Natural Dyes

Prof. Padma Vankar

Department of Chemistry

Indian Institute of Technology, Kanpur

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When we try to see that certain procedures have been developed in the laboratory, whether it comes to dyeing or any other technological advancement, how well is it accepted in terms of the its popularity with the industry. Whether, the industry is happy to have this technology or when any innovation is brought about has it got any advantageous situation or not, is what matters. And we have seen that when we were trying to disseminate the innovated technology, it was very well accepted; particularly we had a big demonstration at the Swaraj ashram where they are they were in to dyeing a lot of fabric and yards and yards of fabric are being dyed every day.

So, in a organization like that when innovative technology is introduced, how acceptable it is for that particular organization to take it up. As we go along this lecture, I will give you an overview of the innovative natural dyeing technology that was develop and then finally, disseminative to the industry.

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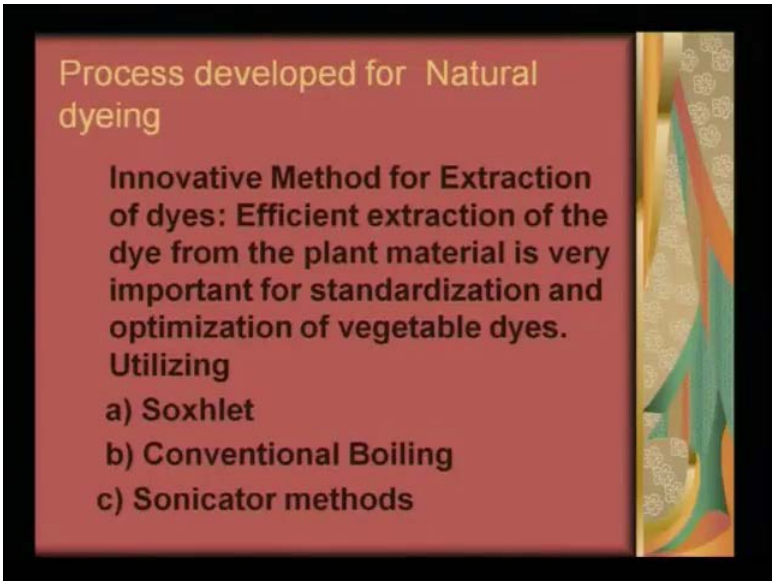

The processes that were developed in the laboratory for natural dyeing consisted of innovative method of extraction of dyes. We because the problem with the industry was that they did not have good methods of extraction; they only knew one method of extraction and that is conventional extraction.

So, therefore, it was important to be able to give them some new methods of extraction and the innovative methods of extraction that were developed were scaled up for the industrial purpose. So, efficient extraction of dye from the plant material is very important. For standardization and further optimization of the vegetable dyes, and utilization of soxhlet conventional boiling and sonicator methods were introduced. Because they had this severe mental block that they will not use natural dye because the process of extraction is very elaborate.

So, we try to break this myth and we try to show that within four hours in a soxhlet within two hours by conventional boiling and within an hour by sonicator method dyes can be extracted very easily from fresh plant parts or dried plant parts. So, one full exercise was dedicated to the process of extraction of natural dyes.

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We were in the process of popularizing natural dyeing and the use of natural dyes. Because after the German brand and the Indian brand there was a very serious condition of offering some good dyes for the dyeing industry, and as a very serious scientific exercise we try to bring in this innovation, so that it is acceptable and doable by the

industry. The innovations that included were improved extraction process, less use of metal mordants, introduction of enzymes in dyeing use of bio-mordants, innovative method for dyeing, optimization of dying process.

So, these were the main line of action we were we planned our technology in a manner whether we can improve any we can bring about any improvement in the extraction of the natural dye, whether there is a possibility to reduce or completely avoid metal mordanting, and in place of that can be use enzymes and bio mordants. And just in the previous lecture I describe that we have come up with many celluloses, proteases and other enzymes plus bio-mordants derived from Pyrus pashia and eurya accuminata - that they can replace metal mordants salts that is what we were using as alum, ferrus sulphate, copper sulphate, potassium dichromate can be completely avoid the use of that.

Then introduction of enzymes, of course, this was done for the first time by us. And then innovative method of dyeing can be now sonicator method of dyeing has now become a very innovative method of dyeing, and overall can we optimize the entire dyeing process if we can do that we can really say that yes we have come up with some innovation we have an innovative technology, otherwise the conventional methods were any way found to be a quite cumbersome.

