Post Harvest Operation and Processing of fruits, Vegetables, Spices and Plantation Crop Products

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Lecture 39

Processing of vanilla beans and production of vanilla flavour

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Hello everyone, today we will discuss about processing of vanilla beans and production of vanilla flavour.

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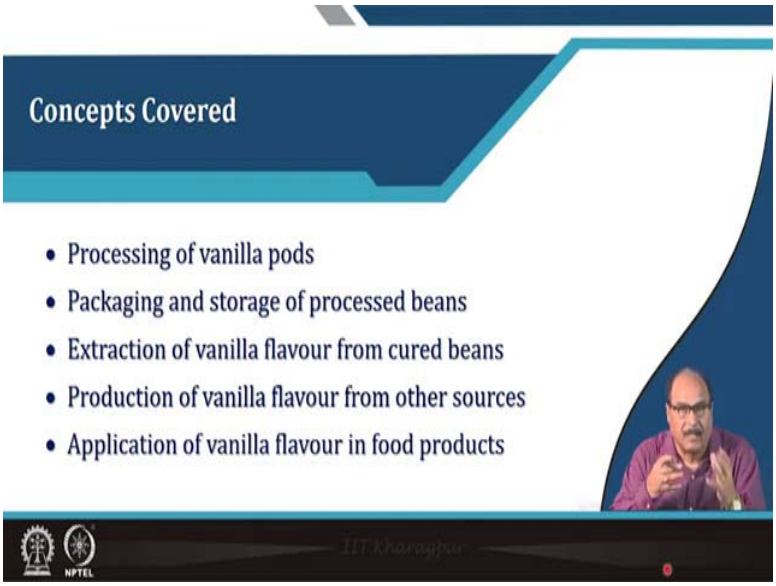

In this the different aspects of vanilla processing, vanilla pods processing, packaging and the storage of processed and cured vanilla beans, extraction of vanilla flavor from the cured beans,

production of vanilla flavor from other sources, and finally, application of vanilla flavor in different food products will be discussed in today's lecture.

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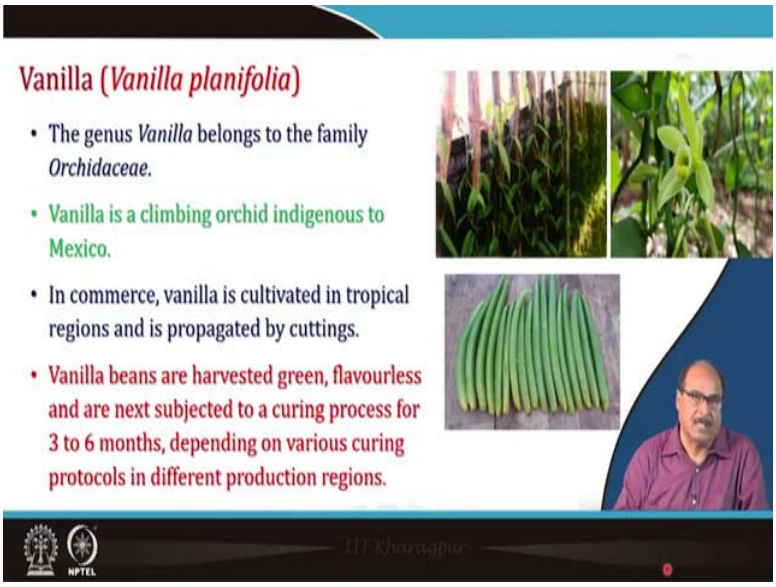

So, let us see what is vanilla? Its botanical name is Vanilla planifolia. The genus vanilla belongs to the family Orchidaceae. Vanilla is a climbing orchid indigenous to Mexico. You can see here in the figure, it is a climbing orchid. In commerce, Vanilla is cultivated in tropical regions and is propagated by cuttings.

Vanilla beans are harvested green, flavourless and they are next subjected to a curing process for about 3 to 6 months, depending upon the various curing protocols in different production regions. You see here in the figure, this is the vanilla beans as they are harvested from the orchid.

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Vanilla pod contains many aroma compounds including vanillins, but they are present in the green beans in the form of glycosides. Mainly precursor of these flavors. Vanillins is the most abundant aroma compound in the cured beans, it is approximately at about 2 percent level. Other important constituents are para-hydroxybenzaldehyde, para-hydroxybenzyl methylether and acetic acid. And some other minor components are also present.

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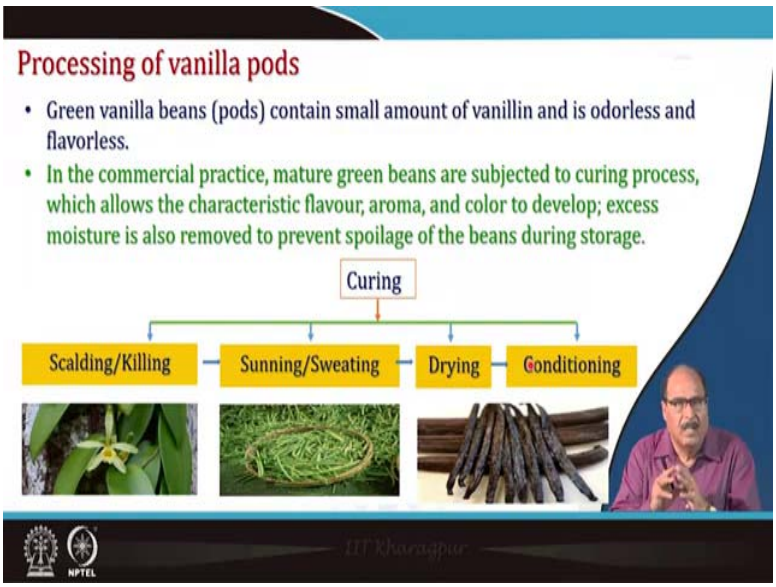

As far as the processing of vanilla beans is concerned, in the earlier classes, in the coffee, cocoa, naturally produced or cultivated beans do not have the characteristic flavor. Similarly, here also in the case of vanilla, that is, the green vanilla beans contains very small amounts of vanillin.

And it is odorless and flavorless. So, in the commercial practice, mature green beans are subjected to curing process which allows the characteristic flavor, aroma and color to develop.

