Industrial Biotechnology.
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Lecture-43.
Baker's Yeast fermentation.

Let me welcome this Industrial Biotechnology course now after the antibiotics fermentation let us go to the other area where biotechnology industry contribute a lot. We know that single cell protein and how we define the single cell protein, single cell protein is nothing but a microbial protein as it has tremendous tremendous potentiality in the market. Because why because your microorganism can grow very fast as compared to any other organism that we had or any other living system that we have like (())(1:00) and other things that we have.

So naturally that now question may arise that why we are not using this single cell protein to a great extent for human consumption. The answer to this question is that that you know single cell protein like when you consider the bacteria you look at bacteria contents lot of nucleic acid and this nucleic acid causes some kind of kidney stone and gouts and that is that is the major issue.

But in case of animal that is not a problem, so animal can take it very easily but but we the human beings cannot do this. Still we have some of the single cell protein is largely used for our in our day to day life. Once such single cell protein is the Baker's yeast and Baker's yeast are used as a nutritious supplement in the bread making industry particularly, it is considered as the leavening agent. Leavening agent means that when we because the bread is prepared by preparing a dough with the help of that wheats and when we prepare the dough we add some kind of yeast powder in it.

And then we keep the dough in the incubator for sometime, then when you keep the dough in incubator for sometime then the bulging of the dough will take place. Because why the bulging of the dough take place because when you when you when you prepare the dough with yeast cells that yeast cell will try to multiply with the living cells. When it try to multiply it produce carbon-di-oxide and when since it is a dough this carbon-di-oxide cannot

go out it remains inside the dough.

So the your dough will be bulged and then we take it out and put it in the Owen for drying purpose and that is why when you you when you cut this bread we will find that lot of pore inside. And this very interesting and but question comes, a question may arise that why we cannot use the sodium bicarbonate, because sodium bicarbonate also when heat it also produce carbon-di-oxide. But obviously that is used for some biscuit making, not for bread making purpose because bread making we want the nutritional quality because that the Baker's yeast contain about the 50 per cent of the protein.

And not only that it has also contains some kind of it is a good source of vitamin B and it slowly slowly expands . Because maybe when you heat it the carbon-di-oxide may evaporate very it produce very fast but when yeast grows it grows truly an slow and so the uniform structure of the pore structure in the bread that will be developed and that is possible only due to yeast. That is why Baker's yeast is lastly used in the different bread making industry and bread is a common raw material common breakfast item that we have in our day to day life

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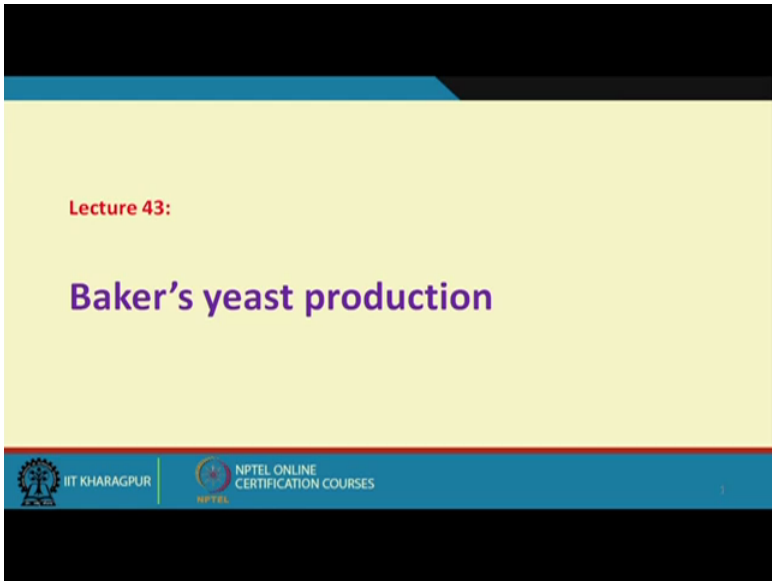

