Dairy and Food Process & Products Technology
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Lecture - 06
Temperature Quotient and Its Impact

In the previous class we said about a blanching and pasteurization and its effectiveness etcetera, and there if you remember we had said that the term called temperature quotient is very applicable, and today we will discuss more on that and see how effective this can give you some of the application .

Though quickly in that previous class we could not finish that some processes like called canning or appertization, where high temperature is being used right to not only destroyed that pathogens, but also many organisms right.

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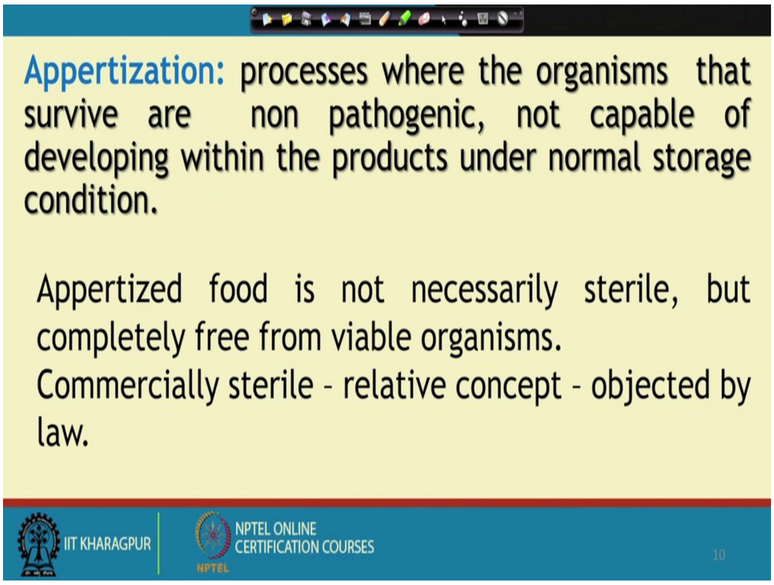

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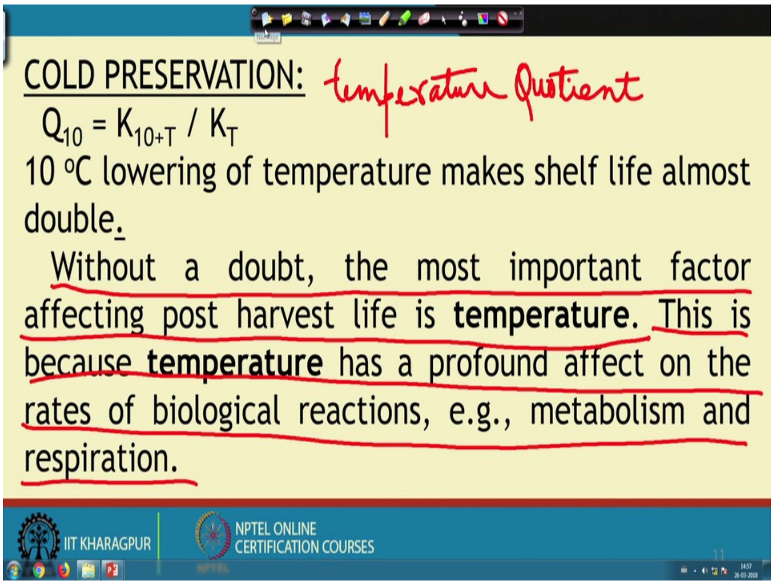

So, here we come to that what is the called term called temperature quotient right, and this why it is coming because earlier we had been dealing with the we said that high temperature was applied. Now, if it is low temperature why the difference will be there right, so to understand that if we understand the term called temperature quotient or Q_{10} right that is called temperature quotient.

So, this temperature quotient is defined as

$$\frac{K_{T+10}}{K_T}$$

Where K is the reaction rate .

You remember in earlier some class, which also said that all whether we are dealing with food right whether we are consuming or processing in any cases, in many cases things are associated with biochemical reactions right, and that is not under the purview of this course.

