Thermal Operations in Food Process Engineering: Theory and Applications
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Lecture - 03
Preservation Techniques

So, good morning. In the previous class we have said about food, about some of the definitions, 'right', as the preamble of this course. Now, let us look also into some other aspects like Preservation Techniques. What are the preservation techniques, because out of which many will come under the umbrella of this, that thermal operations, 'right'. So, let us look into the preservation techniques.

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There we see that first application of heat, by which it is preserved removal of cold, that is also by which it can be preserved, dehydration, physical methods other than thermal, some biological controls, fermentation, chemical preservation, irradiation, emerging technologies, 'right'. Out of which this application of heat removal of cold dehydration these come and some physical methods under which are thermal they come under this category, ok.

So, quickly we will go. So, application of heat is cooking frying, boiling, or simply heating prior to consumption that is under simple heating. Then commercial processes like blanching, then pasteurization, then sterilization, dehydration, they are all under the

application of heat. When blanching comes in many cases, when you will see in other courses that, when you are doing that processing a blanching may be very much essential, 'right' and, this is done around 75 to 95 degree centigrade maybe time duration 1 to 10 minutes.

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The fundamental reason for this blanching is that, it is done prior to drying, or canning, or freezing, which delays the enzymes to act or enzymes inactivation is also occurred. So, blanching is priors or preamble or prior to the process fundamental processing is done. It restricts undesirable changes in odour, flavor, colour, texture, and nutritive values during storage by freezing as well, removes intercellular gases.

Minimizes the potential for oxidative changes reduces microbial load. Leaches toxic constituents such as nitrates, which in many cases call methaemoglobinemia and in that is true for the infants and it removes the pesticides also.

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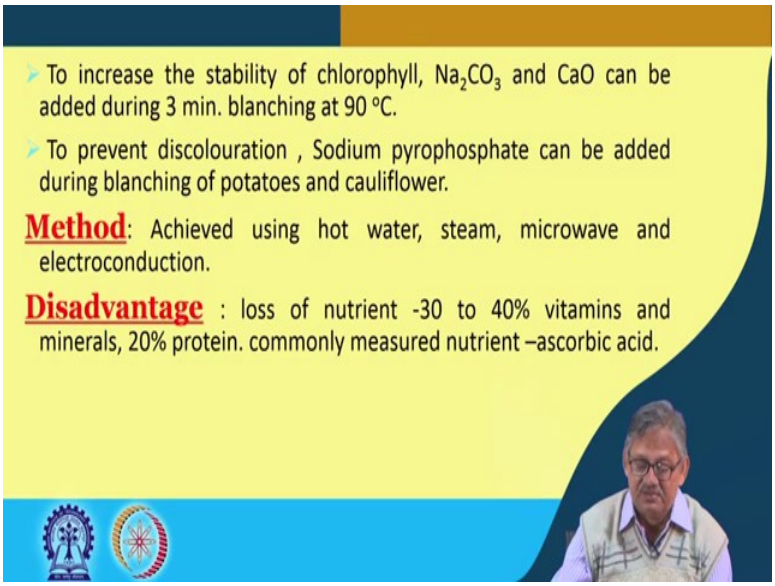

Other reasons for doing the doing the blanching is to increase the stability of the chlorophyll, sometimes sodium carbonate and calcium oxide is used and during the 3 minute blanching at 90 degree centigrade in many cases and also it prevents the dis-colouration.

So, for that some sodium pyrophosphate is added during blanching of potatoes and cauliflower. So, blanching primarily is removing some of the bad part during the main processing. So, that the main processing the changes are minimized. So, for that this is required the blanching method could be achieved, using hot water, steam, microwave or electro conduction, but some disadvantages are associated with it like loss of nutrient around 30 to 40 percent vitamins are lost, vitamins and minerals both, 20 percent of proteins are lost and commonly measured nutrient is ascorbic acid.