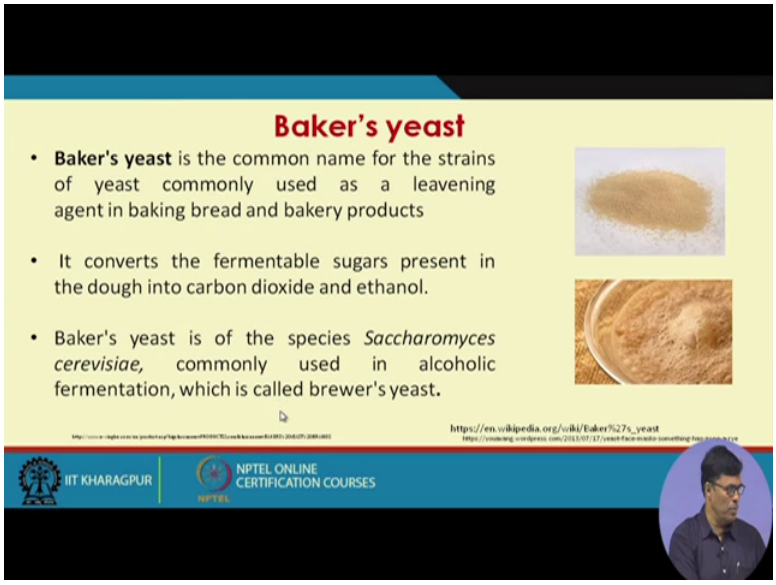

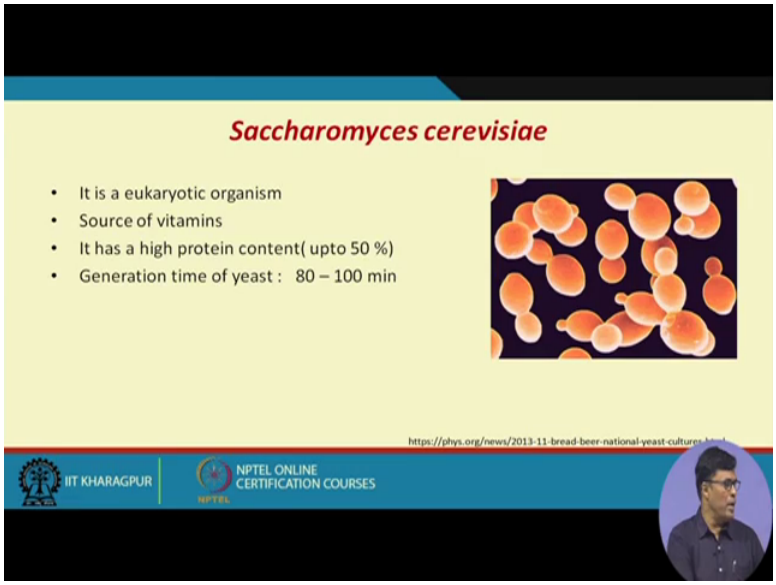

Let me go in details that the Baker's yeast is the common name for the strain of yeast commonly used as leavening agent in the baking bread and bakery product. It converts the fermentable sugar present in the dough into carbon-di-oxide and ethanol, carbonyl and ethanol it produce mostly carbon-di-oxide little bit of ethanol because since inside condition is little bit of anaerobic but not do it great extent very very small extent.

The baker's yeast is the is produced from the species the saccharomyces cerrevisiae common used for alcohol fermentation process is called Brewer's yeast. Now yeast looks very nice under the microscope it has the budding so I can show you I have already told you before also the yeast has a has a budding this is this is called budding, the small budding that we have. It is a eukaryotic organism is a source of vitamin and it has high protein content about the 50 per cent and generation time is 80 to 80 to 100 minutes.

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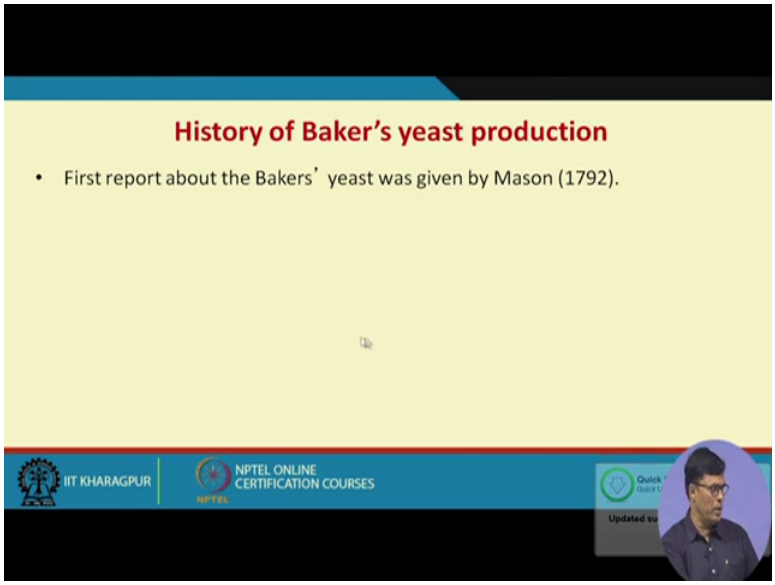

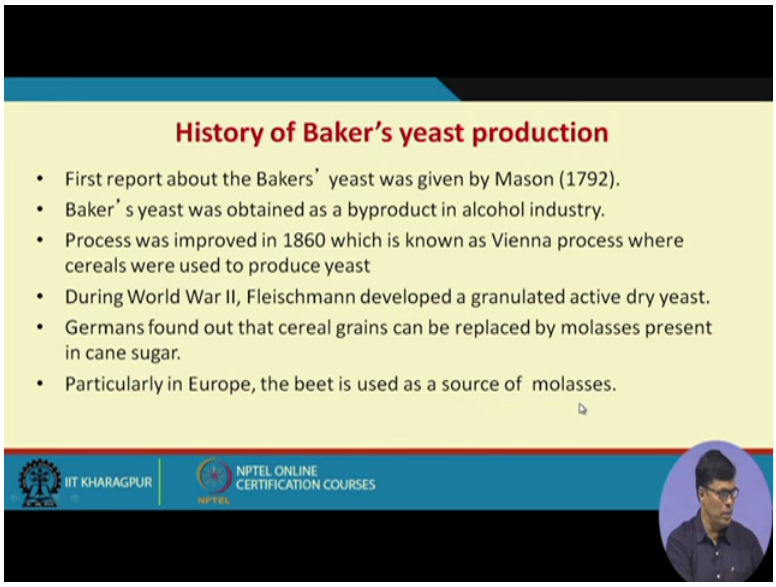

Now if you look at the history of Baker's yeast it is a very old product because if you look among different biochemical products very oldest product. The first report on Baker's yeast was given by Mason in the year 1792, the Baker's yeast was obtained as a byproduct in alcohol industry. Process are improved in 1860 which is known as Vienna process where the cereals were produced were used to produce yeast cells.