But to have some test to have some idea about that we will as and when required we will bring also into it. So, that we feel that where it is needed right. Now, this temperature quotient Q_{10} is K is the rate of reaction and this reaction can be as you said earlier also that any reaction like chemical reaction, biochemical reaction, microbial reaction, enzymatic reaction any kind of reactions is generally following this straight forward relationship that temperature quotient (Q_{10}).

So, this physically means that if you increase the temperature by 10 °C, then the rates of reaction is doubled or if you decrease the temperature by 10 °C, the rest of reaction is half. Say if we take the room temperature say 30 °C and if we increase the temperature by 10 °C, then temperature then the rates of reaction which was at 30 degree will be doubled and 40°C.

Similarly, if we decrease the temperature by 10 °C, then the rates of reaction which were at 30 °C will be half at 20°C right. So, these gives us idea why the application of high temperature is detrimental to the food or is banned for the food whether you are processing or whether whatever you are doing in terms of quality; in terms of quality in all aspects right.

In all aspects of quality, its appearance, its color its flavor, its nutritive value everything together are this is the bad. Whereas, if you we lower the temperature then the retention of color, retention of flavor, retention of nutritive value, everything will be better than what it was at higher temperature right.

So, Q_{10} is so much then associated with all the processes right. So, without a doubt we can say that without a doubt the most important factor affecting post harvest life is the temperature. And this is because temperature as a profound effect on the rates of the biological reactions for example, metabolism or respiration.

The other day perhaps I also had said you that you are aspiring every now and then, for that also you need some material and that was a glucose. Perhaps, we will come to that, but let us go quickly otherwise our time gets away.

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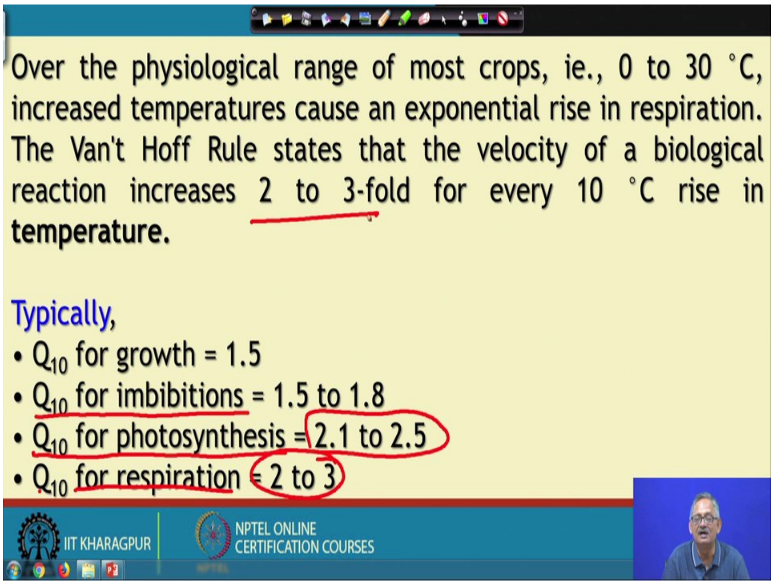

So, this is over the physical range of most crops that is 0 to 30 °C increased. So, over the physical range of most crops that is 0 to 30 °C this is the same temperature range increased temperature causes and exponential rise in respiration.

The Vant Hoff rule states that the velocity of a biological reaction increases twice or thrice or 2 times or 3 times right, for every 10 °C rise in temperature typically we can say that Q_{10} for the growth of the organisms is 1.5, Q_{10} for imbibitions is around say 1.5 to 1.8 is the for imbibition is what 1.5 to 1.8, Q_{10} for photosynthesis is around 2.1 to 2.5 and Q_{10} for respiration is around 2 to 3 right.

So, the thing which we said that 2 to 3 times 2 to 3 falls then is coming correct this is a general this is the general figure right, in absolute in particular case this may vary this may differ, but this gives idea that what could be if imbibition or photosynthesis or growth of the organisms or respiration is concerned what could be the corresponding temperature quotient values right.