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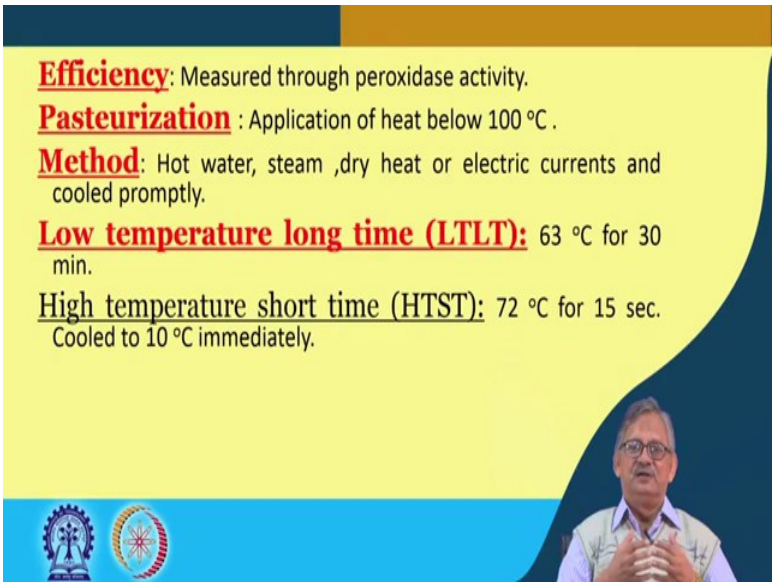

Whether these losses have been occurred or not that is measured in terms of ascorbic acid content means, initially how much ascorbic acid was present and after the blanching how much ascorbic acid has been retained, that indicates, that how much quality deterioration, during the process of blanching has been made, 'right'.

Efficiency is measured through peroxidase activity. Pasteurization is another technique by which it is not blanching by which application of heat is being done and it is below 100 degree centigrade. The method is hot water, steam, dry heat or electric currents and cooled and they cooled promptly the method is done.

Low Temperature Long Time LTLT that is one of the pasteurization technique, where 63 degree centigrade for 30 minutes this LTLT is used for pasteurization, and high temperature short time, high temperature not long time, high temperature short time, it should be at 72 degree centigrade for 15 seconds and then cooled to 10 degree centigrade immediately.

Now, this cooling there is a reasoning for that, that why after pasteurization at say 72 degree centigrade or say 63 degree centigrade, that cooling is done instantaneously. Primarily, because that another thing which we have not I do not know where it is if it is coming very good, otherwise let me also tell here, that there is a term called Q_{10}, 'right' Q_{10}. So, in that Q_{10} there is a definition of it, that Q_{10} refers to the rate of change of anything be it chemical, biochemical, microbial, or enzymatic at temperature T to that,

the same at temperature T plus 10 degree, ‘right’; that means, if you are doing roughly like this perhaps it is coming afterwards if I have not mistaken,‘right’. If it is coming it is like that that if you are heating at 20 degree centigrade.

So, the rate of change in terms of as we said chemical, microbial, biochemical, or enzymatic changes which will happen at 10 degree 20 degree centigrade, if it is increased by 10 degree. So, in 30 degree centigrade, it will be almost double. In most of the cases it is almost double. Whereas, if you lower the temperature from 20 to 10, then it can be said that this rates of change of chemical, biochemical, microbial or enzymatic changes will be almost half compared to that at 20 degree centigrade. So; that means, the higher the temperature more is the likely changes are associated.

So, this is why primarily that is done and another case that while they sharp that you are from high temperature to low temperature, you know I again we will come perhaps in our this preamble classes, that microbes, there are they are particularly bacteria there are 3 types; one is called thermophilic, one is called mesophilic, and another is called psychrophilic. Thermophilic bacteria, is liking the high temperature around say 40 45 to 50 55, then mesophilic around say 20 25 to 30 degree centigrade and psychrophilic is around plus minus 5 degree centigrade.

So, if you are not bringing down the temperature, there is if it is bring down the temperature quickly, there is likelihood that thermophiles may grow or when do something. So, that is why again it is brought down very quickly. So, that organisms are also, if there be any they are also. Now in this particularly pasteurization, you are not killing all organisms, you are killing only the pathogenic organisms or which are disease causing or which can produce some disease which can cause some disease they are killed, ‘right’. So, high temperature short time at 72 degree centigrade for 15 seconds and then cooled very quickly to 10 degree or even lower, ‘right’.

