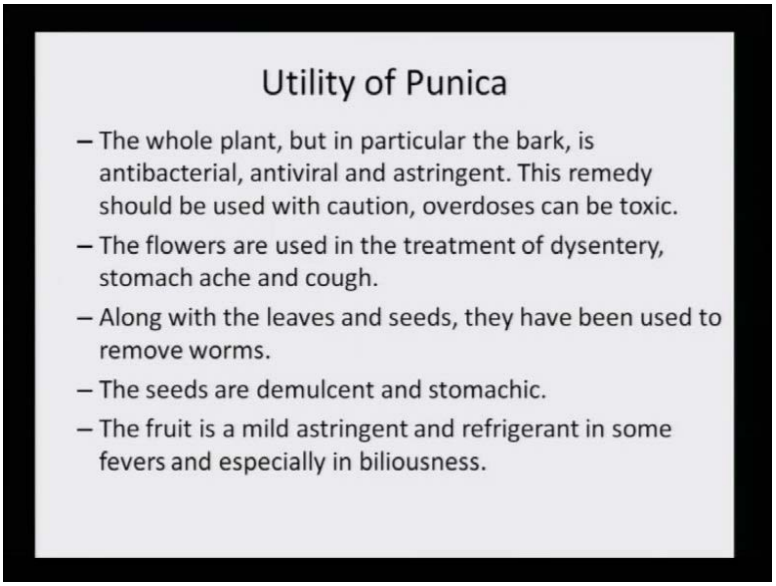

The other utility of punica are the whole plant, but in particular the bark is antibacterial, antiviral and astringent. This remedy should be used with caution, overdoses can be toxic. Now, you see that any compound, if it is administered in dosage which is very high and which is far beyond the assimilation rate of the body. It will become it will come into the category of toxins. So, that has to be kept in mind that overdoses should be avoided. The flowers are used in the treatment of dysentery, stomach ache and cough. Along with the leaves and seeds they have been used to remove warms. The seeds are demulcent and stomachic. The foot is a mild astringent and refrigerant in some fevers especially in biliousness. So, you see they it has its own medicinal spectrum of activity and it has been used by different class of people and these were the utilities of punica which were observed.

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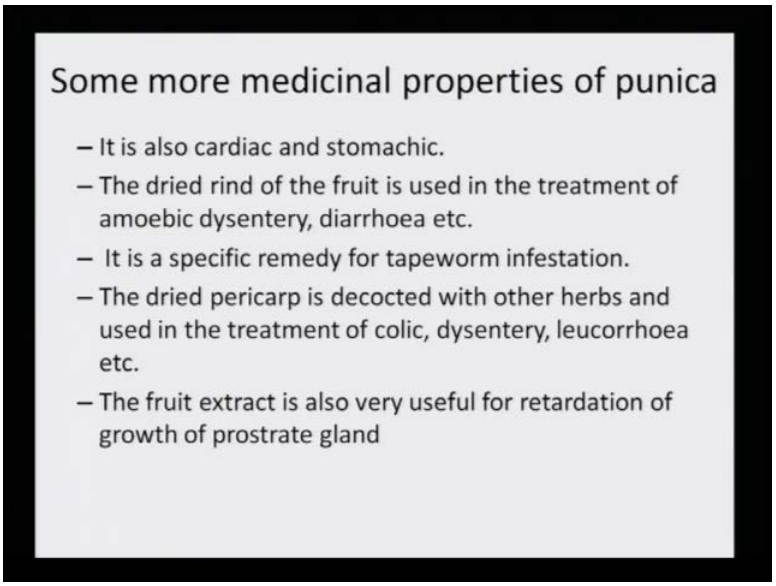

It is also cardiac and stomachic. The dried rind of the fruit is used in the treatment of amoebic dysentery, diarrhea etcetera. It is specific remedy for tapeworm infection infestation. The dried pericarp is decocted with other herbs and used for the treatment of colic, dysentery, leucorrhoea etcetera. The fruit extract is also very useful in retardation of growth of the prostrate gland. So, there are many, many such observations where the decoction of punica fruit rind has been done, taken it internally, and these were the observations that it is effective in these kind of medicinal situations.

