Natural Dyes

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Lecture No. # 10

Selection of plant sources for dye extraction: This is the next chapter that we will try to look. We have now learned so many techniques about extraction just a while ago. We will now see how does one natural dyer then selects a plant and which are the plants; that have the maximum of colorant that can be taken into consideration for dye extraction. So, as we go along, we will try to look at the various plants that are dyes yielding, not all plants can be considered as dye yielding plants. Dyes which are in substantial quantities in the natural plants or vegetables must be only considered; otherwise it is not a good option. So, as we go along, we will try to learn more about how to select and what are the criteria for selection.

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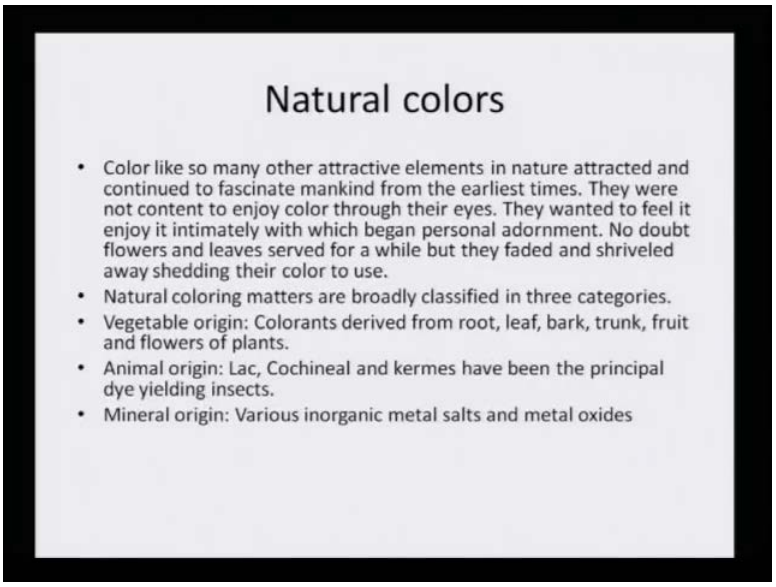

Natural colors: Colors like so many other attractive elements in nature attracted and continued to fascinate the mankind from the earliest times. They were not content to enjoy color through their eyes. They wanted to feel it enjoy it intimately with which began personal adornment. No doubt flowers and leaves served for a while but they

faded and shriveled away shedding their color to use. Natural coloring matters are broadly classified into three categories. They are from the vegetable origin; that is colorants derived from root, leaf, bark, trunk, stem, fruit, flowers and so on. Animal origin is the second; you know class where it could be derived from lac, cochineal, kermes have been principally the dye yielding insects. Mineral origin: Various inorganic metal salts and metal oxides have also been used as colorants.

So, there are three main sources one is of course, a very large source which is the vegetable source; second is the animal source some of the insects which can secret lace dye cochineal dye and so on, and the third one is the mineral origin or the mineral source where metal salts and metal oxides have been used.

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Resurgence of natural dyes, we were talking yesterday about the revival and resurgence of natural dye only after 1856, the development of synthetic dyes came into existence and still dominates the entire dyestuff industries. These synthetic dyes have received faster acceptability due to its ease in dye, reproducibility and cost factors. But in the late 1994, Germany struck a severe blow to dye-stuff industries and subsequently other European countries also executed ban on import of tack textiles and garments colored with the series of azo dyes made from aromatic compounds, which were formed to re-carcinogenic, allergenic and poisonous.

With the present national and international awareness of environmental ecology and pollution controls, natural dyes appear to be ideal choice since they are chosen from the non toxic lot and can be handled very easily and safely; however, it is not so simple, there are some problems encountered in the use of vegetables and natural dyes.

So all that is appearing to be so glossy and good and beautiful is not really so, but if one ways we have seen the toxicity; we have learnt about the oxidation product; we have seen how the reductive cleavage of the azo lineage, azo dyes create awake as compare to that where does a natural dye stand and what are the safety advantages the non toxicity and so on. But what are the disadvantages of handling it of extracting it; we will all learn it through this chapter.

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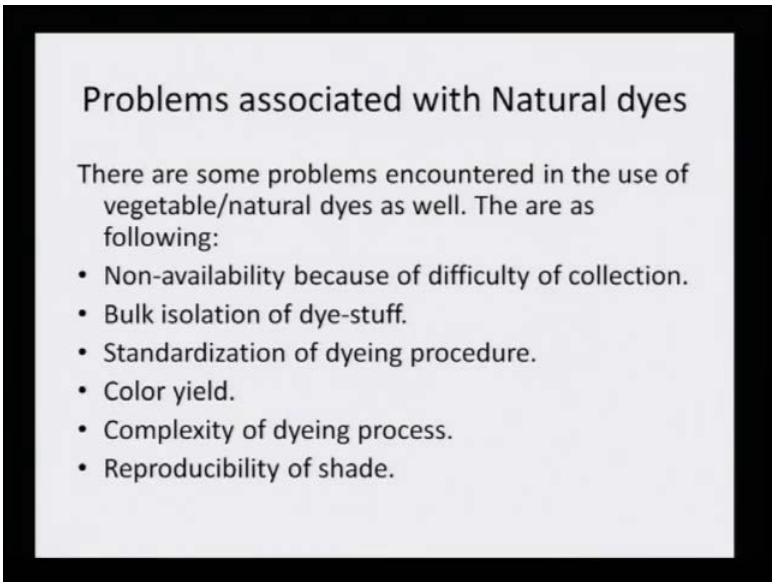

Problems that are usually associated with natural dyes are that, there are some problems encountered in the use of vegetable or natural dyes as well. They are the following: Non-availability because of difficulty of collection; bulk isolation of dye-stuff; standardization of dyeing procedure; color yield; complexity of dyeing process; reproducibility of shades. You see it is true that for quite some time back there was no organize forming for natural dyes, because the importance of the utility or the market was not already set up.