Let us then look into this photosynthesis. So, right from our childhood we have come across this thing photosynthesis right, where this trees they are using daylight and sunlight and using carbon dioxide to produce their to produce their nutrient right. So, from this water plus carbon dioxide it comes to that we get oxygen and $C_6H_{12}O_6$ that is glucose right. So, this is a general equation right the way it is written that

$H_2O + CO_2 \longrightarrow C_6H_{12}O_6 + O_2$

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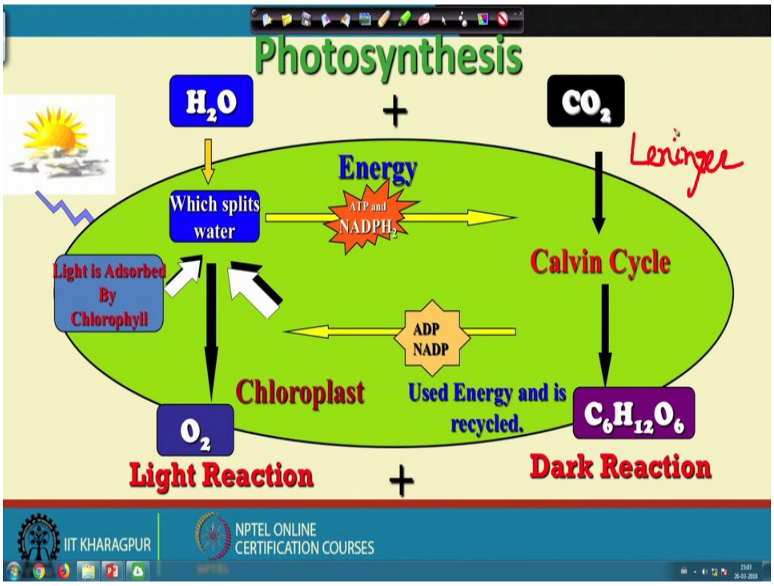

So, easily it can be made right, but in actual it is not some hints we have given here you see this undergoes a cycle typically known as Calvin Cycle right. and just to show you that how difficult or how they are complicated the cycles are and this is called bio chemical cycle.

The other day I also told you that for bio chemistry you go to a book called Leninger right, that is book on biochemistry, if you see that then you can come across that what different types of biochemical reactions are responsible for many things which we undergo right.

So, whether it is metabolism or any other, so that will be very much required. I just have given here one example that we will be doing here this Calvin Cycle how difficult it is you see here though our schematic diagram showed it was so easy, but here you see we are making such a complicated cycle through which we are ultimately we are getting back this from carbon dioxide and water to this your oxygen and glucose right.

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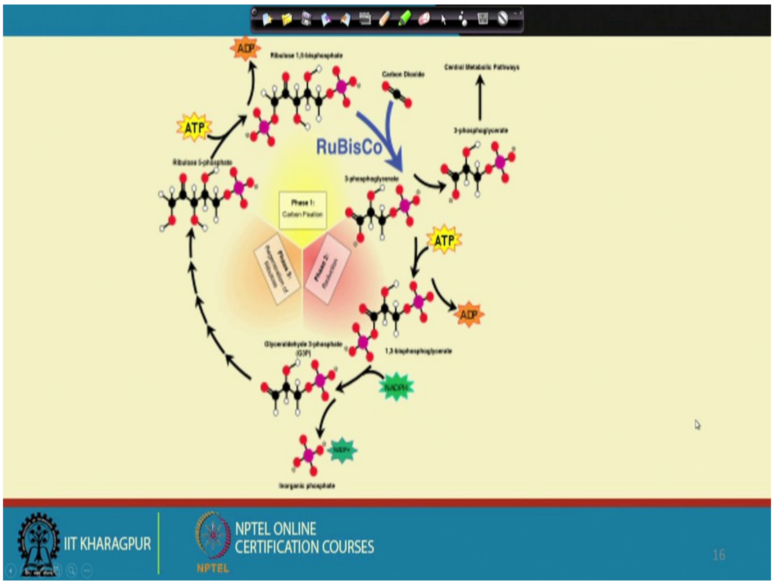