Then during World War II the Fleischmann then they developed the granulated activated dry yeast. I shall discuss about the activated dry yeast because activated dry yeast can be preserved for longer period of time. Germans found that the cereal grains can replace the molasses present in the in cane cane sugar. Because when I discussed the alcohol fermentation process then I I told that molasses is the good raw materials for the yeast

fermentation process, why the because it contents good amount of sugar also it contains vitamin B which is very much required for the growth of the yeast cells.

Now particularly in Europe the beet is used as a source of molasses because in the European country they have the beet, beet as sweetening agent and in our country we use as the cane as the sweetening for for the producing of sugar.

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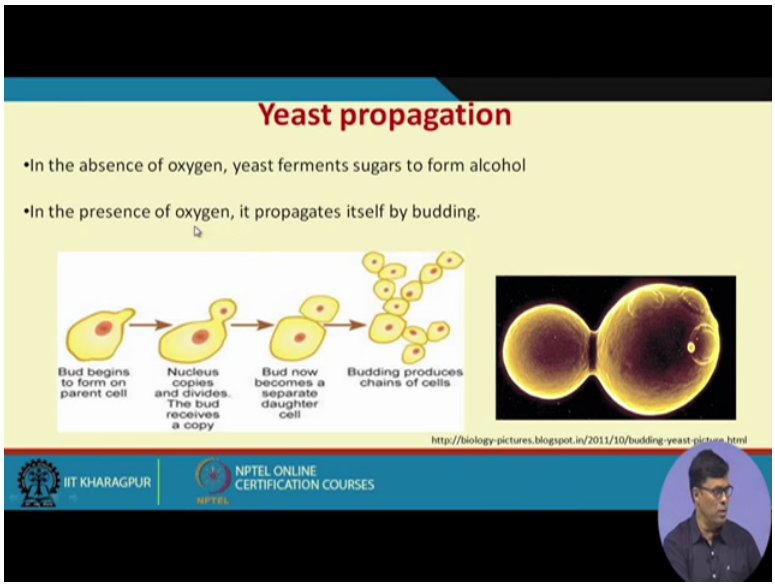

Now this yeast under absence when in absence of oxygen it ferments to produce alcohol but in presence of oxygen it produce cells by budding process. You know this is the budding process how the multiplication of the cells will take place now this is very nice you can see how the budding takes place and budding produces chain of cells how the cells they can binds with each other you can see it.

Now types of Baker's yeast Baker's yeast are classified on the basis of the moisture content. Dry yeast are good choice for long because you know that I discussed whenever we we produce any kind of product we have two type of product so one is called short time another is long time product. Short time product means that we say ready market but as per example that that mostly the Baker's yeast is marketed in two different forms one is called compressed yeast another is active dry yeast.

Compressed yeast contents about 70 per cent of moisture content and since it contains the 70 per cent moisture content, so what happens that that if you keep it in the room temperature in bacteria that present in the atmosphere that will grow very easily on the yeast cells because it contains lot of vitamin, lot of nitrogen source and carbon sources. That is why it is to be it is

to be marketed under refrigerated condition. So that the bacteria growth will be limited and but active dry yeast the moisture content is about 4 per cent under that condition bacterial growth will be very minimum so we can preserve for longer period of time. Depending on the long time and short time use that we produce the two different type of yeast cell. If you if you find ready market we go for compress production because we have ready market but if we have long time market we go for active dry yeast production.

Dry yeast forms good choice for long time long term storage often lasting more than a year at room temperature the types the active dry yeast is consists of glucose granules of yeast with life cells encapsulated in a thick jacketed dry dead cells and other growth medium. It must first be dehydrated, it can be stored at room temperature for a year or frozen for more than a decade it is it is more sensitive than over from a thermal shock when actually used as in recipe.

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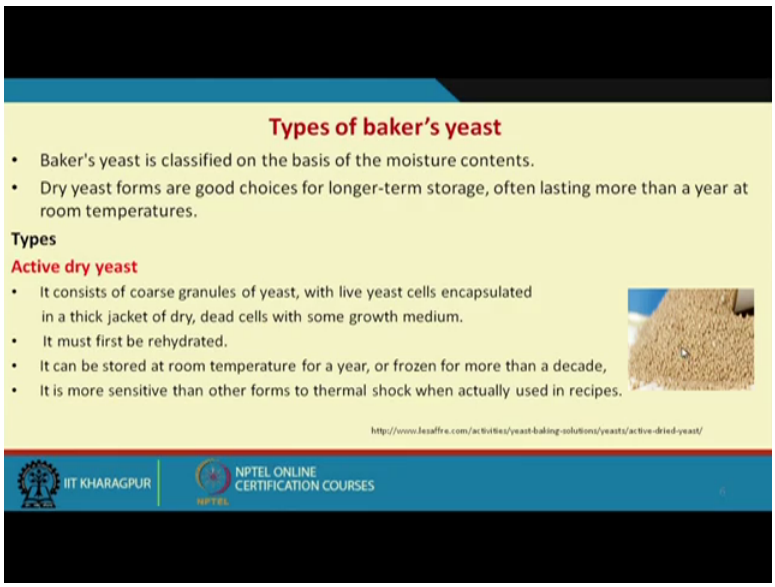