Therefore, there was some times this problem of non availability not all dyes can be available throughout the year, because some of the flowers are seasonal. So, all those non

availability problems of not having an organize forming, not having no at throughout the year production of the colorant moiety where some of the draw backs. Then bulk isolation: You see doing it in a house or in a hobby club or in a little kitchen; it is possible to take this much of plant material and to extract. As I told you that the colorant is only 2 to 5 percent. So, imagine that if I have to make 1 kg of dye then I need almost 100 kgs of that plant material, how do I fit into extract that how what would be the kind of vessel that would be required in so on. So, bulk isolation of dyestuff - natural dyestuff is a problem, and therefore, big factories need big kind of extractors to do this.

Standardization of dyeing procedure: See first the thing is standardization of the dye itself, because as I told you climatic conditions of the same plantation can make a difference in the dye content. I will give you an example, if suppose indigo leaves are grown in Bihar and the same indigo leaves are grown in somewhere in south, they because of the soil condition, because of the climatic condition the indigo leaves will have different content of indigo tin. And therefore, there needs to be a process of standardization, the next chapter deals with that.

So, we will come to that a little later, but at the moment these are some of the disadvantages or problems that are associated with natural dyes. Then the color yield, color yield in one batch of the plant extraction could be 2.5 percent, in the next batch it can be just 1.5 percent. So, you see that one cannot assure that always it will be the same constant factor.

Complexity of dyeing, they, of course, natural dye requires a different kind of dyeing procedure and when we do the basic of natural dyeing we will learn that in more detail,, but for the time being it is important for you to know that these are some of the drawbacks. And then reproducibility of the color, because of the dye content not being standardized in a particular batch of extracted dye - natural dye, it is not always possible to reproduce the same color, the same shade. And this shade variation is not acceptable in the industry, because commercialization factor depends on what consumer wants and if the consumer wants the same shade we cannot offer any other thing other than that.

Therefore, we have certain disadvantages, but nevertheless we also have hand in hand going that there are certain very pronounced advantages of natural dyes.

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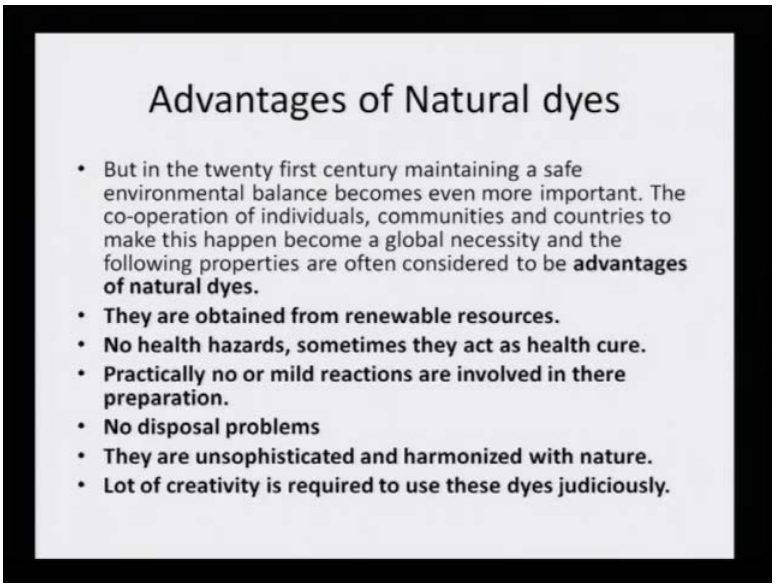

But in the twenty first century maintaining a safe environment balance became very important factor. The co-operation of individuals, communities and countries to make this happen become a global necessity and the following properties are often considered to be advantageous in terms of natural dyes and natural dyeing. They are obtained from renewable sources no health hazards, sometimes they act as a health cure. Practically no or mild reactions are involved in there preparation; no disposal problem was noticed; they are unsophisticated and harmonized with nature. Lot of creativity is required to use these dyes judiciously.

So, you see that one can play around with these natural dyes mix and match and create new colors. Then because they are totally bio-degradable, there is no disposal problem, then because the reaction of this natural dye with the fabric is facilitated with the help of moderns. There is there is mild kind of reaction that is done.

But more so much, there is no health hazard. So far, we have not seen any case of toxic natural dye which is in use. Whereas, we saw that so many synthetic dyes were found to be toxic and that is why the azo ban came into existence.