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Quality standards of natural dyes: Quality standards of natural dyes vary widely, so it is necessary to first contact an importer to find out what they are looking for. The problem

arises with standardization of the colors as no two dyes lots are identical, technicians in the pharmacology, food and textile industry loathe this lack of inconsistency.

For attempting repeatability of shades of textile dye dyeing the recommended procedure as mentioned in the earlier chapters where we have lecture, we have already mentioned certain things I will still further repeat that it is necessary to practice at least that much. Use of only stainless steel dye baths, you saw that all the dyeing machines which were made for industry or made out of steel, why? Because any kind of other metal machine or metal made machine can create problems in the dye color or dye extract and subsequently the dyeing on the fabric. Water hardness was also emphasized in several several lectures, because water if it is not of the proper softness level will create interferences in the dyeing process. And yarn to water ratio should be 1 is to 20. So, at least these three must be always remember be it a laboratory dyeing process or be it an industrial dyeing process.

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Now, this is a typical jigger machine where we used our natural dyeing process and you will see that a man is manually rotating the fabric, and the fabric is going in to the dye bath and at the same time the entire process is done in a such a fast manner that for a particular time not too long the fabric is in the dye bath. So therefore, and because it is in circulation the dye…

So, as you see that it is in old jigger machine which we try to use for our natural dyeing exercise, and whether it is a new mordant jigger machine which we learnt yesterday type of a model or an old machine in all the case or in both the cases the adaptability of natural dyeing is facilitated or is shown. And therefore, we try to teach or we had an awareness program and you know demonstration lecture demonstration of natural dyeing exercise, so that the technologies that were developed in the laboratory could be actually translated to the industry.

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Similarly, this is a winch machine which was shown for silk dyeing. As I told you in the winch machine there are two wheels and cloth is actually rapped or like a rope and then put in to the dye bath there is a dye bath at the bottom, and it was showing very good dyeing results for silk and wool yard.

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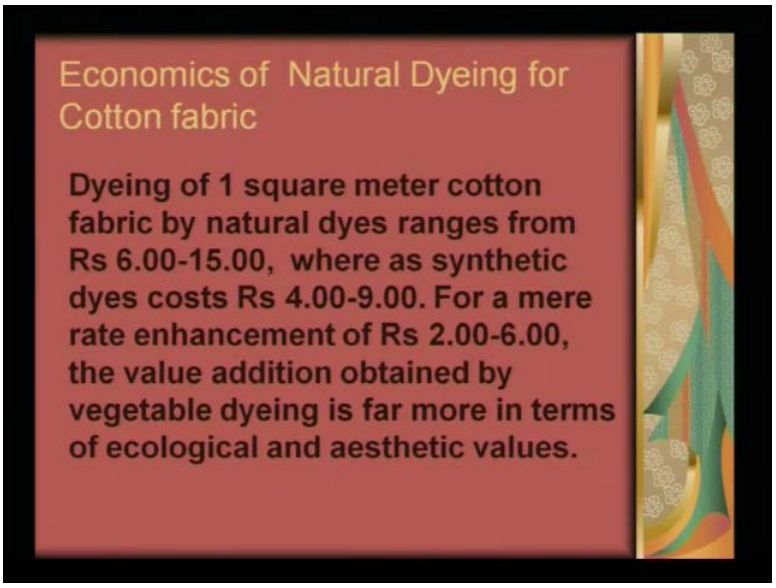

Economics, when we come to anything has to be cost effective. This is the bottom line no industry will take up any innovation, if the innovation is very costly. So, we were trying to show them that there is a definitive economic control over these natural dyeing exercises. Dyeing one square meter cotton fabric by natural dyes ranges from 6 rupees to 15 rupees; whereas synthetic dyes cost about 4 rupees to 9 rupees. So, for a mere rate enhancement of 2 to 6 rupees the value addition obtained by the vegetable dyeing or natural dyeing is far more in terms of its ecological and aesthetic value.