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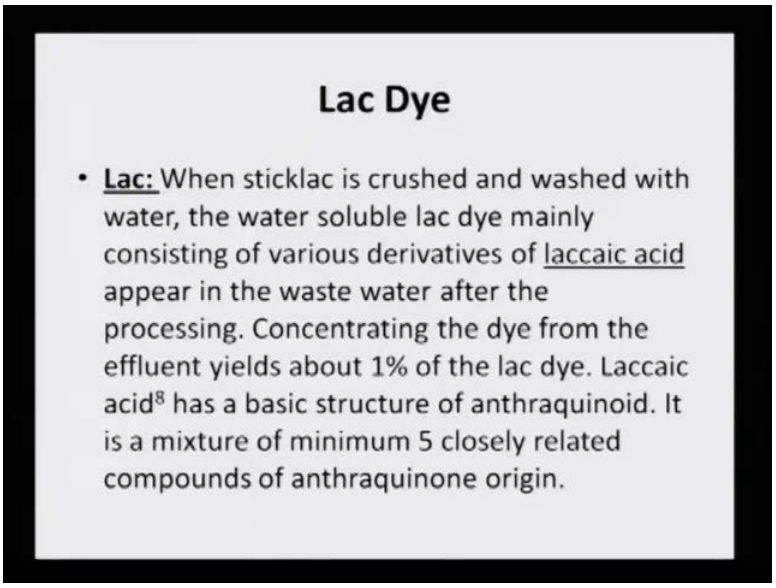

Coming to the Lac dye: This dye is not from the plant origin, but nevertheless it comes under the category of natural dyeing. And it is actually obtained when sticklac is crushed and washed with water. The water soluble lac dye mainly consisting of various derivatives of laccaic acid appear in the waste water after the processing. Concentrating the dye from the effluent is about 1 percent of the lac dye. The laccaic acid has a basic structure of anthraquinoid, it is a mixture of minimum 5 closely related compounds of anthraquinone origin.

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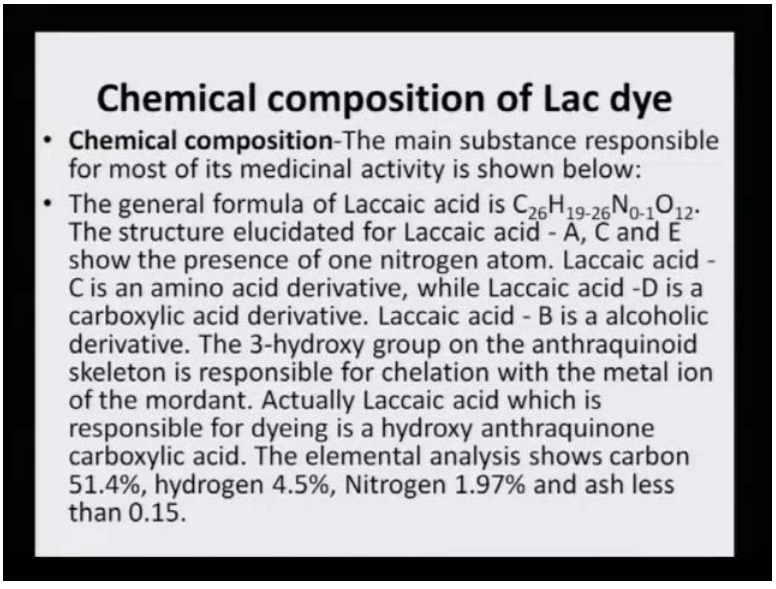