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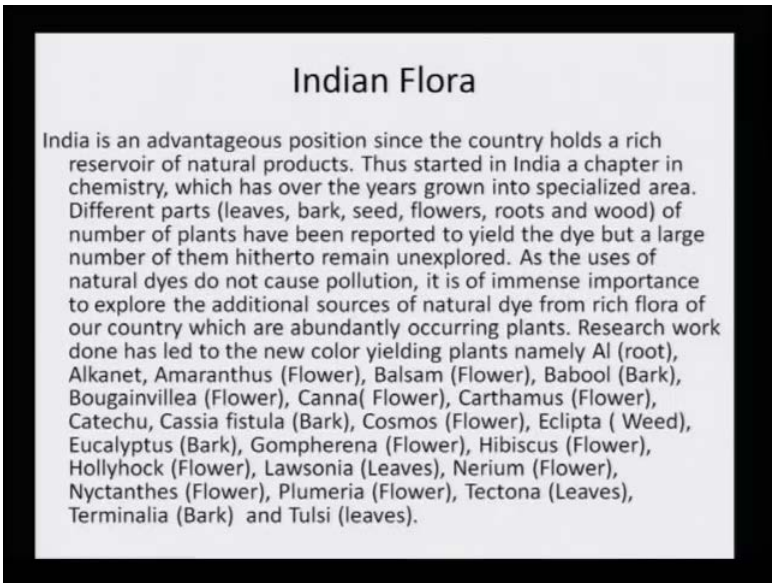

Indian flora: India is an advantageous position since the country holds a rich reservoir of natural products. Thus started in India a chapter in chemistry, which has over the years grown into specialized area. Different parts like leaves, bark, seed, flowers, roots and wood, of number of plants have been reported to yield the dye, but a large number of them hitherto remain unexplored. As the uses of natural dyes do not cause pollution, it is of immense importance to explore the additional sources of natural dye from rich flora of our country which are abundantly occurring plants. Research work done has led to the new color yielding plants namely Al – root, Alkanet, Amaranths – flower, Balsam – flower, Bamboo – bark, Bougainvillea – flower, Canna – flower, Carthamus – flower, Catechu, Cassia fistula – bark, Cosmos – flower, Eclipta – weed, Eucalyptus – bark, Gompherena – flower, Hibiscus – flower, Hollyhock – flower, Lawsonia – leaves, Nerium – flower, Nyctanthes – flower, Plumeria – flower, Tectona – leaves, Terminalia – bark, and Tulsi - leaves.

You see, I am just listing a few of them, there are huge number of plants which have colorants and which are dye yielding plants, and you will see that when I read out all these names. It is not only the flowers; it is the leaves; it is the barks, all have played a role in being natural dyes source. So, this is the kind of rich Indian flora that we have and throughout the country, because there are different temperatures conditions and we have a variety of culture, the soil conditions are different. Therefore, the vegetation that grows

in the north-east are very different from the vegetation that grows in the southern part of India.

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And so, we have a huge variety of flora specialized technique for dyeing. It is a specialized technique for dyeing of the fabric and yarn of cotton by natural dyes for the lovely shade using common mordents like alum and salts of iron, tin and chrome with good wash fastness and light fastness. It is really stands for the pride and glory of the craft of India as this art of natural dyeing has been in Indian as this art of natural dyeing has been in Indian culture from a very long time. Because of the beauty of its results, those who use them, claim that no chemical dye has that luster and under glow of rich color that delicious aromatics smell and the soft light and shadow that gives so much pleasure to the eyes. These colors are alive as all beauty is alive.

So, you see I am just trying to make you understand that natural dyes of their own very enriching experience, because they have very smooth and siding color, therefore, they are more appealing.

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Now collection of dye; that is what you know is a very big challenge, because how to collect these plant material. Plants can be collected from wild forest or grown them, or purchase dye plants from shops specialized in natural dyes. You may have some plant dye plants already growing in your garden, since you can extract interesting colors from a range of common garden and roadside weeds. If you collect plants or plant parts for dyeing, to be sure to use plants that grow in abundance, taking care not to collect any rare or protected species, and also one should bear in mind then one should not destroy the plant; that means, not use the root part for color extraction. Any part which is above the root can be you know a source of renewable source of plant part.

You may need a lot of plant material a four-to-one ratio of fresh plant material to fabric - by weight, for dyeing is generally recommended, and plant fabric like cotton require even higher proportions. Kids can have fun experimenting with different proportions of plant material.

The list below includes just a fraction of plants others have to use the produce dyes. Your results will depend on the host of factors, including the soil type, moisture content, mordant used to bind the dye - if any, to the fabric; and then the ripeness and the freshness of the material, how finely it was shred, and proper a proportion of the plant material to fabric.

So, dyeing is not an easy job; it is an art, but the first and the primary factor to get into that art is to be able to extract maximum color of the dye, so that you have the maximum colorant in hand to play around and do the dyeing.

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Now, some of these common plants that have been used I will just show you have some of the slides these are flowers which we have probably seen. The garden flowers I would now like to show you the entire list of plants that is available and as you go along you will see that garden flowers range from scenario or which is popularly known as Scenaneria, Tagetus erecta or gander then we have Portulaca, Plumeria, Nerium and Mirabilis, Ixora, Balsam, Hibiscus, Hibiscus Mutabilis these are all flowers that were used.