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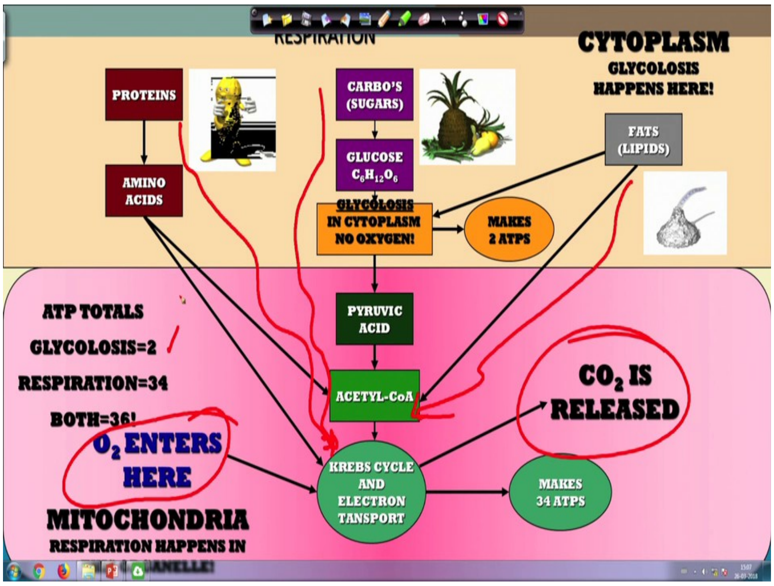

So, and not only that not only this some other things also I will try to show that how difficult or how complicated they are for example, this was Calvin cycle, this is respiration cycle and here you see this is respiration cycle. So, we are taking we are taking carbohydrates say sugars right, coming to glucose and then this glucose on Glycolysis they are making some energy ATPs etcetera, coming to Pyruvic acid, then acetyl CoA and it is undergoing to KREBS cycle right.

So, that KREBS cycle how difficult how complicated this is I would like to show you here also and this is if we are taking carbo with the other day I give you an example if you remember that if somebody is fed with only fat or only protein or only carbohydrate whether you will survive or not because for our respiration here we see that the basic is glucose from glucose we are getting this energy and we are respiring right. So oxygen is required oxygen and glucose we are releasing carbon dioxide water and we are getting a lot of energy right.

So, in the in that question we had said whether people will be surviving if somebody is only paid with carbohydrate or with fat or with protein here we see that we started with this carbohydrate coming to the KREBS cycle, we started with fat we are coming to that KREBS cycle we started with proteins through amino acids we are coming back to KREBS cycle, everywhere this cycle is producing carbon dioxide and energy and we are also taking some oxygen right.

So, there are glycolysis of course, glycolysis is that when you are utilizing glucose for conversion of that glucose into rather glucose that is called glycolysis, that does not depend on whether it is aerobic or anaerobic; glycolysis can happen in both aerobic and anaerobic because that creates the basic that is the glucose. So, once you have that then you it undergoes the cycle it undergoes that formation of carbon dioxide and energy right.

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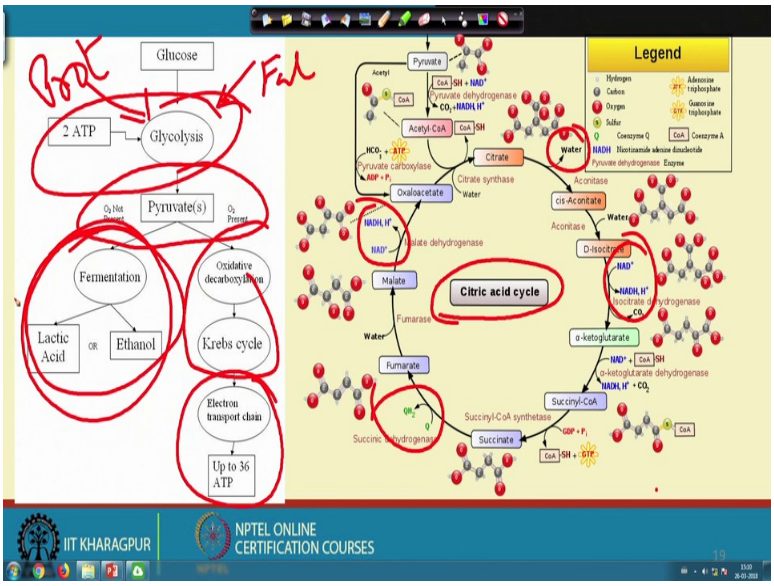