So, you see that laccaic acid is also again not 1 dye. Lac dye is not just 1 dye just the way we saw that munjistin or rubia is not a 1 dye, it 6 has components. Similarly, this lac dye has its medicinal properties related to the laccaic acid. The structure elucidated for laccaic acid is A, C, E will show the presence of 1 nitrogen atom; laccaic acid - C is an amino acid derivative while laccaic - D is a carboxylic acid derivative, laccaic - B is a alcoholic derivative and the 3-hydroxy group on the anthraquinoid skeleton is responsible for chelation with the metal ion of the mordant. Actually laccaic acid which is responsible for dyeing is a hydroxy quininoid carboxylic acid. And the elemental analysis shows that it has 51.4 percent carbon, 4.5 percent hydrogen and 1.97 percent nitrogen and it has a ash less of about less than 0.15.

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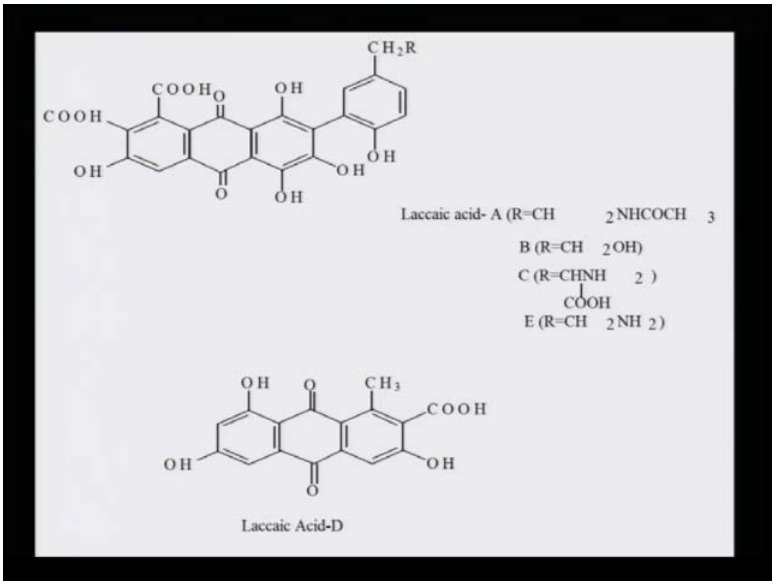

These are the various structures of the laccaic acid and one can see that basically it is made out of this kind of aromatic system with carboxylic acid groups and OH and carbonyl group which make it a very good dye substrate. As I told you the dye substrate are related to the fact that how much conjugation can occur. Even the medicinal property is related to the structure.

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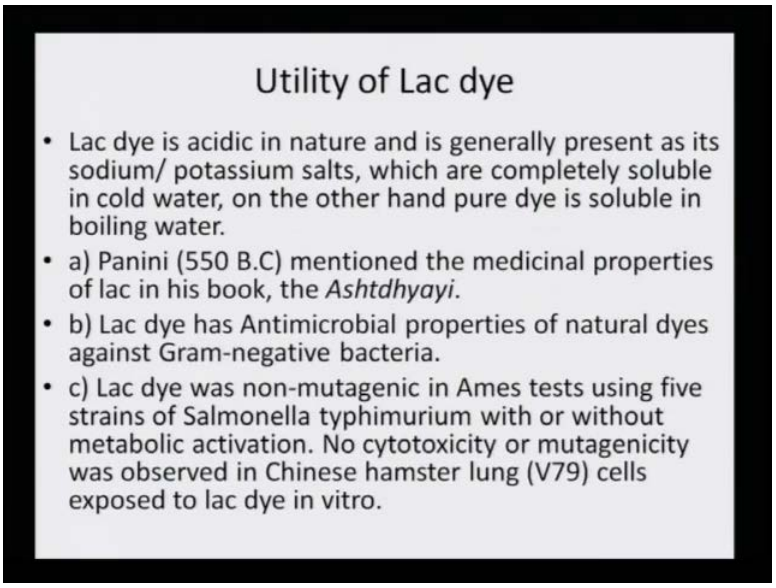