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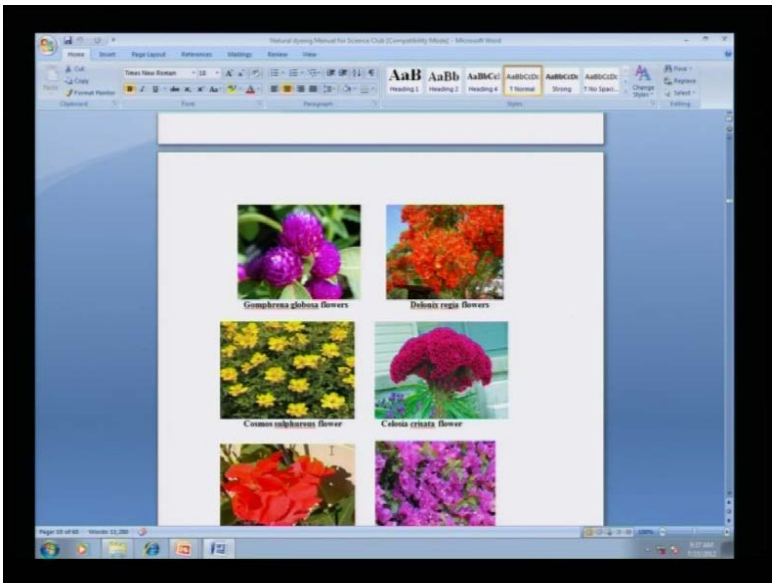

And then this is Gomphrena, Delonix, Cosmos we have just named all these and these are all as you can see the colors, they are all very rich in color. The Canna indicia flower, the Bougainvillea flower, Hollyhock flower, Nyctanthes, Nyctanthes - you will see that there is an orange stem; the flower is white, but this has an orange stem, so that is a very good source of dye.

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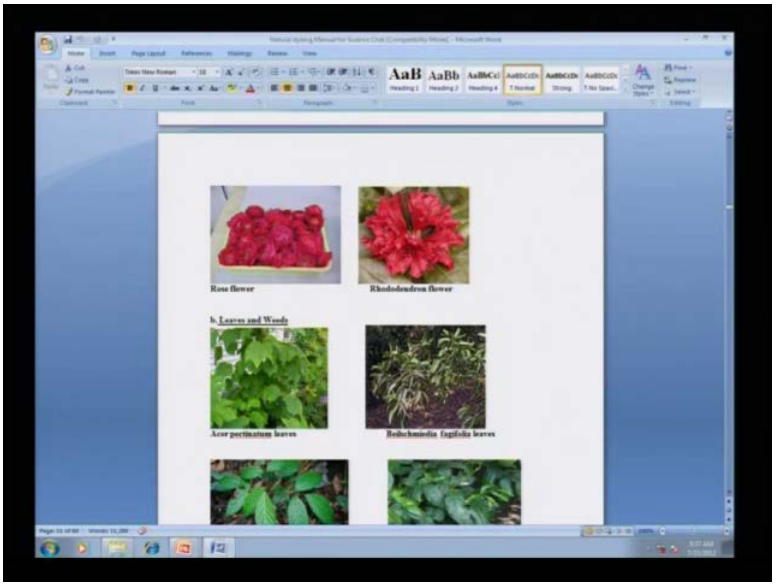

Then we have rose not to forgot that we have so many varieties of roses, but the red variety of rose elutes the best color. And we have Rhododendron, then coming to the

leaves and weeds we have this leaves Acer Pectimatum we have this Beilschemiedia, we have Bischofia, we have Camellia, Camellia is a tea leave.

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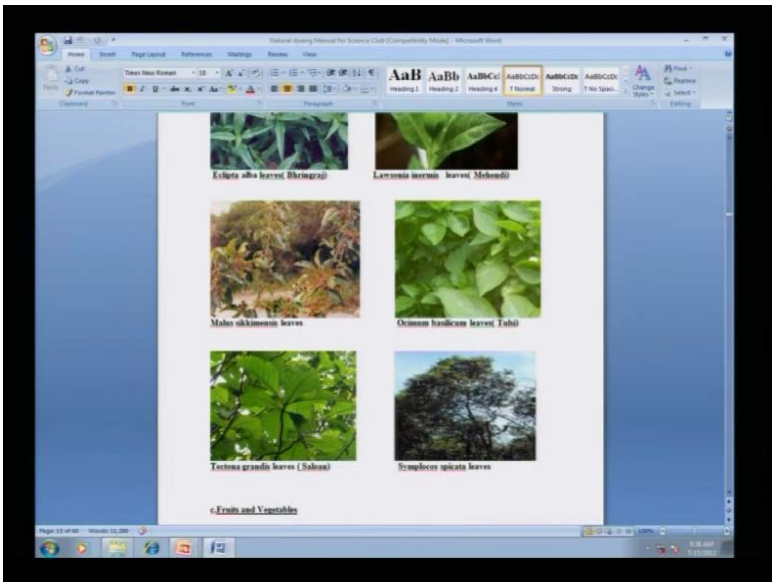

Then we have ecliptic we just named a few of these plants. Lowsonia is the mehendi plant then we have Malus Sikkimesis we have Ocimum that is the Tulsi, then Tectona grandis which gives red color although the leaves are green in color. And we have Symplocos spicata these are some of the leaves that have been used