You see when it comes to dyeing? The synthetic dyes became popular because they were very cost effective. So, one several myths were created and these myths were that you know natural dyes are not available, natural dyes are if they are available they are very costly. So, we try break these myths and we try to show that that is not the case truly. Because we try to show that one square meter cloth, if it is dyed we bought that dyes from the dye natural dye producing companies and we showed that it only ranges from 5to 50 sorry 6 to 15 rupees. Whereas for a synthetic dye you know the cost of dyeing the same material to the same dye depth was about 4 to 9 rupees. Now, there is a mere enhancement of 2 to 6 rupees, but the value addition that it add is far more.

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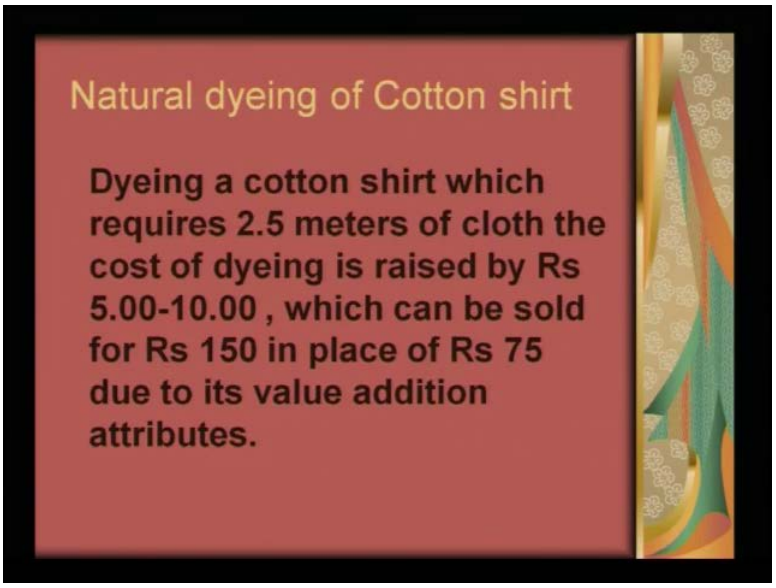

If we take an example of dyeing a cotton shirt, because these were some items that was regularly produced by the Swaraj ashram. So, we try to actually show them fabric by fabric or garment by garment that what is the cost of the natural dyeing process, and compare it with the synthetic analog. Dyeing a cotton shirt which requires about 2.5 meters of cloth, the cost of dyeing is raised by rupees 10, 5 to 10 rupees, which can be sold for 150 rupees in place of a shirt which was initially sold at 75 due to its value addition attributes. So, you see that this kind of you know cost can be charged more if it is a natural fabric, naturally dyed fabric. You know there are mean many (( )) and many such outlets have come up which are giving or which are selling only naturally dyed fabric and they are raising the price because that can increase their profitability. Now, this profitability plus it is you know come being not hazarded, not toxic, and non allergenic is an advantageous attribute of naturally dyed fabric.

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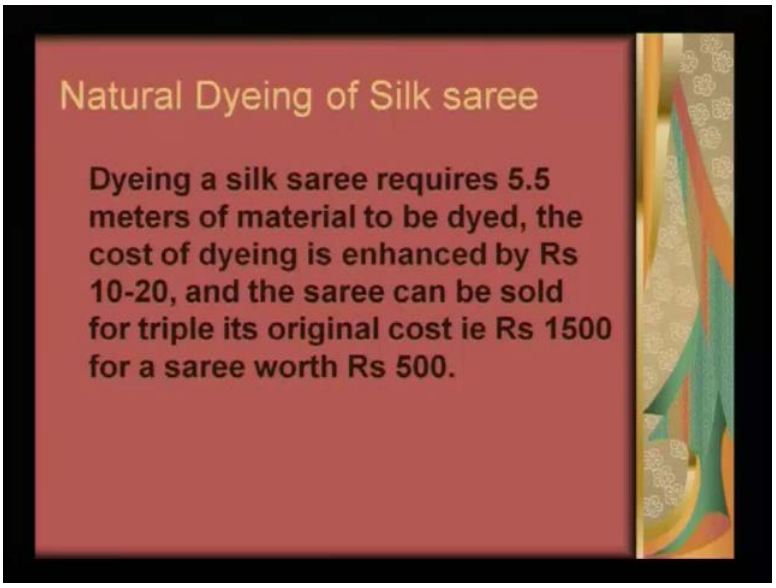

If we take an example of a silk saree, dyeing a silk saree requires about 5.5 meters of material to be dyed, the cost of dyeing is enhanced by 10 to 20 rupees, and the saree can be sold for triple its original price that is from rupees 500, it can be sold to 1500. A silk saree that would was you know available for 500 or may be little more now a days when we did this exercise about 5 years back it is the data from that time and it can be sold for 1500 rupees. So, almost a three, four enhancement in the profitability can be obtained by using natural dyes and the cost affectivity has already been worked out.