And also, excess of the moisture is removed which prevents a spoilage of the bean during the storage. So, the curing of the beans has particularly four steps, stages you can say. That is scalding or killing, sunning or sweating, then drying and finally conditioning. Then you can see that the completely brown colored beans are obtained after drying and conditioning. Earlier, they were green color.

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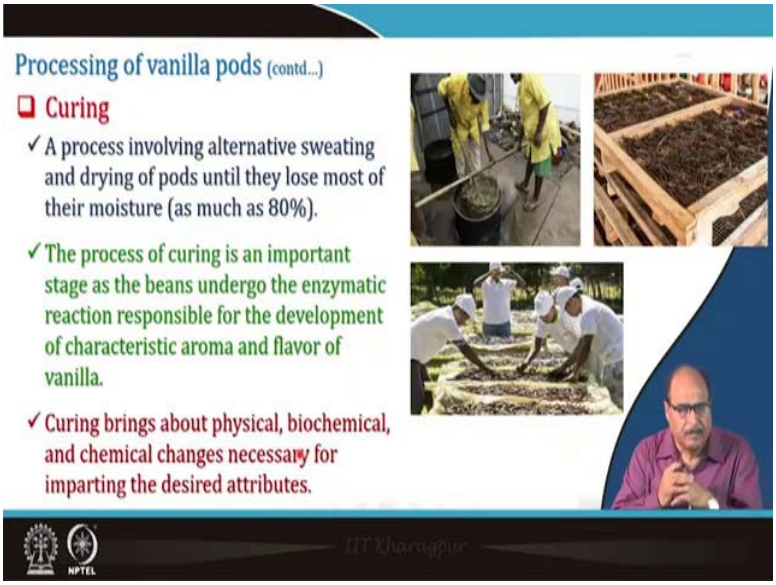

So, the curing is a process involving alternative sweating and drying of pods until they lose most of their moisture content, that is as much as about approximately 80 percent of the total moisture content is removed in the curing and drying. The process of curing is an important stage as the bean undergoes the enzymatic reaction which are responsible for the development of characteristic aroma and flavor. You can see here in the figure that different stages of curing are follow in the industry or in the farm level. So, curing brings about physical, biochemical and chemical changes which are necessary for imparting the desired attributes in the beans.

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So, let us see what happens in the actual curing step, individual curing steps, in the killing, the first step is the vegetative development of the fresh bean get stopped and enzymatic reaction responsible for the production of aroma and flavor are initiated. So, this process is called killing because it disrupts the respiratory functions by destructing cell membranes and cell walls of the bean tissues, thus bringing about their physiological death. And that is why it is called killing process. The method used for disruption of the cell structure or hot water scalding, sun and oven wilting, scarification, treatment with ethylene gas and freezing. The most common methods are sun, oven and hot water killing.

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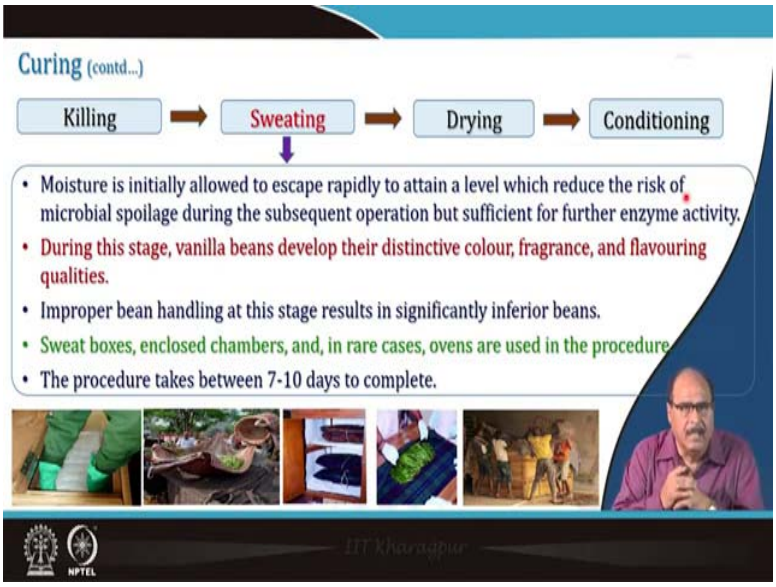

The next step is sweating. Here, moisture is initially allowed to escape rapidly to attain a level which reduces the risk of microbial spoilage during the subsequent operation, but sufficient for further enzymatic activity. That is, the moisture after this sweating process become sufficient for the enzymatic activity. During this stage Vanilla bean develops their distinctive color fragrance and flavouring qualities.

Improper bean handling at this stage results in significantly inferior beans. Sweet boxes are the enclosed chambers, and in rare cases, ovens are even used for the sweating procedure. As you can see here, different boxes and chambers and ovens etc. The procedures takes about 7 to 10 days to complete the sweating process.

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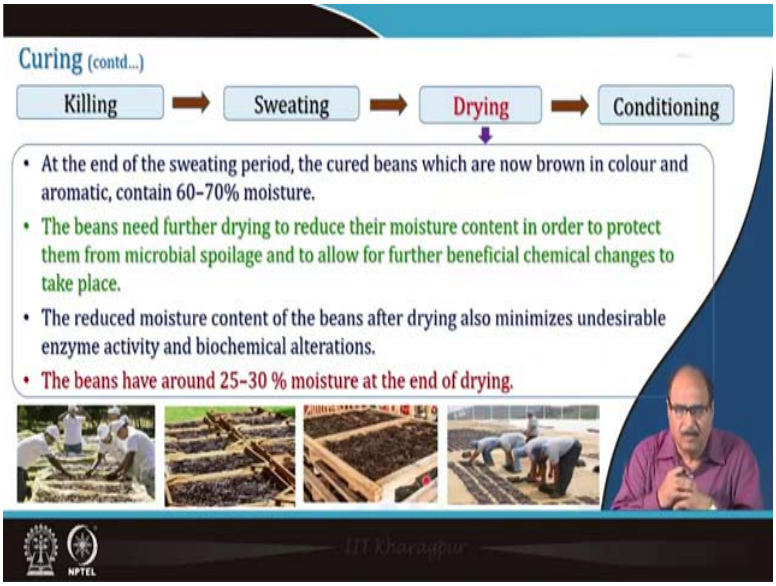

And finally, at the end of this sweating period, the cured beans which are now brown in color and aromatic, they contain about 60 to 70 percent moisture. So, the beans need further drying to reduce their moisture content in order to protect them from microbial spoilage and allow for the further beneficial chemical changes to take place. So, the reduced moisture content of the beans after drying also minimizes undesirable enzymic activity and biochemical alterations. The bean after the drying has around 25 to 30 percent moisture content.