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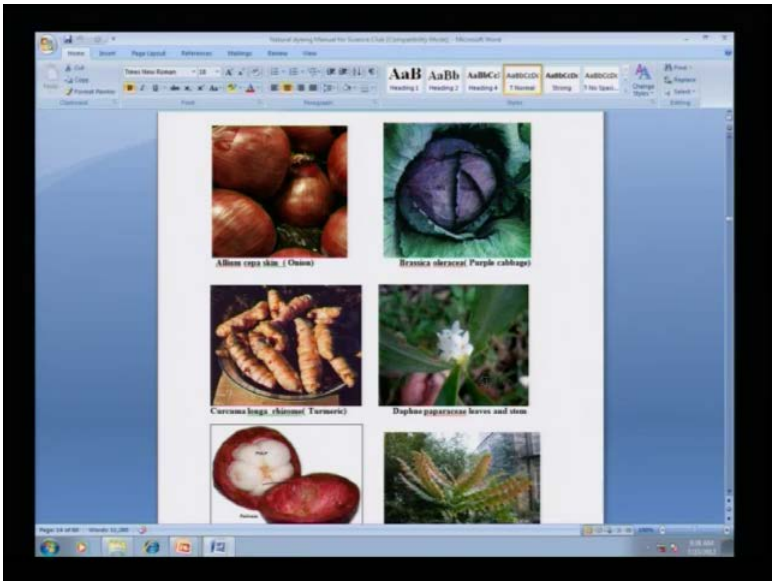

Then we have fruits and vegetable. Now this is you can very well recognize is onion under outer skin of the onion, there are purple cabbage, this is cucumber longer that is turmeric, then this is Daphane leaves and stems which are also source of dye. Garcinia fruit cover is also a dye source Mahonia nepaulensis then we have marinas Tripoli we have melastoma ne nephredium and paprika and panics. Punica is nothing but anaar, an anaar (( )) is a very good source of dye.

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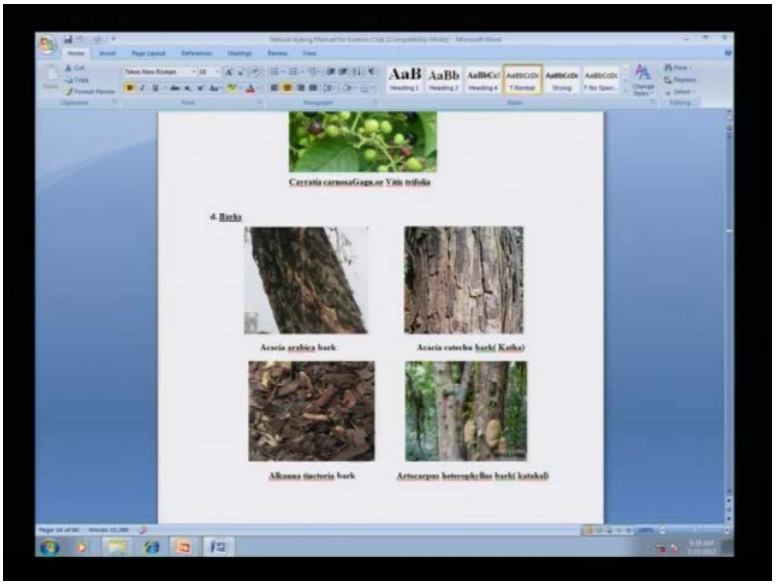

Rubbia cord folia stems then we come to some of the this Cayratia is a wild blue berry then we come to some of the barks which have been popularly used such as Acacia Arabic, Acacia catechu, Alkana tinctoria, Artocarpus is nothing but jackfruit bark.

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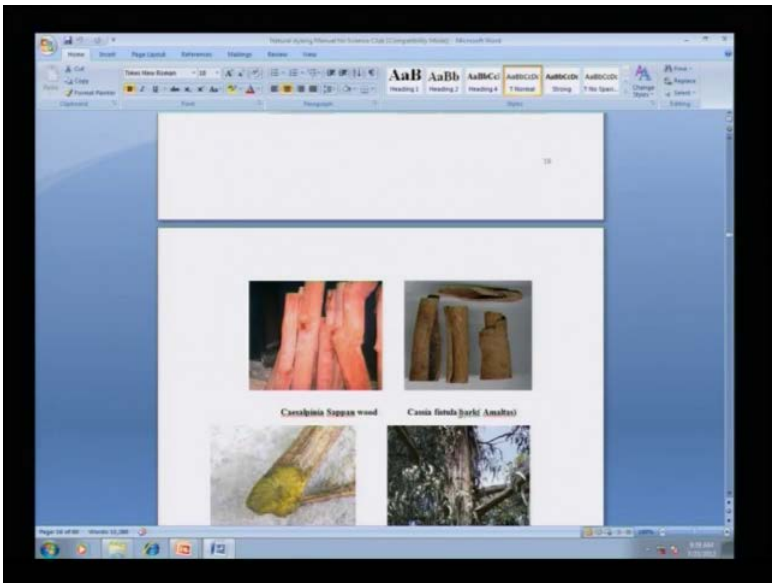

Then caesalpinia that is sappan wood this is the one which I said where we use the solicitor extractor for the first time. Cassia fistula or amaltas then different types of other eucalyptus bark coscinium, melanorrhea uasmata, pasania and salacia were all used as the bark was the source of dye.