So, let us look into that glucoses so here small energy is obtained during glycolysis right. And then through Pyruvate here it is either it is undergoing anaerobic. So their fermentation lactic acid ethanol is being produced or through oxidative where through KREBS cycle we are getting ultimately energy carbon dioxide and water right so with the basic is glucoses.

So, everywhere as in the previous we have shown that if it is fat or if it is protein then all are getting converted into glucose and then that you will be being utilized for the respiration cycle right. And here this is a typical KREBS cycle which is also known as citric acid cycle and you see from Pyruvate it is CoA acetyl CoA citrate Succinate for then Fumarate or malate then oxaloacetate.

So, this cycle is going on and if every cases either releasing or giving some energy or taking oxygen right, so that on releasing carbon dioxide and water, so depending on what you are taking your respiration cycle is offering of course here again I repeat that during respiration it is aerobic respiration.

If it is anaerobic respiration then we come to this level and where we get this ethanol or may be lactic acid or many other means some acids or ketones or aldehydes are being produced, for example when you run for a long time when you are running for a long time then you many cases you have observed that you are getting some pain either typical pain on the legs and others right.

And that is primarily because your body was requiring lot of oxygen which is not getting you are not supplying that oxygen or oxygen is not available. So, that is why it underwear to anaerobic path and that produce this acids or ketones or aldehydes which are not desirable, but if it is going through the oxidative path then it will produce carbon dioxide water and lot of energy. My intention is that how complicated things are how complicated cycles are in that to give you some idea I just highlighted these two cycles and this two are some I can say as example for bringing your inquisitiveness into this biochemical also right.

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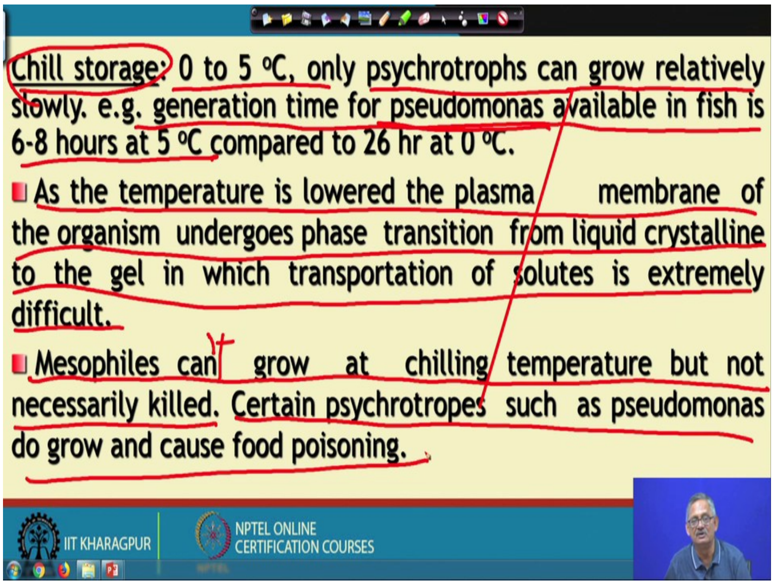

Biochemical is all together different than chemicals and it is much more complicated keep in mind ok. Now, let us go in to some these of course we have said chill storage and other I am not much in favor of this that again this is some definitions 0 to 5 °C is called chill storage, and where psychrotrophs can grow this psychrotrophs can grow relatively slowly for example, generation time for pseudomonas available in fish is around 68 hours around 5 °C compared to 26 hours at 0 °C.