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Then finally, the dried beans are conditioned. The beans are held in tight boxes as you see here in the figure, for the conditioning purposes. And this step, lasts from one month to around several months depending upon the process environmental and other conditions.

During this process, several chemical and biological events such as esterification, etherification, oxidative degradation and so on occur, which produce diverse aromatic compounds and improve the overall flavor quality of cured beans. So, conditioning also is very important step.

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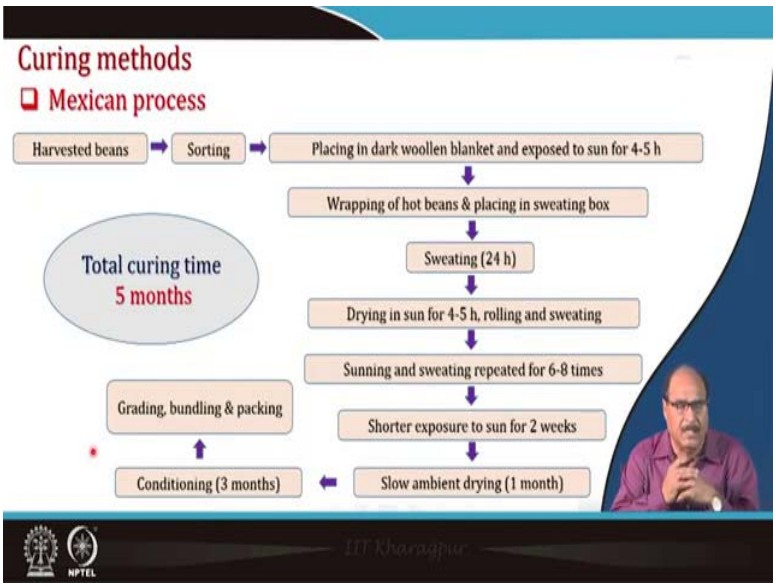

So, here are the some curing methods in the Mexican process of the curing. Harvested and sorted beans are placed in dark woollen blanket and are exposed to sun for about 4 to 5 hours, where wrapping of hot beans and placing in sweet boxes, and the sweating is continued for about 24 hours, which is followed by drying in sun for 4 to 5 hours, rolling and then sweating.

Then sunning and sweating is repeated for about 6 to 8 times. And finally, it is given shorter exposure to sun for about 2 weeks, then slow ambient drying, in the sun drying or even mechanical drying, but normally they do the sun drying and which is followed for about a month or so. And this is followed by conditioning for about 3 months and this conditioned bean are then graded, bundled and packaged. And total curing time in this process, it takes about 5 months or so, in the Mexican process.

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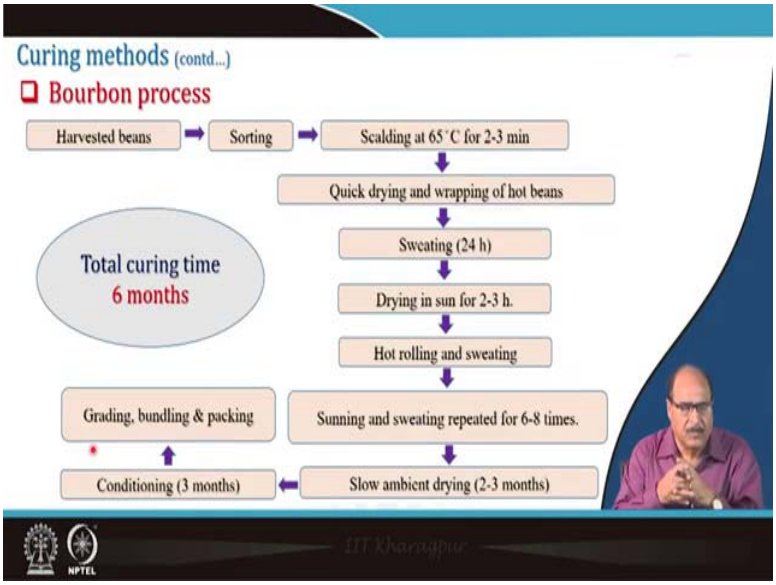

Then there is a Bourbon process in which also the harvested and sorted beans are scalded at 65 degrees Celsius for 2 to 3 minutes, which is followed by quick drying and wrapping of hot beans, sweeting for 24 hours, then drying in sun for 2 to 3 hours, hot rolling and sweating repeated and sunning and sweeting repeated for about 6 to 8 times. Then, it is followed by slow ambient drying for about 2 to 3 months and conditioning for 3 months, which is finally, conditioned bean, graded bundled and packaged. So, total time in this process may takes about 6 months.

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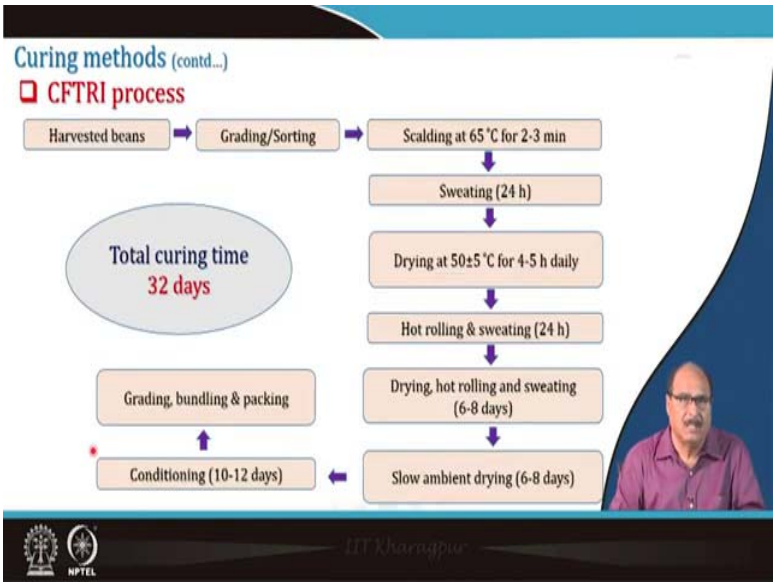

Then in the CFTRI process, in fact, the total curing time has been reduced significantly, it takes around one month to 32 days. So, the harvested beans are graded and sorted. They are scalded at 65 degrees Celsius for 2 to 3 minutes. And then sweating is allowed for 24 hours, followed by drying at 50 degree plus minus 5 degrees Celsius for 4 to 5 hours daily, then hot rolling and sweating for 24 hours. Drying, hot rolling and sweating is continued for 6 to 8 days, which is finally, followed by slow ambient drying for about 6 to 8 days, conditioning 10 to 12 days. And finally, grading bundling and packaging.