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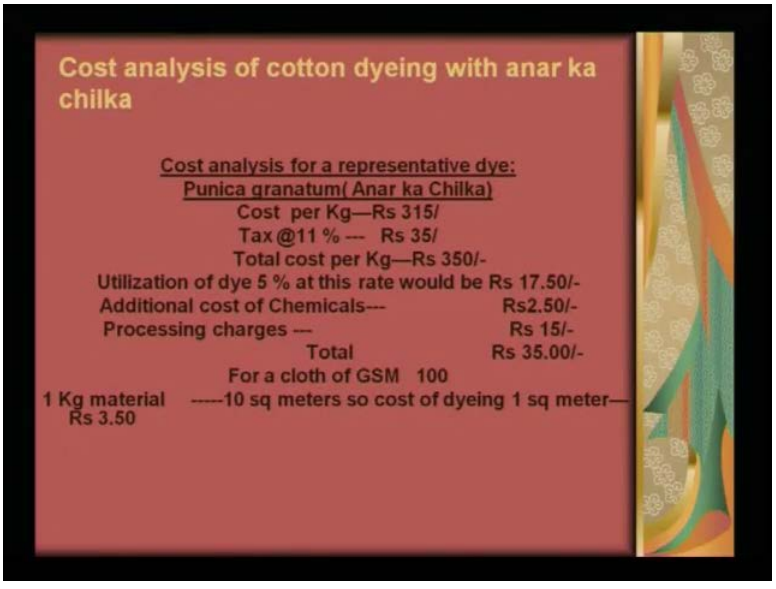

Now if we just try to cost make a cost analysis of cotton dyeing with Anar ka Chilka that is the Punica granatum skin cost of an analysis of a representative dye Punica granatum Anar ka Chilka the cost per kilogram is about rupees 315 and including 11 percent tax and so on and so forth. The total cost per kg comes out to be 350 rupees per kg utilization of 5 percent of the rate would be that 17.50 percent, 17 rupees will be required for dyeing. Additional cost for other chemical processing would be another 250 rupees, 2.5 rupees and processing charge and all that inclusive will be 15 rupees. All put together will be a costing only 35 rupees. For a cloth of GSM 1100 one kilogram material can actually dye 10 square meters. So, the cost of dyeing of one square meter would be like 350 rupees. So, you imagine that the cost enhancement is only 3 rupees 50 paisa; whereas the cloth can be sold for almost double or triple the cost, plus it as its own medicinal, and other non toxic, non allergic and other benefits it has a very southing color and therefore, it is very acceptable.

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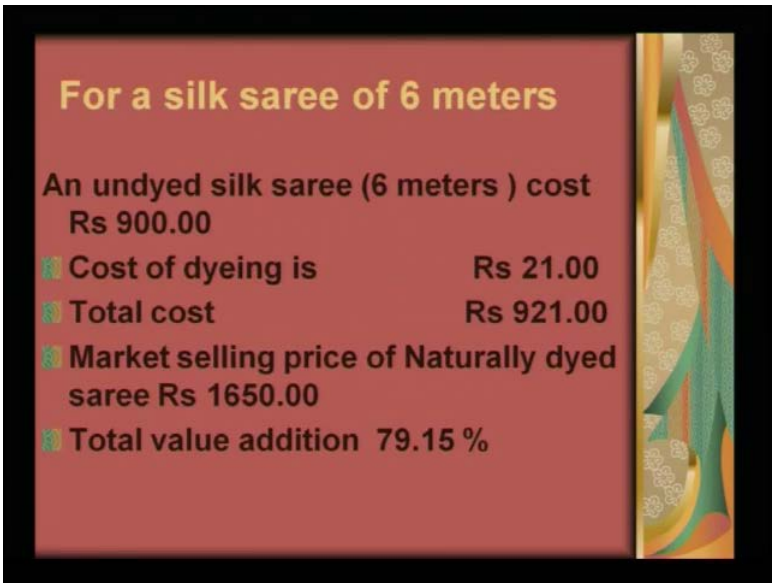

For a silk saree of 6 meter - the undyed silk saree cost about 900 rupees; cost of dyeing was worked out to be 21 rupees, and the total cost that was spent on the dyeing process of a silk saree was almost like 921, but the market selling price of this naturally dyed saree was above 1650 rupees. So, there was a total additional value addition of 79 to 80 percent on the same material. And this is a big game, because if we try to look at the cost analysis.