Utility of lac dye: Lac dye is an ace is acidic in nature and is generally present as its sodium or potassium salt which are completely soluble in cold water, on the other hand pure dye is soluble in boiling water. Panini in 550 B.C mentioned the medicinal properties of lac in his book; that means it ages back to 550 before Christ time. Lac dye has antimicrobial properties of the natural dyes and it works against gram-negative bacteria. Lac dye was non-mutagenic in ames tests using five strains of salmonella with or without metabolic activation. No cytotoxicity or mutagenicity was observed in the Chinese hamster lung cells exposed to lac dye. So, it is that way non mutagenic dye, and therefore, now it is clearly showing the non toxic effect as well as its medicinal property has already been documented way back.

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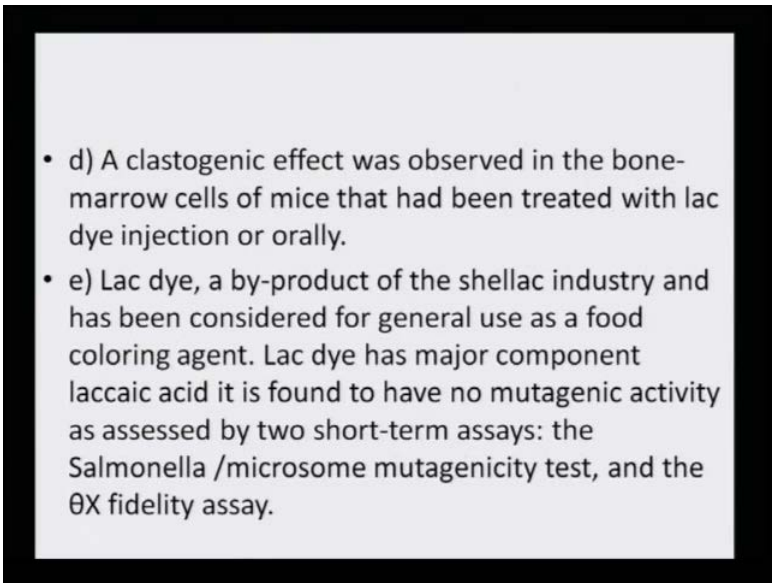

A clastogenic effect was observed in the bone marrow cells of mice that had been treated with this lac dye injection or even with orally administration. Lac dye, a by-product of the shellac industry has been considered for general use as a food coloring agent. So, if it is taken orally and if it is a food dye; obviously, it has its own benefit of the medicinal aspect as well as of the dyeing aspect. Lac dye has major component laccaic acid, it is form to have no mutagenic activity as accessed by the these tests which are done on salmonella.

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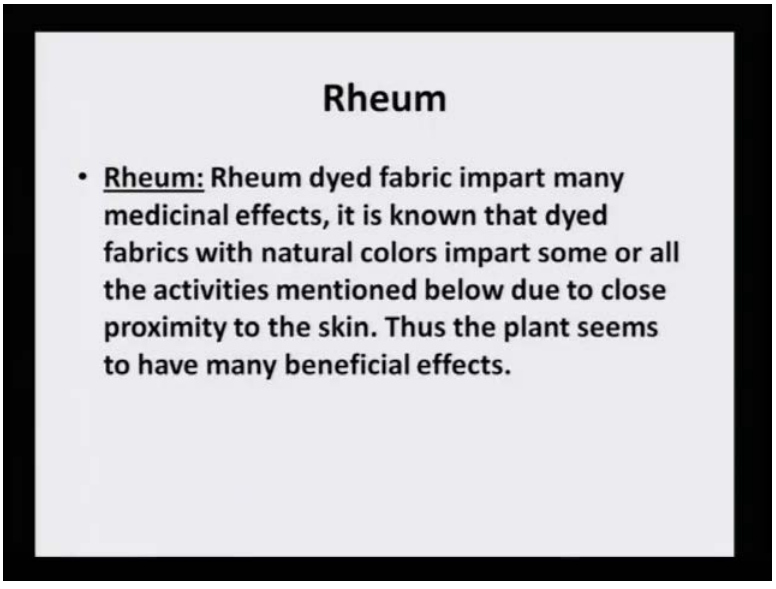