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Regarding packaging and storage aspects of the processed beans, packaging of the condition bean aims at reducing the water exchange with the environment. The bean mass relative to the

surface area exposed to the environment should be large to minimize water exchange and packaging environment have no effect on the stored beans.

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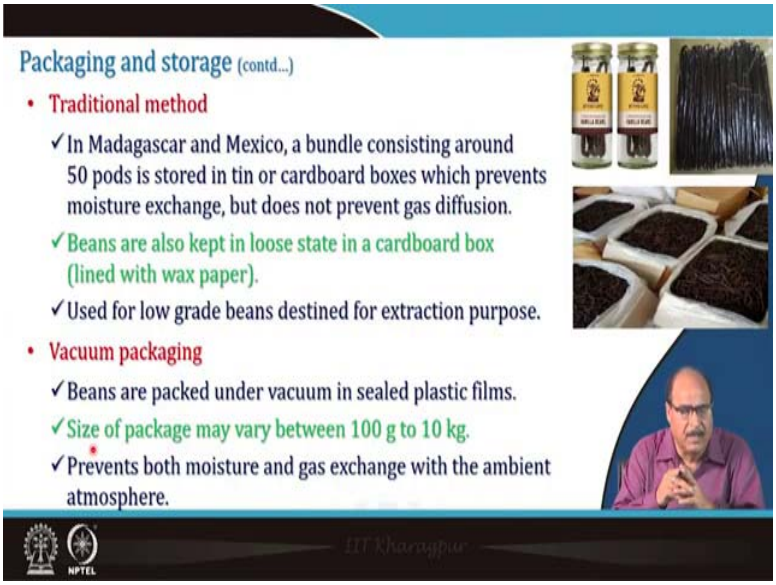

So, in the traditional method of packaging, in Madagascar and Mexico, a bundle consisting around 50 pods is stored in tin or cardboard boxes which prevent moisture exchange. But it does not prevent gas diffusion. So, beans are also kept in loose state in a cardboard box that may be lined with wax paper. It is used for low grade beans destined for extraction purpose. But the improved process is the Vacuum packaging. Here beans are packaged under vacuum in sealed plastic films. Size of the package may vary from 100 gram to 10 kg, and it prevents both the moisture and gas exchange within the ambient atmosphere.

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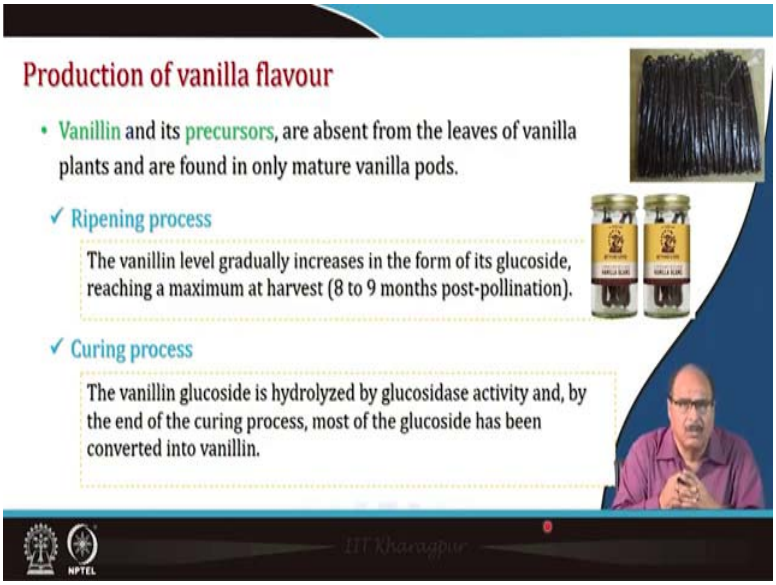

Now, after it has been processed and packaged and cured, so cured vanilla bean, let us see that how the vanilla flavor is synthesized produced inside the beans. So, vanillin and precursors, are absent in the vanilla plant, but they are only found in the mature vanilla pods.

There are two process, ripening process, the vanillin level gradually increases in the form of its glucoside reaching a maximum at the harvest, that is 8 to 9 months post-pollination. And then the most of the final, majority of the compounds are developed in the curing process. The vanillin glycoside is hydrolyzed by glucosidase activity during the curing process at the end. And most of the glycosides has been converted into vanillin.

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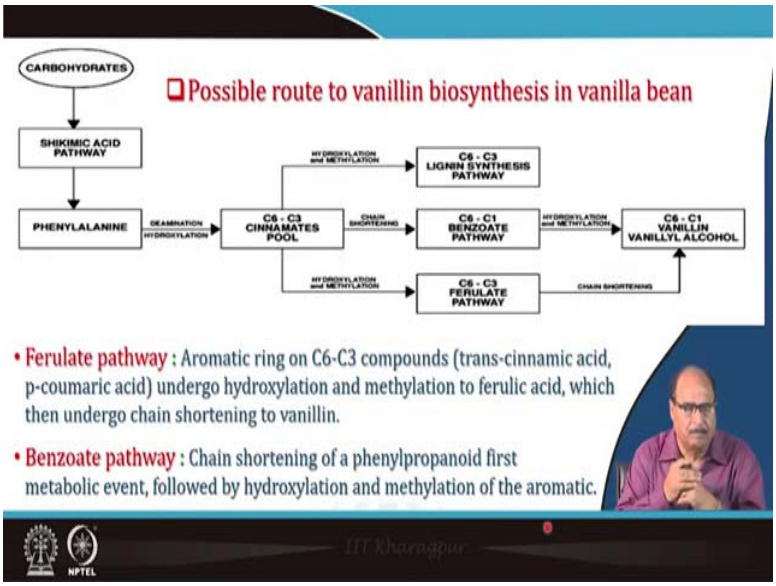

So, this is one of the possible routes has been suggested to vanillin biosynthesis in the vanilla beans, that is, there is the Ferulate pathway where aromatic ring on C6 to C3 compounds, that is trans-Cinnamic acid, para-Coumaric acid undergo hydroxylation and methylation to ferulic acid which then undergo chain shortening to vanillin. In the Benzoate pathway chain shortening of a phenylpropanoid first metabolic event, which is followed by hydroxylation and methylation of the aromatics.