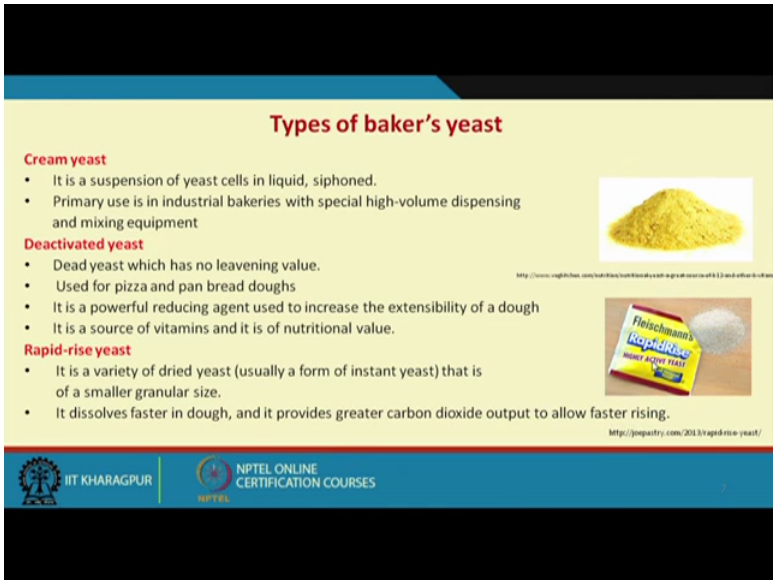

So this looks like this if you look at very clearly it looks like pebbles it is small, small pebbles I shall explain more in details when you dry it, it forms kind of pebbles here. Now in case of cream yeast because this this is the semisolid picture is suspension of yeast cells in liquid and yeast can be siphoned. And primarily used in the industry bakeries with specially high volume dispensing and mixing equipments.

Deactivated yeast, the dead yeast which has no leavening value used in pizza for pizza and pan bread dough. It is powerful reducing agent used to increase the extensibility of a dough and it is the source of vitamin and it is it has the nutritional value. It looks like this how how this deactivated yeast looks like this. Now rapid rise yeast it is a variety of dry yeast that is smaller granules it dissolve faster in dough in dough and it it provides greater carbon-di-oxide output to allow the faster rising so this is rapid rising that is active dry yeast that we have.

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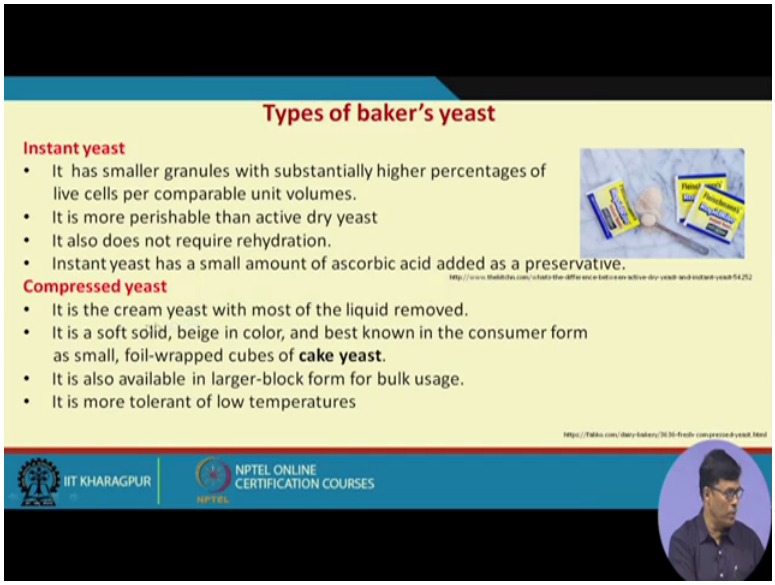

The instant yeast it is the smaller granules that substance is (())(12:03) higher percentage of life cells per comparable unit volume. It is more perishable than active dry yeast, it also does not require dehydration, instant yeast for a small amount of ascorbic acid as a preservative it is marketed like this. But I told you that basically we have two type of yeast that is in the market largely used in the market one is active dry yeast another is compressed yeast.

It is the cream yeast with most of the liquid removed and because the moisture content is about 70 per cent, it is soft solid and best known in the consumer form as small and foil wrapped cube of cake yeast.

It is just like our butter cake butter cake we know butter that we half kilo that butter cake is that we have it is something similar to that, it can tolerate the more tolerable at low temperature so it is like this. So it is in the in this like you know butter we have this kind of form this is available but this is usually marketed under refrigerated conditions otherwise this will this yeast will be spoiled.

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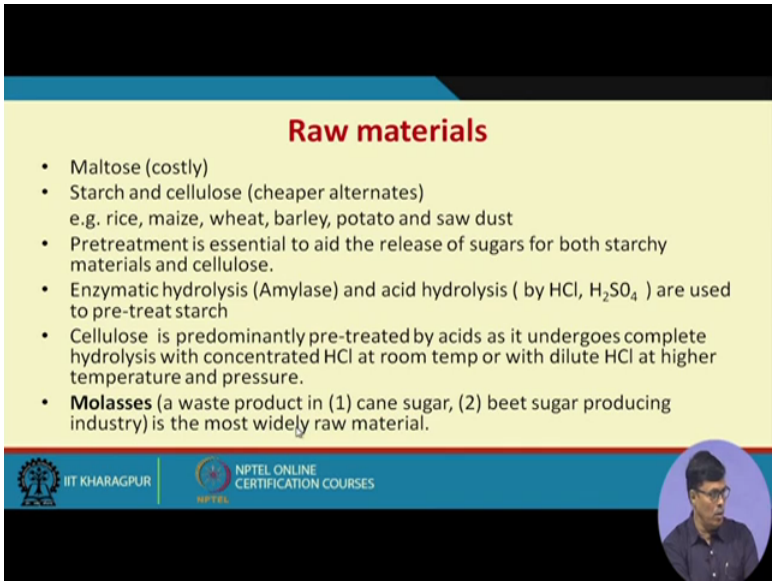