So, that chill storage is good for that we are getting we are showering down the microbial activities as example we have given pseudomonas that is available in fresh fish is growing up since 6 to 8 hour at 5 °C whereas, at 0 °C it takes around more than one day 26 to 27 hours right. So the lower the temperature then better the product is that Q_{10} is coming directly here right.

So, as the temperature is lowered the plasma membrane of the organism undergoes phase transition from liquid crystalline to the jail, in which transportation of solutes is extremely difficult that is why they are not surviving and mesophiles. I hope psychrophyll mesophile this we understand thermophile a thermophile is at high temperature organisms, mesophyll is medium temperature organisms, and psychrophyll s are low temperature organisms for their production activity all right.

So, they love they those who love at high temperature are called thermophile lows who are loving at low temperature called psychrophilic. So, mesophiles can grow at chilling temperature, but not necessarily get killed right this cant mesophiles cant grow at chilling temperature, but not necessarily be killed right. So, it should be cant certain psychrotropes such as pseudomonas do grow and cause also food poisoning at relatively low temperature.

So, I said in the beginning that this is generally not in particular. So, that pseudomonas is typical example which can cause some bad and food poisoning may occur right, this I am giving as example right example in the sense that this is the typical away from the normal right.

Then we come to another that is called moisture loss right you remember in the previous class we said that there are many ways of preserving food material that moisture loss is oen such that is drying. So, by that is the major problem is moisture.

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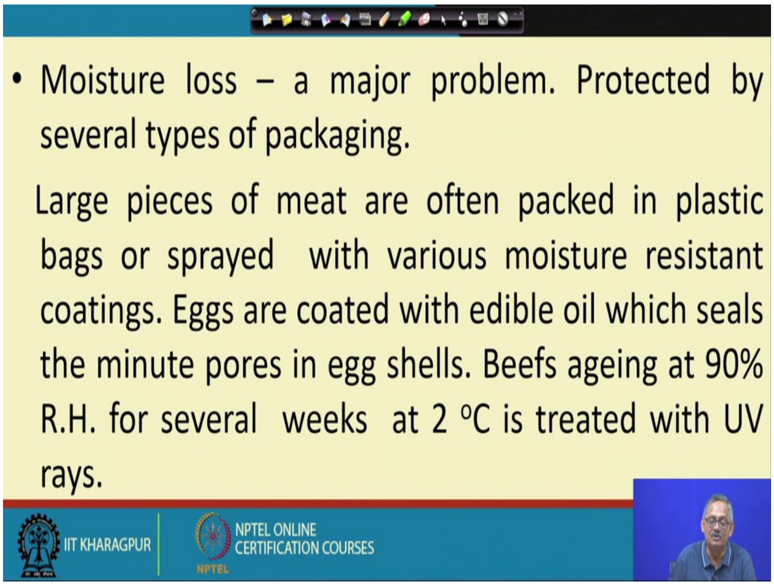

Moisture is the primary problem of the food material to keep for longer time or preserve it for long time because that produce several types of pro packaging are also nowadays come up and that helps in maintaining that moisture. So, moisture is a primary enemy for the food because the highest the moisture level more it is vulnerable for changes right.

So, the lower the moisture level better is the quality better is the retention better is the life of the food material. I give two examples one with high a high moisture content food material right say a fish meat they are all perishable right, but low moisture that is powdered baby powder or milk powder.

So, they are at very low temperature low moisture content. So, low moisture material do survive for a longer period right or do. So, in that case large pieces of meat are often impact in plastic bags or spread with various moisture resistant and coatings and eggs are coated with edible oil which sells the minute pores of the egg shells beefs aging at 95 %, RH for several weeks at 2 °C with ultraviolet rays. So, these are a typical some example of high moisture or the moisture problem right.