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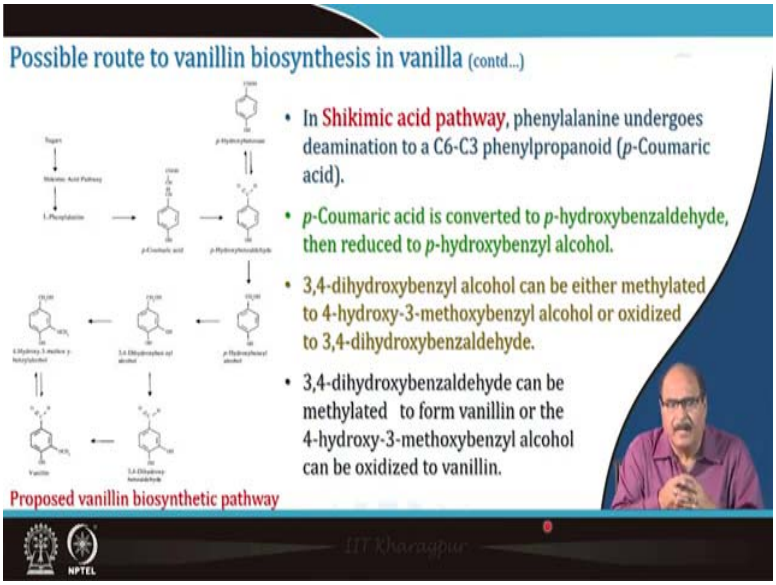

Then the in the Shikimic acid pathway, the phenylalanine undergoes deamination to a C6 to C3 phenylpropanoid, that is para-Coumaric acid, and then this para-Coumaric acid is converted to para-hydroxybenzaldehyde which is then reduced to para-hydroxybenzoyl alcohol. Then 3,4-dihydroxyphenyl alcohol can be either methylated to 4-hydroxy-3-methoxybenzyl alcohol or it can get oxidized into 3,4-dihydroxybenzaldehyde.

3,4-dihydroxybenzaldehyde can be methylated to form vanillin or 4-hydroxy-3-methylbenzylalcohol can be oxidized to vanillin. So, these are the proposed compounds and figures. So that is how that these Vanilla, as precursors are converted into vanillin or flavour compounds.

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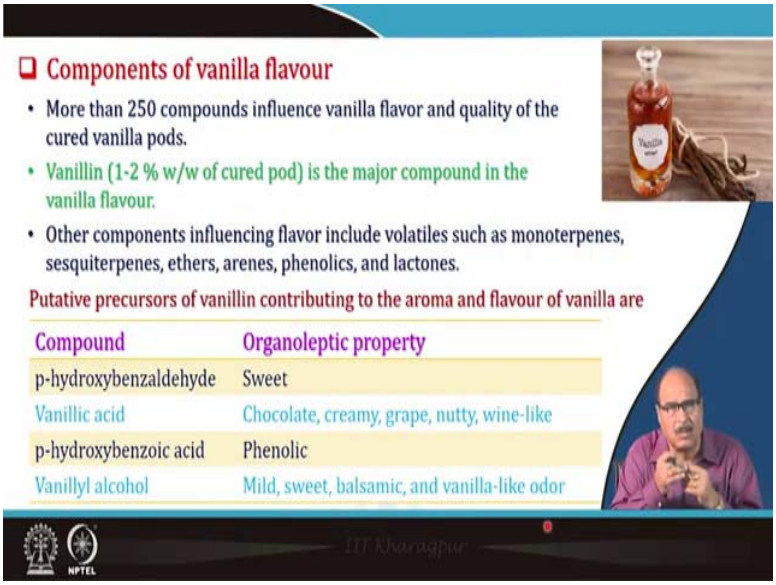

The components of vanilla flavour, you can see there are about more than 250 compounds influenced the vanilla flavour, and the quality of the cured vanilla pods. Vanillin is around 1 to 2 percent of the cured pod, is the major compound. Other compounds influencing flavor include volatile such as monoterpenes, sesquiterpenes, ethers, arenes, phenolics and lactones.

Also, there are various precursors, that is putative precursors of vanillin contributing to the aroma and flavor of vanillin are like para-hydroxybenzaldehyde, which is normally sweet tasting. Vanillic acid, they give this organoleptic property of chocolate, creamy, grape, nutty, wine-like or para-hydroxybenzoic acid rich. Vanillyl alcohol, they are mild sweet, balsamic or vanilla-like odor.

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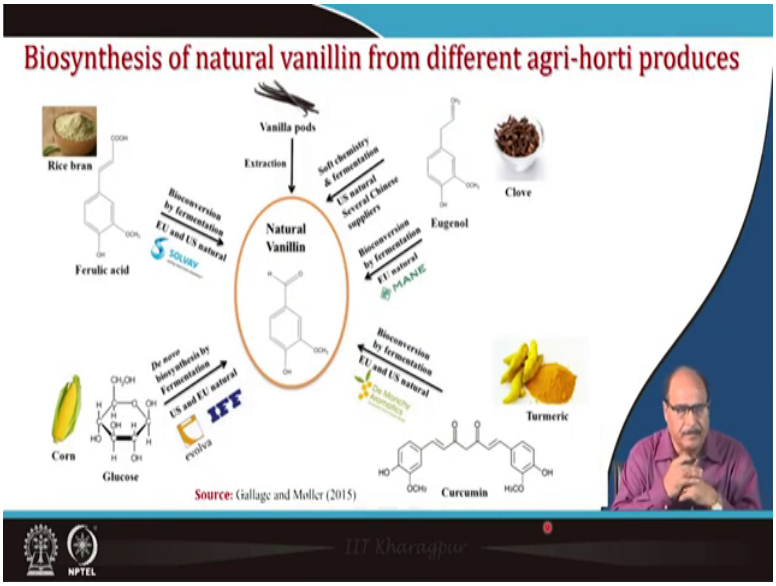

Now, this natural vanillin may be extracted from various different agri-horti produces and this slide shows one. If the vanilla pod, that is the cloved dried vanilla pod, conditioned vanilla pod is used and it is subjected to extraction and we get natural vanillin. So, apart from this even rice bran, rice bran has ferulic acid, and through bioconversion by fermentation is converted into vanillin.