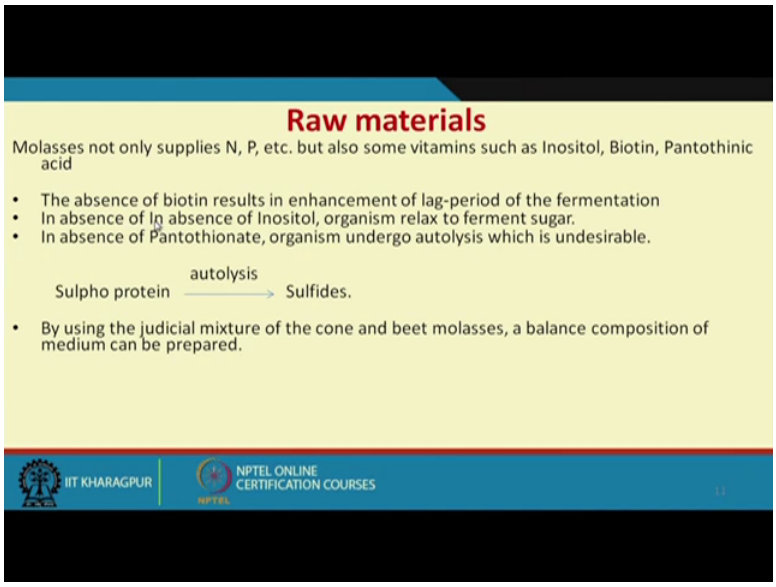

Now let me talk about the production of this yeast how the production takes place. The maltose is very costly maltose we know that it is the disaccharide contains two glucose unit starch and cellulose is appears to be the cheaper as for the example rice, maze, wheat, barley, potatoes and sawdust. The pre treatment is essential to aid the release of sugar for for both starchy and material and cellulose and enzymatic hydrolysis that is amylase and acid hydrolysis are used to pre treat the starch.

The cellulose is pre dominantely pre treated by acid as to undergo complete hydrolysis with concentrated HCL at room temperature or dilute HCL at higher temperature and pressure. The molasses it is not waste it is a byproduct of the sugar industry it widely used as a raw materials for the yeast production process. So apparently it looks like that starchy and this

cellulosic material appears to be the cheaper, but only the problem is that we require to have some kind of pre treatment before we can utilize this material for the growth of the yeast cells.

But in case of the cane molasses which is a byproduct of the sugar industry so you can directly use for the growth of the yeast cells. That is that is the how that is why the cane molasses is largely used by the industry. Now raw materials that the molasses not only supplies the nitrogen, phosphorous but also some vitamins such as inositol, biotin and pantothenic acid. The every vitamin has different purpose because let me explain that the biotin because I told you that that every cell has a life cycle like this we have we have lag phase we have lock phase stationary phase and death phase.

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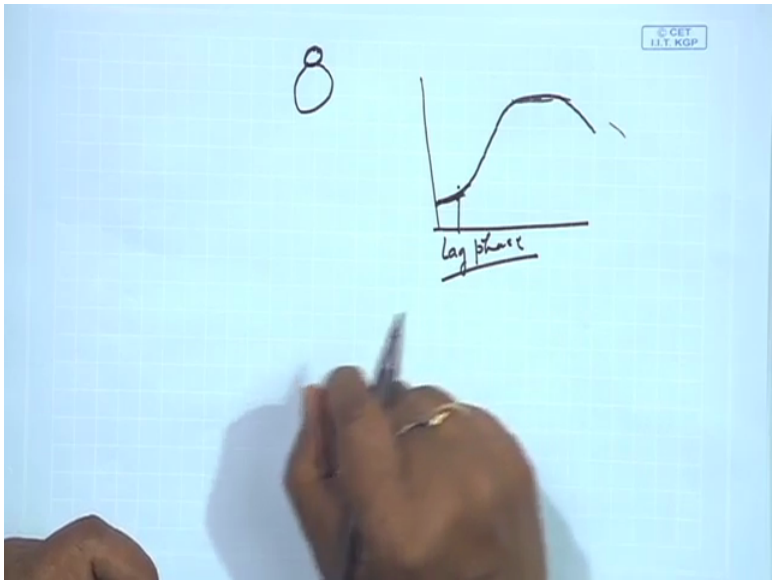

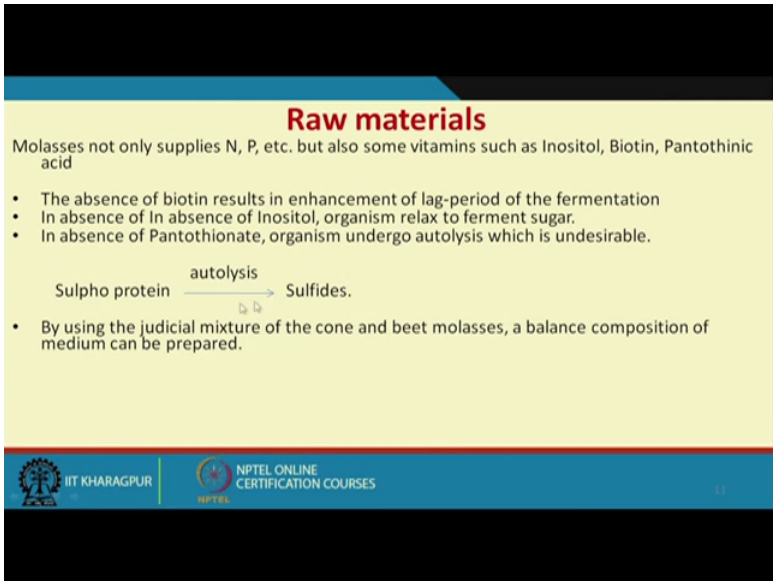

Now this lag phase this is considered as the lag phase, the lag phase it will be extended if the media does not contains biotin. Biotin is a here the biotin is a very important raw material that if biotin enhances the lag phase, now if the biotin enhances the lag phase that means your time of fermentation increases to a great extent but in absence of inositol the organism relax to ferment sugar. So your organism will not will not ferment sugar.