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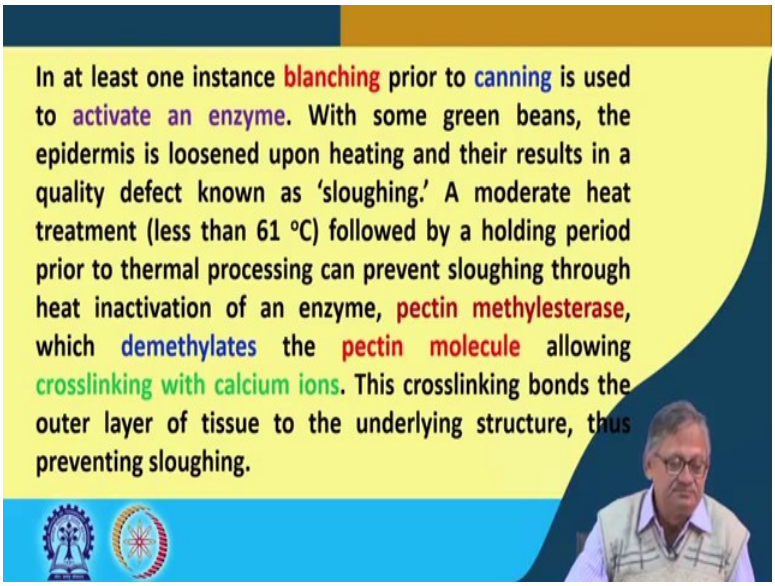

At least one instance of branching prior to canning is used to activate an enzyme. With some green beans, the epidermis is loosened upon heating and their results in a quality defect known as 'sloughing'. A moderate heat treatment less than 61 degree centigrade followed by a holding period prior to thermal processing can be prevented can prevent sloughing through heat inactivation of an enzyme, pectin methylesterase, which demethylates the pectin molecule allowing cross linking with calcium ions.

This crosslinking bonds the outer layer of tissue to the underlying structure underlying structure, thus preventing sloughing.

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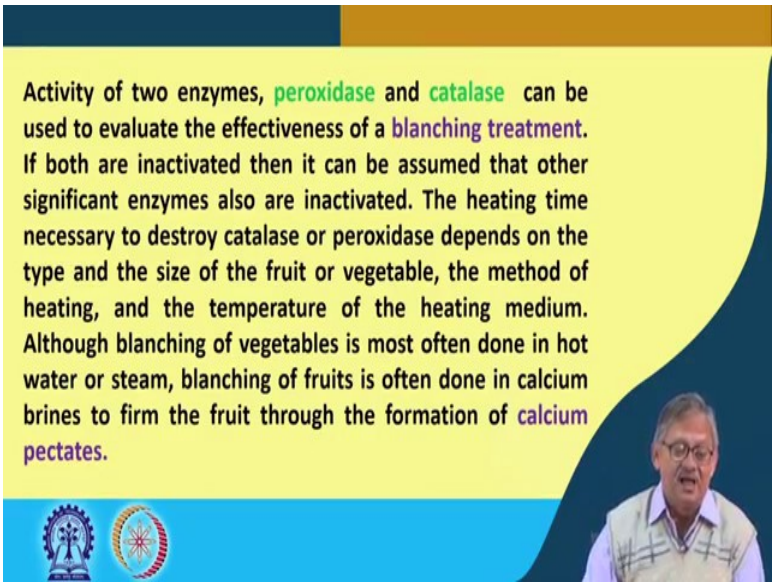

Activity of two enzymes, like peroxidase and catalase can be used to evaluate the effectiveness of a blanching treatment. If both are inactivated then it can be assume that other significant enzymes also are inactivated. The heating time necessary to destroy catalase or peroxidase depends on the type and the size of the fruit or vegetable, the method of heating, and the temperature of the heating medium.