Corn, the glucose and this glucose also by de novo biosynthesis by fermentation process and in many countries, European countries, or U.S. country they are using these raw materials agricultural horticulture to produce natural vanillin. So, this turmeric, turmeric contains curcumin.

This Curcumin is bio converted by fermentation into Eugonal, that is, into natural vanillin. And other very important source which is used by the industry commercially to produce vanillin,

other than the vanilla bean, is the clove, there is a clove, Eugonal, it contains essential oil, Eugonal and this Eugonal, either by soft chemistry and fermentation or bioconversion by fermentation, it is converted into natural vanillin. So, these are the natural sources for getting the vanillin.

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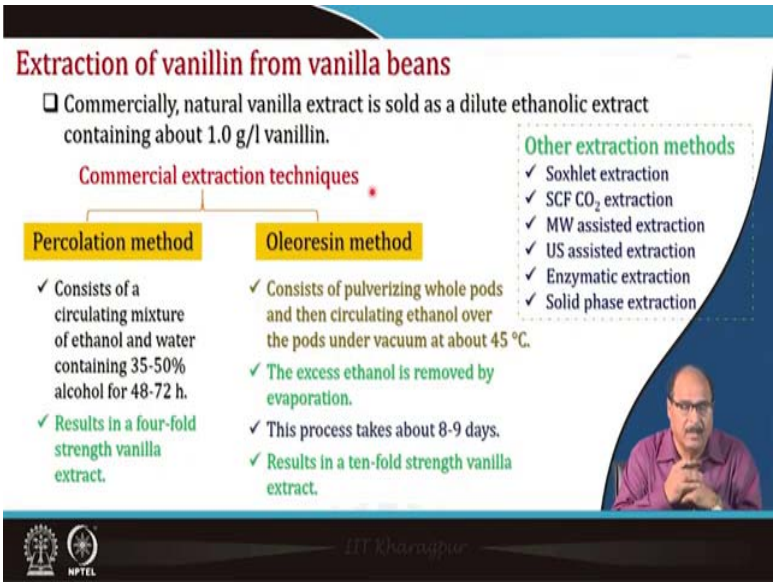

So, as far as the extraction of vanilla from vanilla beans is concerned, you know that it is available commercially in the form of vanilla essence, its natural Vanilla extract is sold as a dilute ethanolic extract containing about 1 gram per litre vanillin. So, the commercial extracts and techniques include percolation method or Oleoresin method.

In the percolation method, a circulating mixture of ethanol and water containing 35 to 50 percent alcohol are placed for 48 to 72 hours. And this powdered vanilla beans are kept. And this results in a four-fold strength vanilla extract. In the Oleoresin method, it consists of pulverizing whole parts and then circulating ethanol over the pod under vacuum at around 45 degrees Celsius. So, the excess ethanol is removed by evaporation and this process takes about 8 to 9 days. It results in 10 fold strength of the vanilla extract.

Other methods for extraction, maybe Soxhlet extraction, supercritical carbon dioxide extracts and microwave assisted extracts and ultrasound assisted extraction or enzymatic extraction, solid phase extraction, so, all these various methods, with principle and method of operation, have already discussed in earlier classes.

So, they can also be used for extraction but it is better to go for the microwave assisted or U.S. assisted extraction process or supercritical CO_2 extraction process so that the, atleast flavor

compounds, their purity can be retained and their flavoring potential, maximum flavoring potential is obtained in the extract.

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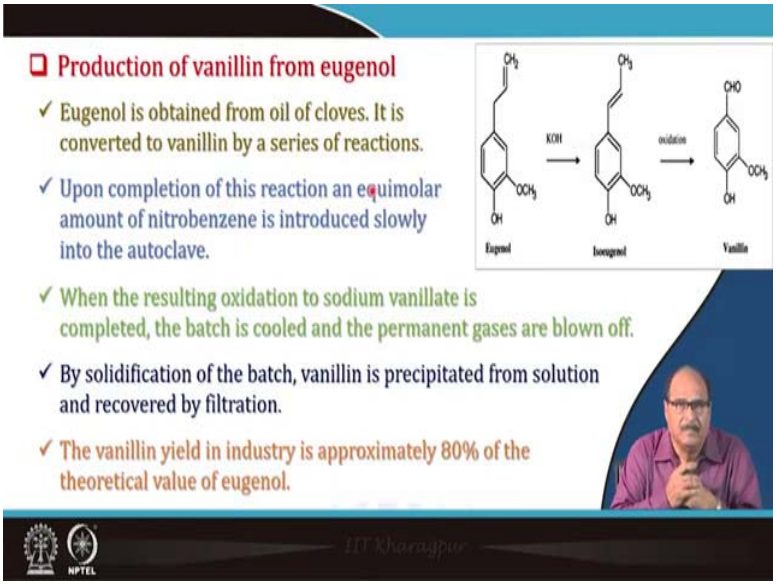

Then, for the production of vanillin from eugenol, eugenol is reacted with KOH and then it converts to iso-eugenol and which is finally oxidized into vanillin. This is a very simple way, I have told, but this is a very complex group of reactions. A series of complex reactions are there by which Eugenol is converted into vanillin.

So, upon completion of this reaction, an equimolar amount of nitro benzene is introduced slowly into the autoclave and when the resulting oxidation to sodium vanillate is completed, the batch is cooled and the permanent gases are blown off. By solidification of the batch, vanillin is precipitated from solution and recovered by filtration. The vanillin yield in industry is approximately 80 percent of the theoretical value of eugenol.