So, has the innovation has the introduction of natural dyes into the market, really made any impact, yes it has and that is the reason, why so many boutiques, so, many outlets with naturally dyed fabric only are coming up and these sell they are goods like hot cakes. So, it is because there is a demand in the market there is also the so, I mean the producers are prompt it to meet this demand. If there was no demand in the market, these outlets would be just sitting with their stuff and it would not be sold for this price. People are ready to buy these prices simply because they have understood the usefulness of natural dyes and natural dyed fabric. It is not that the research and the revival has come only because of the German brand and the Indian brand. It is because the market now needs a substitute for these dangerous toxic synthetic dyes, and this alternative or natural dyes has really brought about or real (( )) in the dyeing industry.

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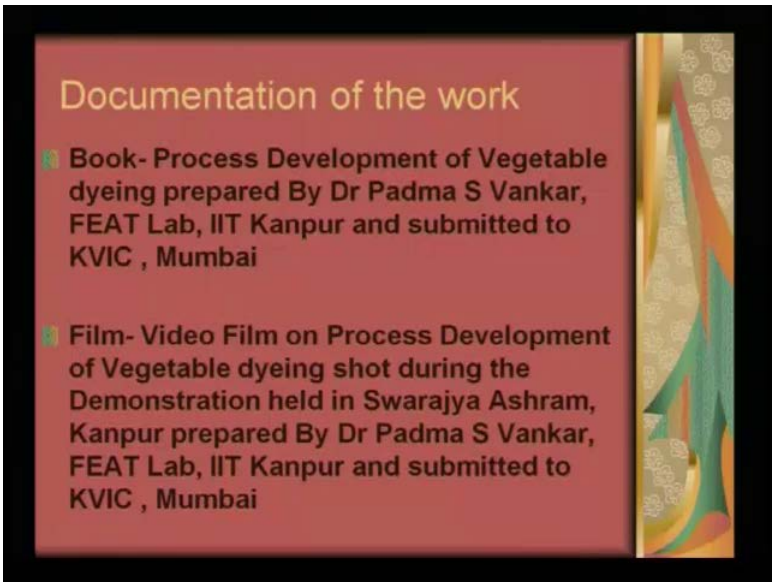

When we try to you know do this innovation work, we try to put in the book form process development of vegetable dyeing and it can be produce this document primarily for the Khadi and Gram Udyog village industries, and the book has been submitted to KVIC. Similarly, we shot a video of the entire processing and we submitted it to the Khadi process, Khadi gram udyog commission, and this film was known as process development of vegetable dyes which was shot during the demonstration that was held in Swaraj ashram. And it was developed by FEAT lab, IIT Kanpur.

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Now when we try to look at the various pure natural fabrics; that is cotton, silk and wool. Silk dyeing with different newer mixer of natural dyes sources was specially developed for khaki garment industries. Because it was found that many, many new hue colors can be offered. No, the problem with you know switching over from synthetic to natural was mainly the color gambits that the synthetic dyes offer and so, if we can mix and match several dyes in the same dye bath, or we can do sub sequent dyeing with different dyes, it can create a huge number of colors and shades and therefore it will be accepted. So, as you would recall that in one of the lectures, I gave you certain recipes, and those recipes can be further repeated or more permutations combinations can be carried out. So that, these dyes can be accepted for many many color generation.

Cotton dyeing the same way with new combination of natural dyes for cotton Kota and chicken embroidery was also popularize. We have done one full exercise with chicken embroidery people. And we try to show because in this sector, it was only synthetic dyes they were using only synthetic dyes for dyeing the fabric; they were using synthetic dyed yarn for embroidery. We try to show that if we can bring in naturally dyed yarn for embroidery, and further naturally dyed the fabric it will be definitely having again more value addition and it will fetch the more money.