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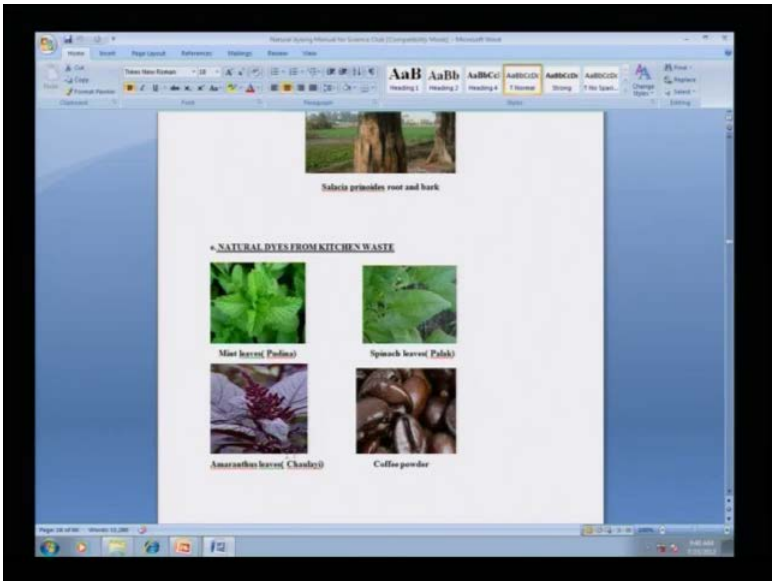

Then comes the dyes from the kitchen waste. You know, we throw away lot of plants or some of these vegetables that are that we eat also can be a good source of dye one is

meanly that is pudina, spinach which is palak, amaranthus leaves which is chaulayi, then coffee powder is also another source.

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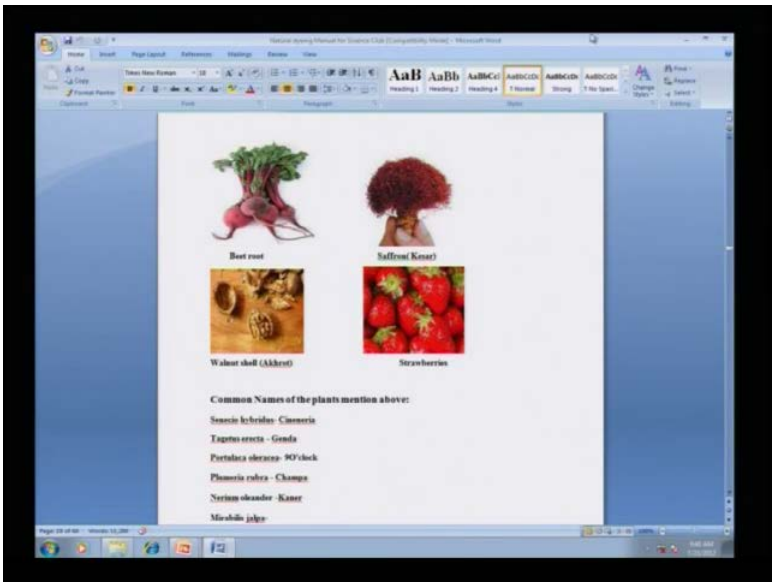

Beet root, saffron, walnut shell that is akhrot, strawberries and the list is you know never ending, but nevertheless I just wanted to bring to your attention this particular list because it is of importance for you to know which plant to choose and when to choose.

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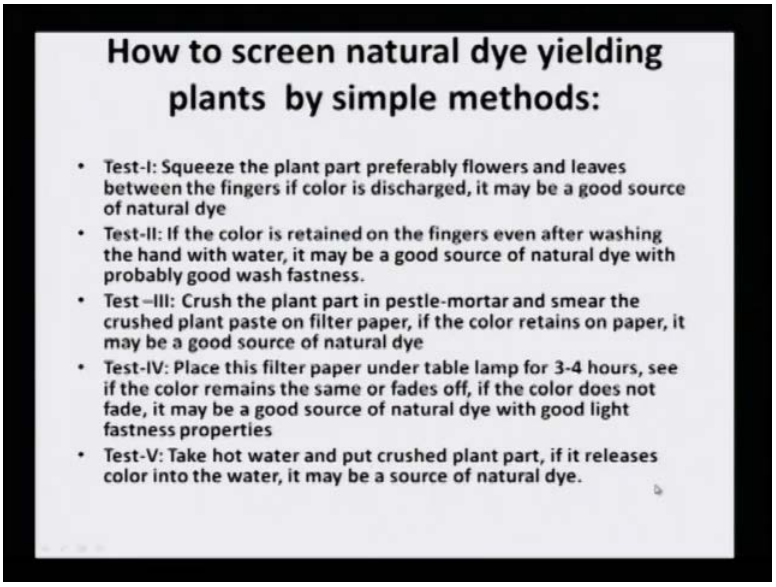

How to screen a natural dye yielding plant by simple methods: Having chosen that this is a plant which is giving very bright colored flowers. So, whether there flower or the leave

or the bark or whichever part we are using or the fruit skin how do we understand by simple methods that it has done.

The first test that can be carried out is squeeze the plant part preferably flowers and leaves between the fingers if color is discharged, it may be a good source of natural dye. So, simply crush it between your leaves and see whether any color is coming on the finger tips. Second test will be if the color is retained on the fingers even after washing hand with water it may be a good source of natural dye with probably good wash fastness. So, the second test would be the colorant that is come onto the finger, you just try to wash it with water, if it runs off then it does not have a very good wash fastness, but if it still retains on the skin it means that it is having a good fastness property.