Coming to the last dye of these series, because I had chosen six main series, a six dyes are varying in different color indigo blue, manjjustin red, catechu brown, punica yellow and lac was purplish and now rheum is greenish-yellow. Rheum dyed fabric impart many medicinal effects too, I have chosen these, but there are the list is exhaustive. But these are the common colors that I used that; that is why I chose them for the study of or for the understanding of their medicinal property.

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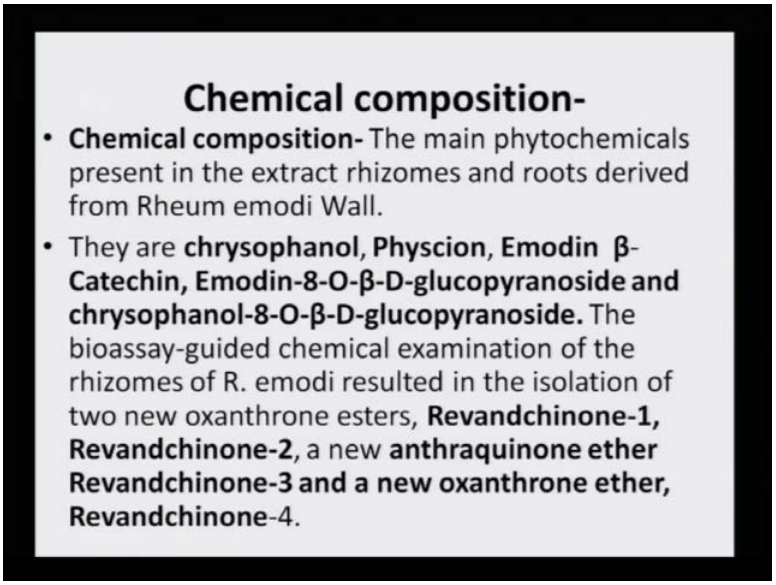

If one tries to look at the chemical composition: The main phytochemical present in the extracts of the rhizomes and the roots derived from rheum emodi wall are chrysophanic, physcion, emodin beta catechin, emodin-8-O-beta-D-glucopyranoside and chrysophanol-8-O-beta-D-glucopyranoside. The bioassay-guided chemical examination of the rhizomes of rheum, emodi resulted in the isolation of two two new oxanthrone esters that is the revandchinone-1 and revandchinone-2, a new anthraquinone ether revandchinone-3 and a new anthraquinone ether revandchinone-4 were also isolated. So, this is the kind of chemical composition of rheum and thus they are the once which are responsible for the coloration as well as for the medicinal property.

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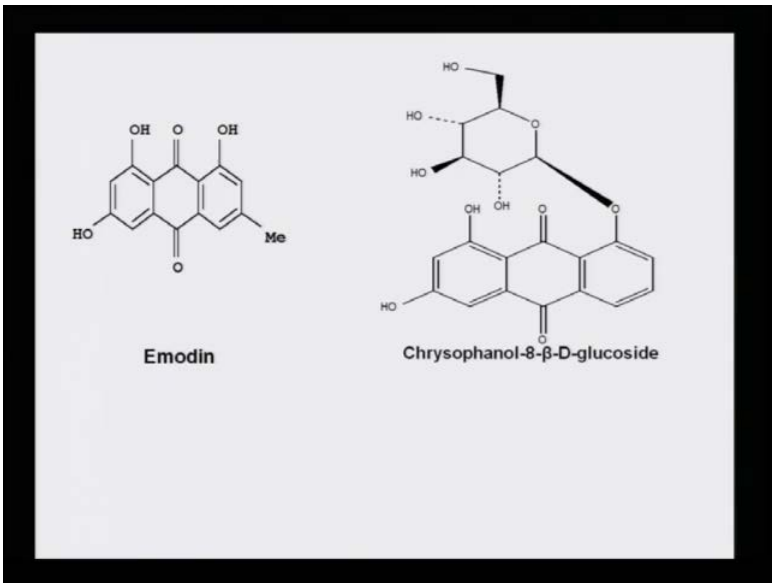