So, eventually these innovations which are develop in the laboratory or actually meant for the industry. It is not that we do research for the sake of doing research; it is a research for

bringing in new innovation in the existing technology. And in the existing technology, there was a need felt that the synthetic dyes should now be eliminated. And in order to do that we try to bring in natural dyes, and a variety of colors were offered, but still there is a scope of more and more and more color generation by mix and match method. So, whether it is silk or whether it is cotton or whether it is wool, it is possible to do this mixing of colors re-dyeing, over dyeing and all other possibilities are there with natural dyes.

Usage of new natural dyes: Newer dyes developed were used for dyeing silk and cotton primarily because this was what was being marketed more popularly. Wool dyes were less shown are demonstrated. Different pretreatments and mordant for better fastness properties of the fabrics for wool, silk and cotton was shown and practiced. Development of innovative dyeing for wool for commercial use in the carpet industry was also demonstrated.

We then try to focus our innovation towards carpet industry. This is a very big market not only domestic market, but international market for carpet industry. And therefore, and because the use only wool and there was a market which was demanding naturally dyed wool carpets therefore, we started working on dyeing of different shades of wool and then giving in to the carpet industry for doing the knotting. And they were able to use this and that also created initial market for them, and got them very good pricing because after all if the synthetic dyes have to be replaced, and if this is cost effective only then it will natural dyes will be accepted in the market.

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Preparation of almost like 16 dyed fabric for the development of different colors were offer to the Khadi gram udyog commission, because they wanted that ok. If you have some technology, why do not you demonstrate it in our organizations and has several places these awareness program and demonstration and lectures were held. To show that in their existing machinery system we can still do natural dyeing.

Another factor that we did not want them to understand that it is going to be a costing them anything. So, we did it free of cost and in their existing machine. No new machinery was bought we try to use our technology in their existing machinery system. I just showed you that on which jigger the existing azo jigger was used for natural dyeing.

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Now the places where betterment was required in this wool industrial process was, it was considered that the extraction processes is very tedious. So, low color value and long dyeing time higher cost of dyeing etcetera, but the general problems that the people were facing from the existing knowledge that they had. So, they felt that there is a need for betterment in this area - that the extraction process should be improved, the color value should increase, and the long hours of conventional dyeing should be reduced to shorter dyeing period. Therefore the cost will come down automatically, and then of course, the use of metal mordant has to be avoided. For the simple reason that you know these metals after all when they are you know used in the dye bath, the dye a fluent then has lot of dye as well as metal mordant which is run out of the factory, either into the water bodies or in to the rivers or in to the ponds or in to the agricultural land.

Now, these create a lot of ecological problem, environmental problem, because it is bulk and bulk of water that is being run out; it is not just one or two or four litters. So, that is the reason if the metal mordant use can be avoided; it is better, but if one has to use metal mordant then use safe mordants like alum, ferrous sulphate, and at the most stannous. But definitely if one is using copper or chromium then one should use only one to two percent for if that shade requirement is there, because they gave unique shades there is no doubt about it.

With the same dye extract the shade obtained with copper and the shade obtained with chromium a mordant is definitely very attractive. So, if it can be avoided, it should be avoided and in place of that either bio-mordant should be used or enzymes should be used. So, frequently used metal mordants like iron, aluminum, copper, led and tin should be avoided. If at all it has to be use using these metal mordants have ecological constraints as they generate polluted affluent from the dye bath.

I have just explained to you that why this should be avoided, and if we are avoiding this we really can not completely avoid it why because this metal has a very vital and mandatory role. So, it has to be supplemented or replaced by bio mordants which we learnt about them in the previous lecture that pashia pyrus pashia and eurya accuminata had copper and aluminum respectively in very desired small quantity just sufficient for the fabric interaction.

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So, these measurements should be taken in to a account for the betterment. Why there was a need for betterment better process. Traditional dyeing process - enormous amount of heat is consumed in terms of heating the dye bath to obtain the desired color. And heat sensitive dyes cannot be used in conventional dyeing prolonged heating decomposes the dye molecules. Dye up take by the fabric is also far from extortion as well as a result fare amount of dye is wasted in traditional methods. So, there were very serious problems of the traditional methods and that is why it was not popularizing.