Third test would be crush the plant part in pestle-mortar and smear the crushed plant paste on the filter paper, if the color retains on the paper it may be a good source of natural dye. So, the second or the third test could be just you know grind it on the pestle and mortar and then try to smear this paste on the filter paper, and see whether any color is coming on the filter paper. The fourth test could be place this filter paper under table lamp for three to four hours, see if the color remains thus the same or fades off. If the color does not fade it may be a good source of natural dye with good light fastness properties. So, this these are some of the simple methods of finding out whether the dye has a good wash fastness or the dye has a good light fastness and therefore, one should do this test first if one is working with the completely new plant.

Of course there are many many plants which are now established as good dye yielding plant, but if these test are simple test which are required to be done only when one is screaming new natural dye sources. The fifth test is taking hot water put crushed plant part, if it releases color into the water - hot water, it may be a source of natural dye. Because just by giving colored water does not mean that it is fit into the category of dye.

I told you a dye is only acceptable as a dye or any colorant molecule will become a proper dye, if it has good wash fastness good light fastness and good adherence to the fabric. I gave you an example of turmeric, white turmeric failed as a good dye although it is very rich in yellow color and we all use it in our cooking and it gives very good yellow colored vegetable when it is cooked, but the same when it is applied to the fabric is not a good dye because it does not have a good adhering property and it fades in light. So,

these light fastness and wash fastness and not good adherablity to the fabric made turmeric not a good dye. So, the way the plant needs to be collected and stored is also very crucial.

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Collect of plant material from your region. A good rule of thumb is to have any color part of the plant. This is true for at least the flowers, fruits, fruit skin, leaves bark, but you may find other plants yield as much die with less collected material, especially when they dry out. Flowers yield best color when used fresh, but still yields color when dried. We tried this experiment with fresh canna flowers and dried canna flowers and we found that you know both give almost equal amount, but this may not be true for all the plant parts.

Fill the pot with plant material and cover with water. Boil at least for one hour, at this point you may want to let the dye bath stand at room temperature overnight. This will release more dye from the plants. To test the color, submerge a glass jar into the dye bath. The water should show some deep color. Strain the dye bath through the screen into another container and dispose of the plant material into the composed pile. Pour the dye bath back into the dye pot. Submerge the mordant fabric for dyeing. So, this is how it is done, but most of the time, the same dye bath cannot be used where the extraction is done why because the extraction is done at a much diluted level.

Almost ten times water is taken as compare to the plant material or sometimes even twenty times water is to be taken. So, therefore, the dye solution is very dilute. So, once the plant part is strained out then it needs to be concentrated and brought to a concentration where there is almost like 4 to 5 percent of dye in water. So, if that is the kind of concentration that can be reached then the dye solution is ready for dye, otherwise it is a very dilute solution and will not give the required color.

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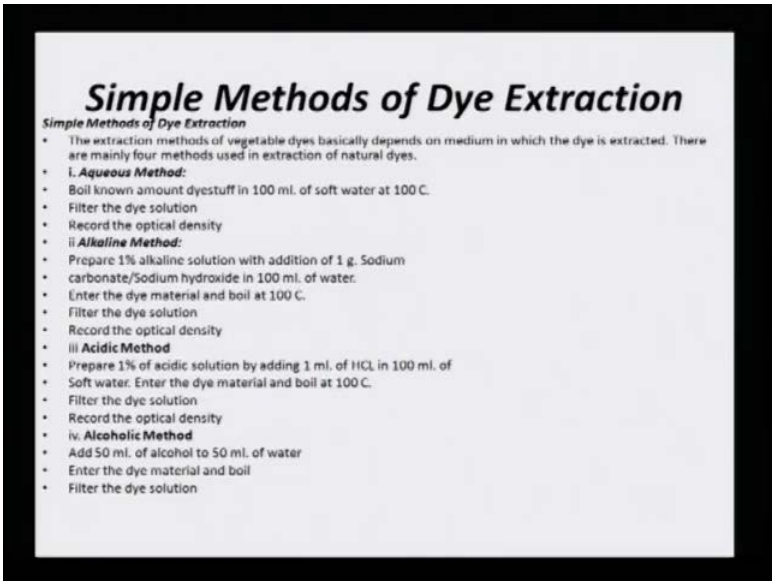

Simple method of dye extraction: If one tries to explore new, you know areas of dye extraction. The simple method of dye extraction of course, would be that the extraction methods of vegetable dyes basically depend on medium in which the dye is extracted. There are mainly four method used in extraction of natural dyes. Now please do not get confused with the methods of extraction that I gave you. This is like you know on a laboratory scale, if you are screening a new dye then how you should follow. Whether you should have an aqueous extraction, whether you should have an alcoholic extraction or whether adding a bit of acid would help or whether adding a bit of alkaline would help that is what is meant by these simple methods of extraction.

Now let us try to look one by one. Aqueous extraction, boil known amount of dye plant in 100 milliliter of soft water for at 100 degree; that is boiling water. Filter the dye solution and record its optical density. And see whether how much of the colorant has come. Similarly, alkaline method would be that in the water solution or the water that is

used for extraction one percent NAOH is added or one percent sodium carbonate is added and then the dye material is you know extracted. So, that would also show whether the dye has come more or less than the previous method.