If we try to look at some of the simpler molecules emodin and chrysophynic-8-beta-D-glucoside; this is how they look like. One is an anthraquinone I mean both are anthraquinone dyes, but one has a glucoside linkage and the other one has only hydroxy and methyl groups around it.

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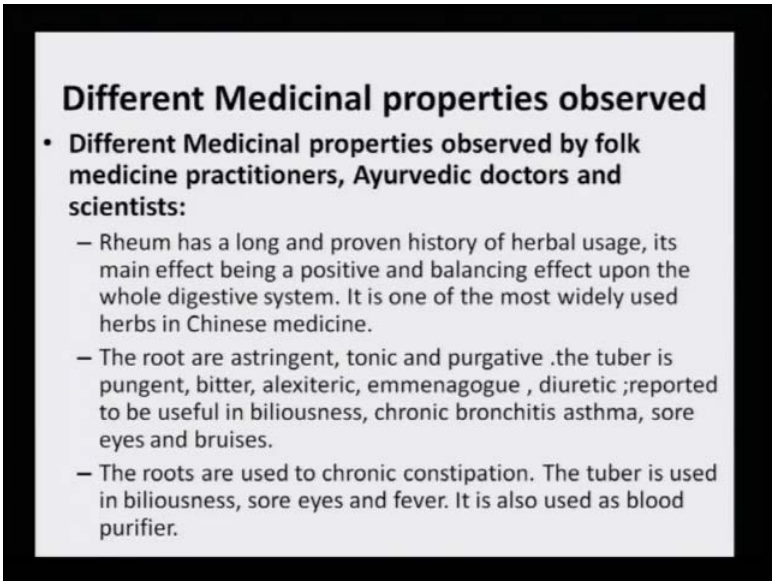

If we try to look at the medicinal properties; rheum has a long and proven history of herbal usage. Its main effect being a positive and balancing effect upon the whole digestive system; it is one of the most widely used herbs in even Chinese medicine. As I

told you just like our ayurvedic system which is an Indian medicine herbal system, Chinese also have a very enriched herbal system and that also traditional Chinese medicine system TCM also uses rheum as one of its main component. The root are astringent, tonic, purgative and the tuber is pungent, bitter, alexiteric, emmenagogue, diuretic and it is reported to be useful in biliousness, chronic bronchitis asthma, sore eyes and bruises. The roots are used to for chronic constipation, the tuber is used in biliousness and sore eyes and fever it is also used as blood purifier.

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Some more utility of rheum dye which has been practiced is that the root is anticholesterolemic, antiseptic, antispasmodic, antitumor, aperients, astringent, cholagogue, demulcent, diuretic, laxative, purgative, stomachic and tonic. So, you see it has many, many medicinal properties small doses act as an astringent tonic to the digestive system while larger doses act as mild laxative. The root is taken internally in the treatment of chronic constipation, diarrhea, liver and gall bladder complaints, haemorrhoids, menstrual problems, skin eruptions due to accumulation of toxins. Externally, the root is used in the treatment of burns. A homeopathic remedy is prepared from the dried root. This is used especially in the treatment of diarrhea in teething children.

So, you see that we have taken an overview of the medicinal properties, and an overview tells us of just the 6 dyes that they have a wide spectrum of activity, and all the this medicinal activity is related to the structural components that make the dye.