So the media should content inositol and pantothionate acid if it is not there it it undergoes your organism will undergo the autolysis, autolysis means the whatever sulpho protein as for example methionine methionine that is a kind of sulpho protein (())(16:46) is a sulpho protein. So this this one is degraded it produce the sulphite so your biochemical character of the organism will lost your organism will be killed.

By using the judicial mixture of I I I showed you when I discussed the the alcohol fermentation process the best raw materials for Baker's yeast fermentation process if you mix the cane molasses and beet molasses in the 1 is to 1 proportion. Because if you look at the this vitamin I was talking about the biotin inositol and pantothenic they present in different amount in beet molasses and and cane molasses.

Naturally since they present in different amount when you mix together then you have significant amount of this vitamin present in the molasses. So your growth of the organism will be very high because that is usually recommended that 1 is to 1 proportion of cane molasses and beet molasses usually the base raw materials for the yeast fermentation process. Now the yeast cells cannot grow without above vitamin this is called Bios.

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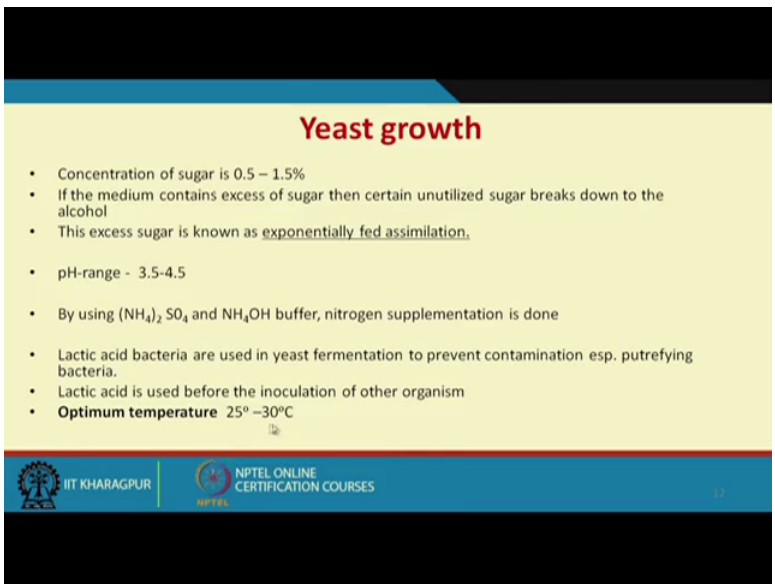

Now in yeast growth that concentration of sugar is 0.5 to 1.5 per cent is the medium contents excess of sugar and then it unutilized sugar breakdown to alcohol. Now this excess sugar is is known to as exponentially fed assimilation and pH is 3.5 to 4.5 and by using ammonium sulphate and ammonium hydroxide buffer nitrogen supplementation is done. Here again let me point it out, I mentioned this in alcohol fermentation process the ammonium sulphate is considered as the best nitrogen source, because because the yeast fermentation usually they carry out at the acidic pH.

When ammonium sulphate dissolve in the water automatically that it is dissociated to ammonium hydroxide and sulphuric acid. Sulphuric acid is a stronger acid as compared to ammonium hydroxide, so pH of the solution will go to the acidic side. So you do not add the acid from outside to maintain the pH of the medium acidic so that is why ammonium sulphate is found to be the best nitrogen source.

Lactic acid bacteria is usually used in the in the yeast fermentation process now this is very important because I I when I discussed about the lactic acid fermentation process then I mentioned the one important property of lactic acid is that it is a good preservative. And I have given the example that cheese production you know that I will discuss the cheese afterwards.

And the cheese is a kind of product is a kind of process cheese making is a kind of process through which you can preserve the milk protein and fat for longer period of time. Now question comes that if when milk is the best food as per human beings is concerned because the protein is the animal protein. We know animal protein we have all the amino acids they are well balanced. So since all the amino acids are since the amino acid are there. So we can utilize that protein very easily.

In the day to day life as per example we can take we we if we take the vegetables same amount of protein maybe 1 or 2 essential amino acids are not present there. The utilization efficiency of the vegetable protein will be significantly low as compared to that of animal protein. So that is why the milk protein and fat is very good for human consumption now we cannot preserve the milk unfortunately for longer period of time, because why because milk is good media for the growth of pathogens, because if we keep it then you know lot of pathogenic organisms will grow there.

So this is this is a problem with the with this milk preservation. And even you do the pasteurization we cannot preserve 3 to 4 days after some times we have to we have to discard it. But you know when we produce the cheese that during cheese making process we remove the moisture from the from the milk and we concentrate that and not only that during that process it produces lactic acid and this lactic acid adds the preservatives for and then so that it can preserve for longer period of time.