Similarly try out a third method, because this is a screening method. So, it is important to know the dye content on which of the method will be the best method for dye extraction is what is being evaluated. So, first a simple water method then by adding one percent alkaline solution either sodium carbonate or sodium hydroxide and then extract it. And other similar condition or a third type would be that one percent acidic solution of dilute HCL is added to the same water and then extracted under the same conditions of boiling water and then the optical density is recorded.

And the fourth type is to use methanolic solution. Using 50 percent water and 50 percent methanol and then carrying out the same experiment and trying to find the optical density. You will see that in all the cases I am saying that record the optical density; optical density is recorded on UV-machine, we have learnt about UV-visible spectrophotometer just a while ago and that gives an idea about the absorbance and the lambda max. So, we will also get an idea whether we are getting the same dye from all the four processes or we are getting different dyes, because different dyes will have different lambda maxis first thing. Second thing are we getting the same amount of dye will be given by the absorption that is coming in the UV. So, UV recording the optical density will give us a lot of information as to which procedure is the most because you see the extraction procedure should be very efficient; that is the bottom line. And if that is to be achieved then one should use the method which gives the maximum which is able to extract the maximum amount of dye.

So, how do we evaluate which process is best? We evaluate on the basis of the optical density. So, UV machine identification is must and UV gives us the not only the amount that is extracted per each method, but it also gives us the lambda maxis of the dyes if they are the same then we will get only one lambda max, but if variety are you know extracted. By these various methods and we will get different lambda maxis. So, you see that this method becomes very, very efficient in helping us to identify the natural dye that is present in the new source. So, it helps in screening; it also helps us in telling us whether this is a potential dye, a yielding plant or not.

And the amount which will be extracted in which kind of whether alkaline solution, acidic solution, aqueous solution or alcoholic solution which is the best method of extraction and then once having achieve that, we understand that this is a method of screening. We also understand the number of colorants that will be co-extracted. We also understand what is the lambda max and therefore, we get some idea about the structural variety whether it falls in the category of flavanoids or anthoquinoids or a indigoids or dye hydro parent type of chemical structure dye. So, a lot of information can be obtained by the use of ultra violate spectrophotometer.

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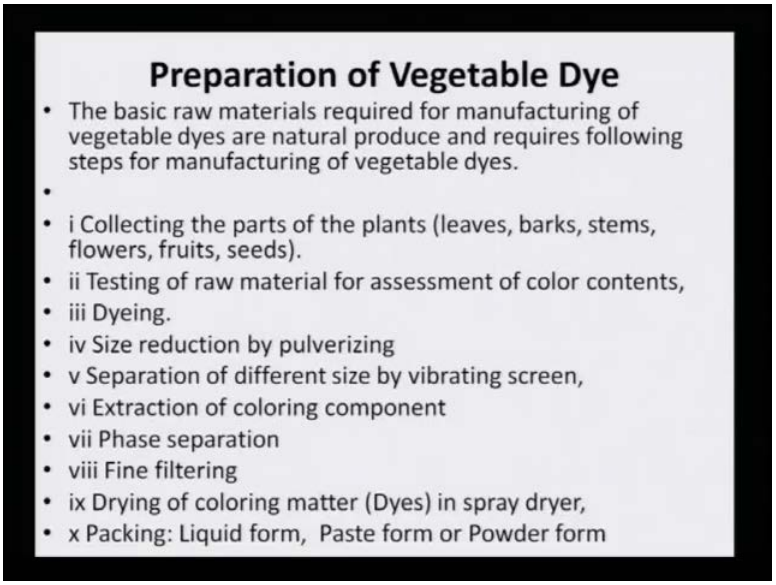

Preparation of vegetable dye: The basic raw material required for manufacturing vegetable dyes are natural produce and requires following steps. Collecting of the plant parts; that is leaves, barks, stems, flowers, fruits or seeds. When testing of raw material for assessment of color content which will be done by the method that I just mentioned, then using it for dyeing; size reduction by pulverizing. Separation of different sizes by vibrating screen, extraction of coloring components, phase separation, fine filtration drying of color matter; that is the dyes in spray dyer, and then packing it either in the liquid form or the paste form or powder form.

So, these are the various methods were preparing having screen that yes this is a potential natural dye or vegetable dye plant, then these are the following steps. First is to collect then to pulverize then to extract by various methods - that is the aqueous method,

the alcoholic method, the alkaline method and the acidic method, and then with the help of UV machine, we can screen out and see which is the best method. Once that is done, the extraction is carried out, and after extraction the phase separation; that means, the biotic material which is a based sent to the composting pile and the extract is then concentrated. And concentration should be such that it should not deteriorate the plant dye material.

So, the concentration should be done on rotary evaporator under vacuum. So, that it does not hamper the chemical structure or it does not destroy its quality. And then of course, it can be packed as liquid dye or paste dye or powdered dye. So, with this we have come to an end of the standardization method of screening. And you have understood that these methods are very important when we are trying to identify new plant sources I give you a huge list of about fifty four plants which have already been extracted and use in our laboratory.

That shows that there is still a big scope because the Indian flora is, so rich in dye yielding plant that there is still many, many dye yielding plant that remains unexplored. So, there is a lot of scope of research in this area, because all the time the industry needs new colorants and colorants in huge quantity their availability. Organize forming are being encouraged, agricultural lands are being used for growing natural dye yielding plants.