So, we try to look at the problem one by one, and we try to tackle and find an alternative which could be an acceptable alternative by the industry. Because a lot most of these jiggers you saw the machine of the jigger which was an open machine, now so much of steam is being wasted. Now the jigger machines that are being made out of stainless steel or all are very compact, a compact machine then keeps the steam within the body of the machine and therefore, the dye up take and the heat exchange is not wasted.

So, it is a energy intensive machine that is being now manufactured, but the traditional open jiggers were not energy efficient machines. So, therefore, continuous heating was required if continuous heating is required continuous fuel is required and so on. And also the temperatures that were attained in these jiggers were of the boiling point of water, and many heat sensitive dyes would decompose. So, it was not necessary to heat you see that we reduce the temperature in the sonicated dyeing from 80 degrees to 40 degrees. So; obviously, the reduction in temperature has not cause any deterioration in dyeing process; on the other hand, it has enhance the dyeing process, it has you know helped in dye better dye adherence and that is why it is so acceptable. So, if we are offering an innovative technology then the technology must, must have an advantageous situation otherwise the technology will not be acceptable to the market to the industry.

Also whether the dye uptake is the final and the most important thing is enhanced or not. we can do any kind of dyeing; be it conventional dyeing; be it microwave dyeing; be it sonicated dyeing; be it x dyeing; be it hang dyeing; be it arm dyeing; the ultimate moto is whether dye is being up taken by the fabric and what is the dyed strength or the color strength or the k by s value. If it is improving by any method that method will be acceptable; if it is cost effective, energy effective, and time effective.

So, you see there are many many parameters which go hand in hand till it is accepted. And the traditional methods definitely had a serious drawback. So, therefore, there was a need for better better processes to be brought about in the market.

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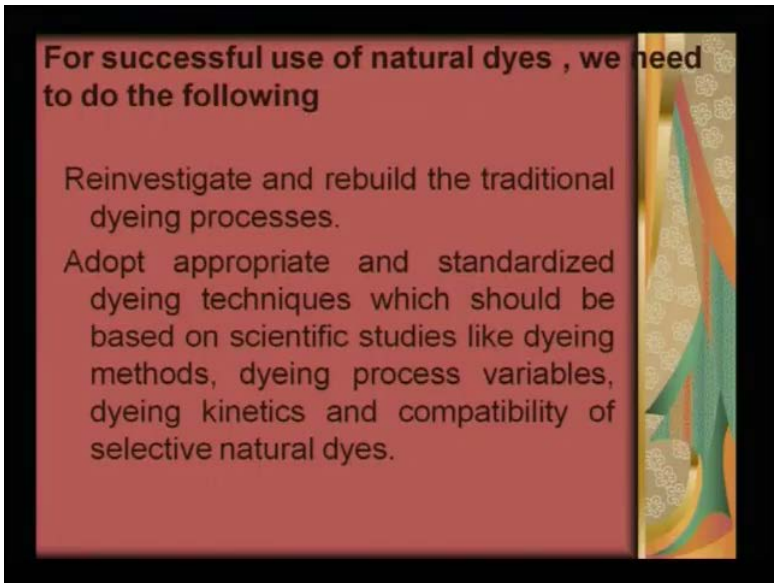

For successful use of natural dyes, we need to do the following. Reinvestigate and rebuild the traditional dyeing processes. Adopt appropriate and standardize dyeing techniques which should be based on scientific studies like dyeing methods, dyeing process variables, dyeing kinetics and compatibility of selected natural dyes.

Now; obviously, if we have to introduce a new technology, we must first understand the drawbacks of the traditional technology. And then see where are we losing out - are we losing out on the cost, are we losing out on the energy, are we losing out on the time part, if these are the main criteria. Then to adapt a new technology, we have to keep in mind to take care of these problems and very scientifically we need to modify the dyeing method, the dyeing process variables whether we can reduce the steps as what we saw in the preparation of cloth chapter that by nearly bringing down the steps. We can save time and energy and cost and then see how we can improve the dyeing kinetics by using some more hesitation methods which are doable and cost effective, because we cannot bringing something which is very costly; it will not be acceptable to the market. And finally, it should be like it should have a compatibility that the natural dye should remain in its best form during the dyeing process they should not be any deterioration.