So like lactic acid bacteria in this in this Baker's yeast fermentation process purposefully we inoculated with this with the inoculum so that we can the storability of the yeast can be increased to a great extent. Now lactic acid is used before the inoculation with other organism optimum temperature is 25 to 30 degree centigrade.

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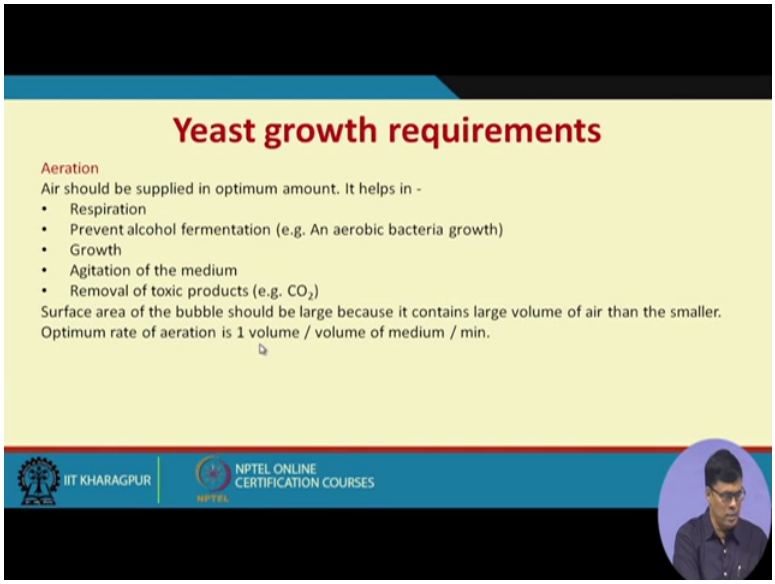

Now growth requirement because the first because because I told you that during aerobic during the aerobic fermentation process cells grow and but anaerobic fermentation it produce mostly the alcohol. So I told you that in case of aerobic fermentation process the growth rate of organism usually 10 times higher as compared to the anaerobic condition, because so amount of nutrients consumption in case of anaerobic fermentation process much less as compared to the aerobic fermentation process. So air is required when the aerobic fermentation process because I told you the organism can take the oxygen which is dissolved in the in the medium.

They cannot take the oxygen which is prepared in the which is present in the air. So air should be supply to the media in the optimum amount, it will help in for the respiration of the

cells and prevents the alcohol formation, growth of the cells agitation of the medium, the removal of toxic product like carbon-di-oxide we know when cell respire it produce carbon-di-oxide and this carbon-di-oxide is the toxic product if allowed the carbon-di-oxide to accumulate in the system that will affect the growth of the organism.

The surface area of the bubble should be large because it contains large volume of air then the smaller, so so optimum rate of air is 1 vvm, 1 vvm means I just explained that what do you mean by 1 vvm, 1 volume per volume of the medium per minute. And foaming to control the foaming the antifoam compounds like octadecanol, tetradecanol, hexadecanol all different oils are used to evaporate the foams. So different type of antifoam oil we use also in this fermentation process.

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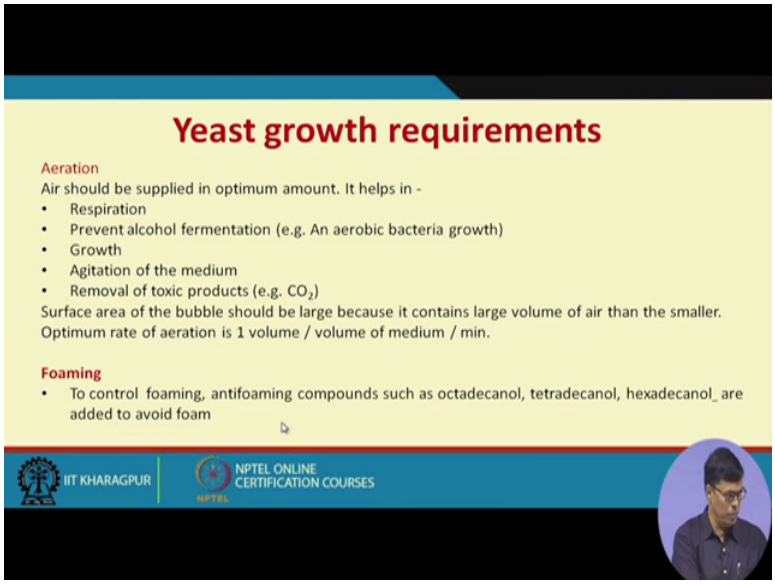

Now stages, there are different stages we have for this Baker's yeast production first is the selection of microorganism we have to select the suitable I I told you the organism should be robust, we call it industrial microorganism. It should genetics characteristics of the organism should be same, genetically stable or biochemical character should be unaltered and then selection of medium for the development of seed yeast and the and the and the fermentation process because this should be cheaper and this should use the and lot of different types of carbons source should be used so that you have lot of choices.

Then fermentation process the kind of fermentation process also used that is very important because if it is start time reactor is usually recommended because your cells will be oil suspended in the liquid so that it freely interact with a substrate and and and multiply

properly. Then the separation of the yeast cells the is also very important that how you can easily you can separate the yeast cells from this the this and dewatering of the yeast cells after that you have to remove the water content and packaging. And this I shall show you that one thing I want to highlight here that suppose yeast cells when you dry when you when you remove the water then I showed you kind of compressed yeast that it produce some kind of block.