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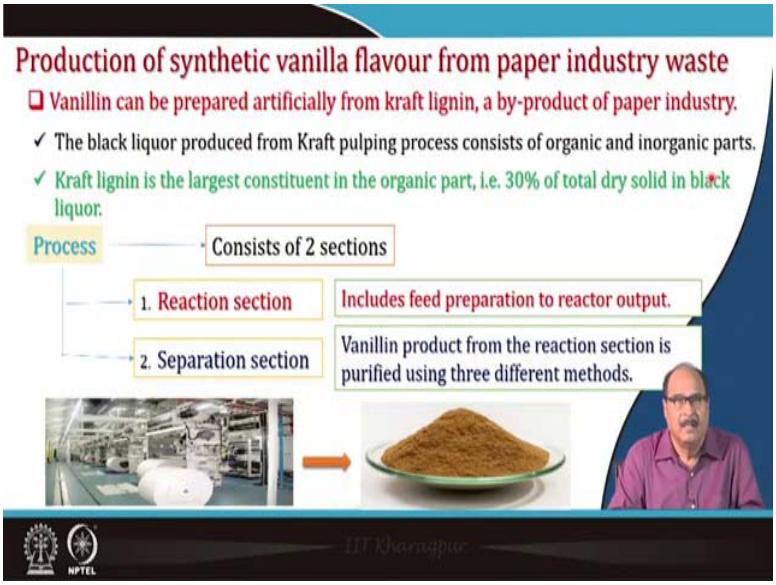

Then, production of synthetic vanilla flavor from paper industry waste, and in the market that synthetic vanilla is available also for using various products. So, in fact, synthetic vanilla is prepared artificially from kraft lignin, which is a by-product of paper industry. The black liquor produced from kraft pulping process consists of organic or inorganic pods.

And this kraft lignin is the largest constituent in the organic part, that is about 30 percent of the total dry solids in black liquor. So, this process consists of two sections, one is the reaction section where the preparations feeds is prepared, and it is fed into the reactor output. And then separation section, that is vanillin product from the reaction section is purified using three different methods.

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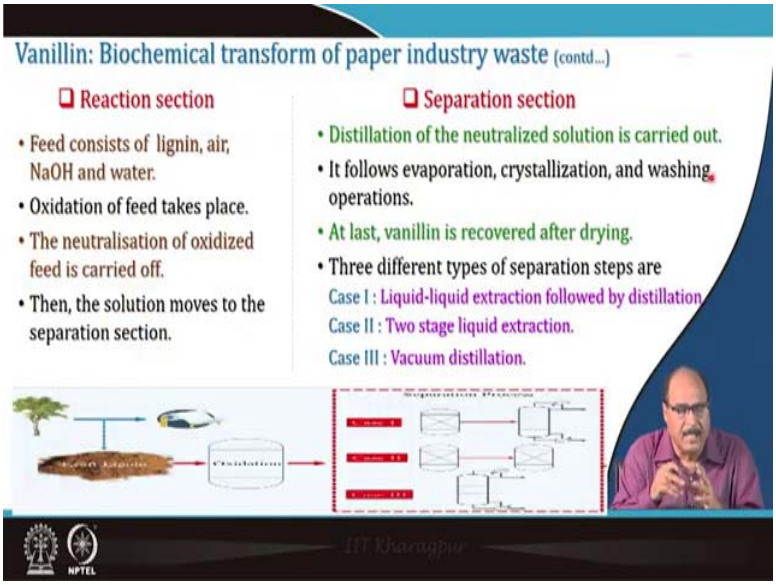

So, in the reaction section, feed that is lignin, air, sodium hydroxide and water, they are fed into the reaction vessel, then oxidation conditions are given for oxidation to take place and then neutralization of the oxidized feed is also carried out in the reaction section. And finally, the solution moves to the separation section, after the reaction is over.

In the separation section, distillation of the neutralized solution is carried out, it follows evaporation, crystallization and washing operations. And at last, the vanillin is recovered after drying. Three different types of separation steps are used. That is case 1, liquid-liquid extraction is followed by distillation, case 2, two stage liquid extraction, and finally, vacuum distillation. So, these are the very complex chemical reactions and by which these compounds, are transformed into vanillin, synthetic vanilla.

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Now, let us discuss the application of vanilla flavor in food products. Vanilla is the one, very commonly used flavoring materials in various products like dairy products, in beverages, in baked goods, confectionery products or it is also used as a flavor enhancer in the market. As I told you, both vanilla is available in the form essence or vanilla is available in the form of flavour. As a vanilla essence, that is the natural vanillin extracted from the vanilla beans are from the other natural agricultural or horticultural produces and the synthetic vanilla produced from the paper industry, liquor waste or so.

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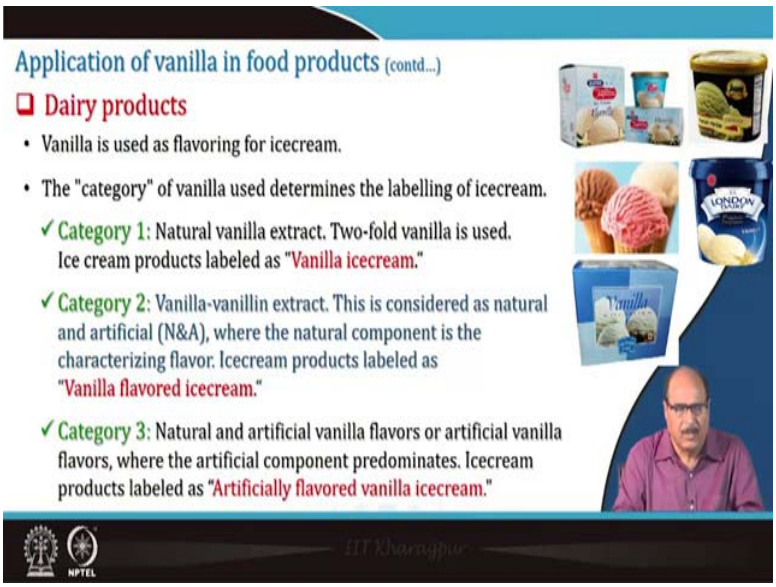

So, in the dairy products, Vanilla is used as a flavoring, our ice cream and even some other product, yogurt etc. The category of vanilla used determines the labelling of ice cream.

Category 1 that is natural vanilla extract, two-fold vanilla is used and thus ice cream product is labeled as vanilla icecream. And a category 2, vanilla-vanillin extract the used and this is considered as a natural and artificial (N & A) where the natural component is the characterizing flavor. And icecream products are labeled as vanilla flavored ice cream.