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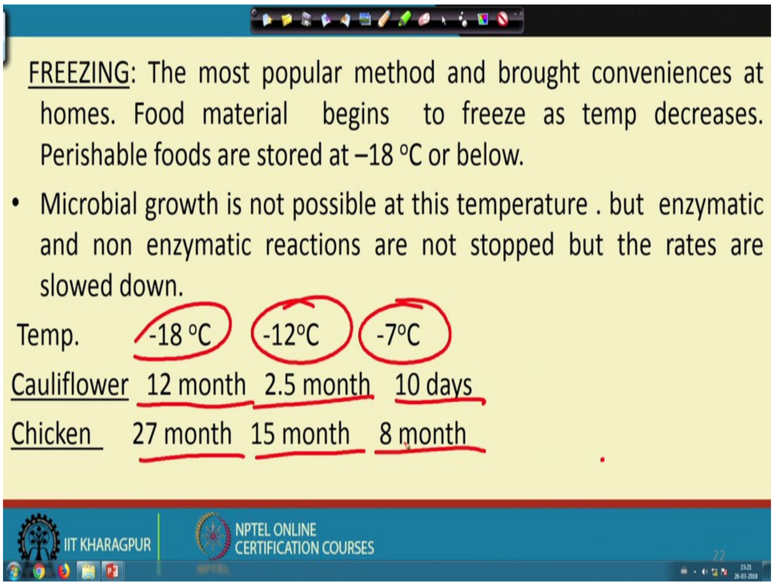

So, in that another thing which comes in is the freezing right, in the low temperature that is the freezing if we lower the temperature and freeze it then we have just said that the rates of reaction comes down drastically depending on how far you are going right that example also we will be giving how far you are going in terms of temperature this is not only processing, but also the storage right.

So, when you are making it then this will be the method will be beyond the purview of this class, because that is another technique either drying or freezing these are different techniques they different engineering processes which is beyond the purview of this class, but to have some idea we will say that freezing you can differentiate that if keep you keep one small bucket of a water in your house hold refrigerator you will see that it will take maybe several hours to freeze depending on the size and the container.

If you keep in plastic container then it will take much longer time then if you keep it in some metallic container right. So depending on that it may be vary but time requirement is very high whereas, if you have same say carol liquid like liquid nitrogen you can freeze it instantly almost in no time may be in terms of seconds or in terms of minutes right. And in both the process your size of the ice crystals number of the ice crystals there been produced there also are quite different in some case in the farmer case that is when you are keeping in the house hold refrigerator the size of the ice crystal is very high number is very low.

So, the cell damage and other losses are very high whereas, if you would have done that thing the same thing in nitrogen then that would have been much much better, and you could have done a lot in that in the sense then size of the crystals are very very small, number of ice crystals are very very high. So, to make that comparison I have given that when you are storing cauliflower at around -18 °C, or -12 or -7°C you see the storage time 12 month for cauliflower 27 month for chicken.

That means, depending on what product you are taking time temperature period all are getting different at -12 it is 2.5 months and 10 or 8 moths -7 °C right. So if you look at this is a typical different time temperature combination for storage right, I just give an example I am not discussing this then before this I think there was one no ok.

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Product	4 °C Temp	-18 °C Temp
Fresh egg in shell	3 to 5 weeks	Don't freeze
Raw yolks, whites	2 to 4 days	1 year
Hotdogs,opened pckge	1 week	1 to 2 months
Fresh Beef, Lamb, Pork	3 to 5 days	6 to 12 months
Chicken or turkey, whole	1 to 2 days	1 year
Pizza	3 to 4 days	1 to 2 months
Juices, fruit drinks, punch	3 weeks unopened	8 to 12 months
Butter	1 to 3 months	6 to 9 months
Cottage Cheese	1 week	Doesn't freeze well
Lean fish (cod, haddock)	1 to 2 days	6 months
Fatty fish	1 to 2 days	2 to 3 months

So that means, when we are talking about that the temperature is one of the primary consideration where you are freezing before or that is below freezing or above freezing that is a primary concern as well at what temperature you are keeping right. So, this will dictate you how long you can keep your material under good condition right. So, we stop it here

Thank you.