Now yeast cells are the segregated cells if you want to even you compress it you want to produce some kind of broth then what will happen as soon as you want to it will it will it will break because you know that the yeast cells they do not have the binding characteristic. So we we add some kind of binder to it like an agar, pectin you know different type of binder that use so that it can hold the cell together, and then and only then we can form the blocks.

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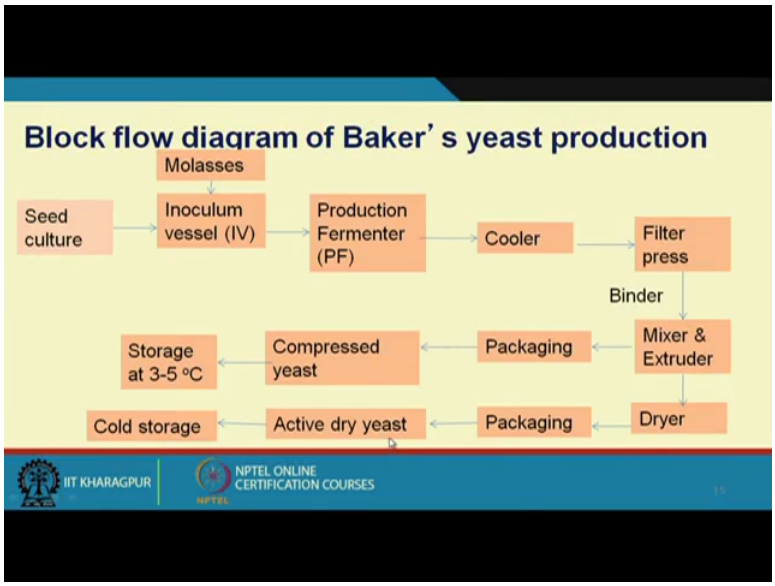

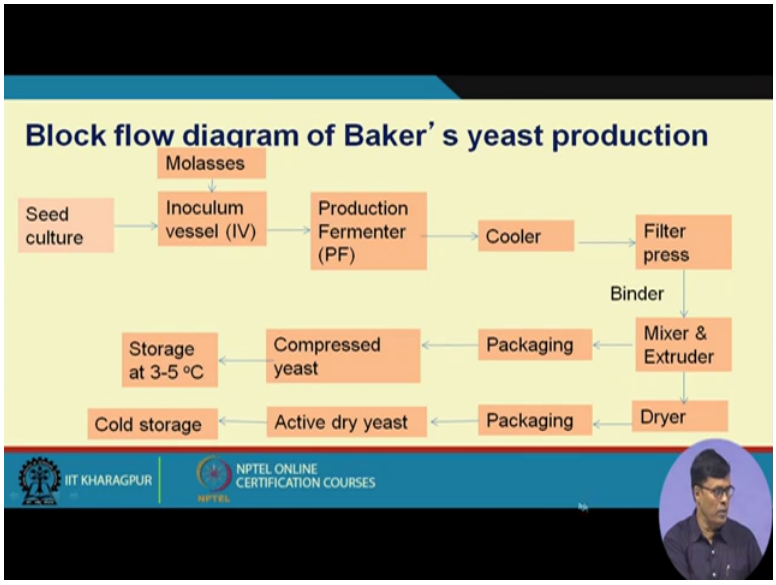

So this is this is in practice and distributed under the refrigerated conditions so let me let me tell you that that whole process how this this compressed yeast and the active dry yeast actually the production takes place. That is the seed is to be prepared because this is the unicellular cells so we can easily prepare the culture very nicely in the in the lab, R and D lab and then we take this culture in the form of seed can we take it to the and transfer in the inoculum vessel under acetic conditions. And this is aerobic fermentation process we take molasses as a media and then when you have and this capacitive of this should be 5 to 10 per cent as compared to production fermenter.

And then we transfer to the production fermenter in the production fermenter we take molasses here so molasses is a raw material that we transfer here then then after the production is over we cool that and after that we pass it through the filter press, I shall show you that how the filter I showed you and previously, I shall show you again how we use the filter press then we add some kind of binder so that we you can hold the cell together.

Then mixer and extruder I shall show you the extruder, extruder means we pose the material to pass through the small orifice and then we have we do the packing here and we get the compressed yeast and storage is 3 to 5 degree centigrade. But when we produce the active dry yeast we do the this we passes through the dryer we cut it in the small sizes to increase the surface area, so the rate of drying will be rate of, we know the rate of drying depends on the surface area.

More surface area more will be drying and not only depends on temperature surface also plays very important role. After drying it contains about 4 per cent of moisture we do

packaging mostly in the polythene package and then we have the active dry yeast, if we if we keep it in the cold we can we can store for couple of years if we keep the normal temperature, we have we can store for a year only.

So this is this is how compressed and active dry yeast can be produced I I shall tell more details in my next lecture. And what I tried to tell you here that that the what is the importance of the Baker's yeast because Baker's yeast is mostly used for the bread making industry and it used for the leavening purpose. It has several purpose not only called leavening purpose it is used for as a source of protein as a source of vitamin which increase the nutritional quality of the bread.

And and then the this produce we find the cane molasses and the beet molasses 1 is to 1 proportion is appears with the base for production is a boot media for the growth of yeast cells and time of fermentation is about 10 to 11 to 12 hours and temperature is about 27 to 30 degree centigrade. pH is about 4.5 to 5, so it has the acidic pH so and since the size of the cells are varies from 3 to 5, 3 to 7 microns so we can easily separate it with the help of fluid and filter press. In the next next lecture I shall concentrate on the process in details. Thank you very much.