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The novelties of the work that we have now produce for the industry are the following. Use of newer natural dyes we have introduced new hue colors with many plants of course, but to name a few four plants Hibiscus mutabilis, Eclipta alba, Rubia cordifolia, Cayratia carnosa have been shown that good dye extraction was possible and good dye yield was possible.

Hibiscus mutabilis and Cayratia was use for the first time. Use of bio-mordants obtained from plant material and selected enzymes in place of metal mordants, to prevent the toxic effect of the metal ions was also shown. Enzymes used were cellulase, protease, trypsin and plant material like eurya accuminata and pyrus pashia as bio-mordants was also demonstrated for cotton, silk and wool.

Introduction of new techniques of dyeing that is ultrasonication. Although we also tried microwave, but we made a comparative data and we found that microwave is not feasible for very large pieces of cloth. So, therefore, for industry it was the ultrasonication which has given encouraging results with respect to dye up take capacity as compared to conventional dyeing method.

So, we have proven time and again that this is now ready technology for dissemination and we have even disseminated the technology at several places to show its utility and its advantageous situation.

To make the whole dyeing process bio sustainable and more echo friendly. We have shown by the use of enzymes, by the use of bio-mordants, by the use of complete replacement of these metal mordants wherever possible we have shown that the whole process can be you know bio sustainable as well as it is more echo friendly because all the components that I used are bio degradable.

The overall idea to develop a cheaper and greener process using enzymes and bio-mordants in dyeing with natural resources and optimization of different parameters for this kind of study to increase brightness and color depth on every kind of fabric. We have shown that you know it was a method that natural dyes are very dull; they are not really appealing, we have brought about very many bright colors; we have brought about that you know the finished good or finished fabric cannot only be applied on cotton or silk or wool, but it is like you know an overview if you see it is a complete package which shows that extraction, modification in extraction, modification in dyeing, modification in using, different pre treatments and even that dye fixes we have use we have develop indigenously, and we have shown that it has rarely worked very well in terms of its application. Because the bottom line is that the product should be of consumer's interest; if we make anything which is very exorbitantly price consumer will not buy.

If we make something which is not acceptable to the consumer, consumer will not buy. So, we have tried to develop these technologies in order to keep in mind the consumer and its demand.

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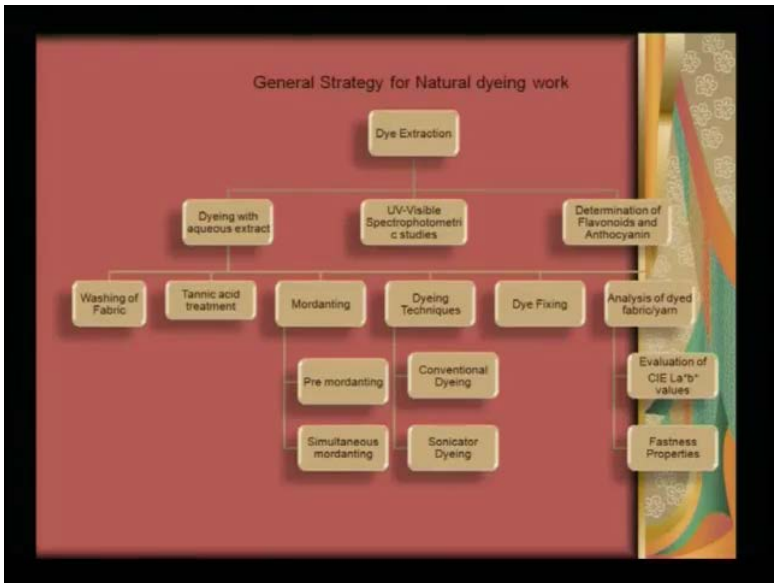

If we have to just look at general strategy of the natural dyeing work will see that we have programmed it in such a way that natural dye extract if ones it is taken out. The echo's extract is used for dyeing, the extract is aqueous extract it is then taken for optical density measurements, and even for other tests like finding out whether flavonoids and anthocyanins are present or not, and then subsequently the aqueous extract is then use for dyeing by after doing the washing of the fabric that ionic acid treatment, mordanting.. Mordanting, we tried out both the pre-mordanting and the simultaneous mordanting by reducing the number of steps and so on and so forth. So, this is the overview general overview of the general strategy that we followed with our natural dyeing work.