And third category includes natural and artificial vanilla flavors or artificial vanilla flavors, where the artificial component predominates. And icecream product in this category is labeled as artificially flavored vanilla ice cream. So, Vanilla ice cream, vanilla flavored ice cream or artificial flavored vanilla ice cream depending upon the nature or form, whether synthetic or flavored or combination of both is used.

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In the bakery products, that is pure vanilla extract is not used for baking, because the aromatic components of extract begin to vapourise or volatize at about 135 to 150 degrees Celsius, which is a temperature that is readily attained in cookie baking. So, cakes rarely exceed 100 degrees Celsius during baking process internally. So, the extract or blend of extract maybe used, even synthetic or natural vanilla or vanilla extract can be used because here the temperature is not very high.

But in the bakery product where temperature is very high maybe 135 to150 degrees Celsius or more, there, a natural extract may be avoided. Vanilla-vanillin extract or artificial flavors are recommended in such baking operations. Natural and/or artificial flavors can be used with various flavor notes such as buttery, nutty, brown sugar and so on.

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In the beverages, vanilla is an important flavor component in cola drinks, soft drinks, cream soda, root beer, and some fruit beverages also contain vanilla. Vanillin or vanilla flavors are used in many alcoholic beverages such as even whiskey, cordials and cocktails. And here, they are used to round out and smooth the harsh edges of the alcohol. So for such alcoholic beverage, they improve the flavour.

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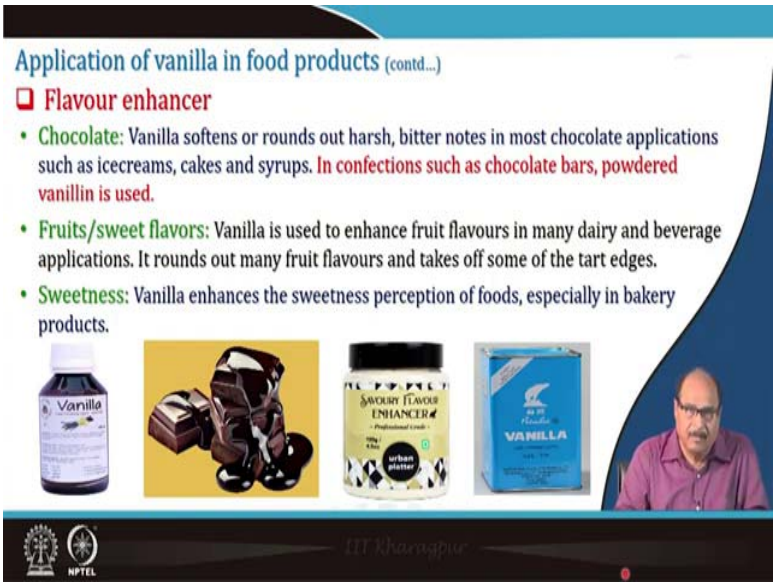

Then the vanillin is used as a flavor enhancer in various product like in chocolate or in the food or sweet flavors etc. So, in the chocolate, vanilla softens the round out harsh, bitter notes in most of the chocolate applications such as ice cream, where the bitter chocolate is used in ice cream, cakes etc. So, when these bitter chocolate together with the vanillin or vanilla flavor is added, then it improves the, or it reduces the bitterness of the material. So, in contractions such

as chocolate bars, powdered vanillin is used to do the job. The fruits or sweet flavors, the vanilla is used to enhance fruit flavors in many dairy and beverage application. It rounds out many fruit flavors and takes off some of the tart edges.

As a power of sweetness, that vanilla enhances the sweetness perception of foods and especially in the bakery product. So, the vanilla is very popular and commonly used flavoring materials in various foods.

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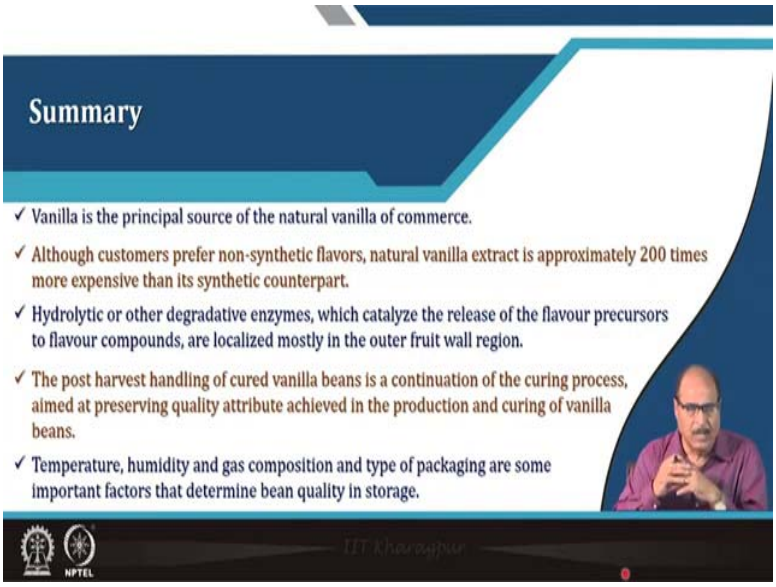

So, I will say now that the major principal component which gives the flavor of vanilla is the vanillin, and this vanillin can be obtained naturally from the vanilla, cured vanilla beans or from eugenol, from the clove essential oil from the rice, that is starch or corn starch and glucose or even from such other agricultural materials.

It can also be prepared directly, that it is from paper industry waste or some synthetic vanillin. So, although the consumers like obviously the natural flavor, but if you look at the production, cost and another things, these synthetic flavors, synthetic form is quite cheaper.

The natural extractives are 200 times more expensive than its synthetic counterpart because cultivating and producing the vanilla beans then curing, and after curing the extraction of the material it is a costlier process. Novel technology has to be used for the extraction, mostly supercritical fluids, carbon dioxide as such as the novel methods. Obviously it will involve the cost, it will have more cost.

So, means that is a good harvesting practices should be done and beans should be properly cured, conditioned, and then extracted using novel technologies, so that you can get a good quality, that is vanilla essence. And the temperature humidity and gas compositions are the some of the issues which should be taken care. Packaging and storage of the cured bean as well as, even the extracted essence, this should also be properly packaged and kept in the container suitably so that its volatiles does not get evaporated.

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These are the references which has been used in this lecture. Finally, thank you very much for your patient hearing. Thank you.