Although blanching of vegetables is most often done in hot water or steam, blanching of fruits is often done in calcium brines to firm the fruit through the formation of calcium pectinates or pectates.

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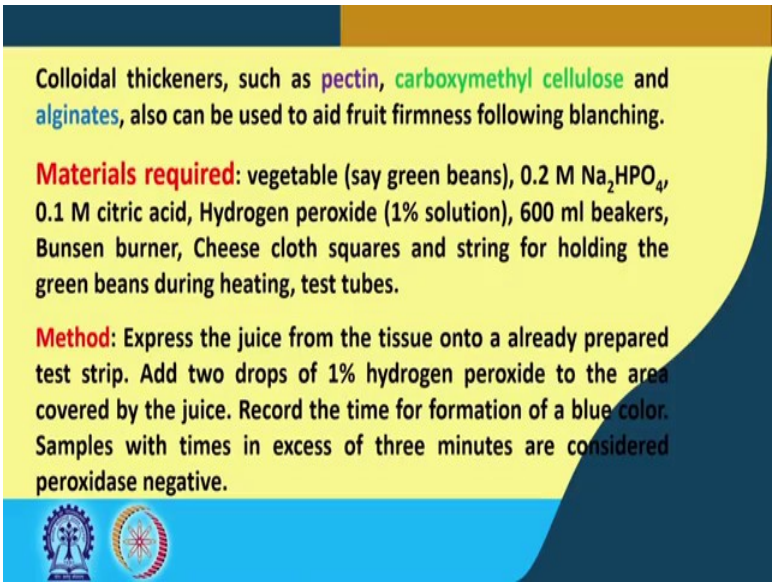

Colloidal thickeners, such as pectin, carboxymethyl cellulose and alginates, also can be used to aid fruit firmness following blanching. Material requires are vegetable for examples say, green vegetables or green beans 0.2 molar Sodium hydrogen phosphate, sodium hydrogen phosphate, 0.1 molar citric acid, hydrogen peroxide around 1 percent solution. Since, 600 ml beakers, Bunsen burner, cheese clothes squares and string for holding the green beans during heating, test tubes. However, we are skipping this is given to you.

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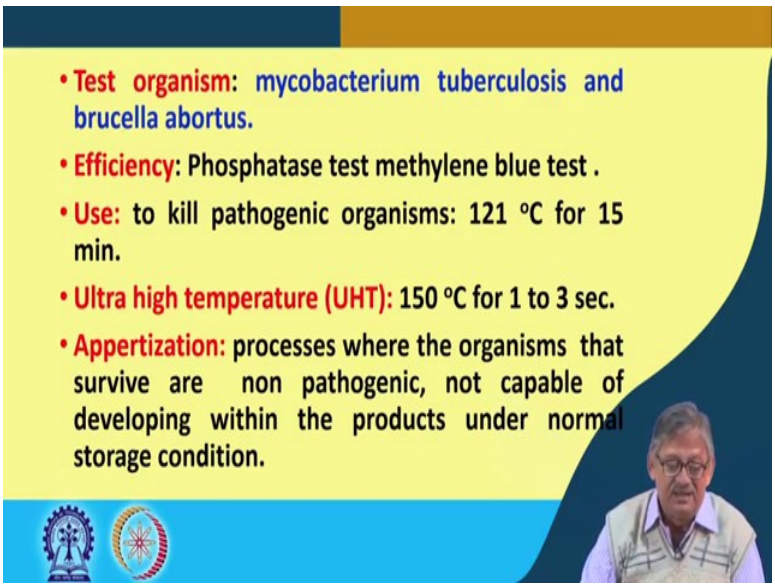

So, you can see afterwards. Test organism is mycobacterium tuberculosis and brucella abortus, 'right'. Efficiency is determined by phosphatase test methylene blue test this way 'right'. It is used to kill the pathogenic organisms 121 degree centigrade for 15 minute and Ultra high temperature around 150 degree centigrade for 1 minute or 1 to 3 second so, that is used.

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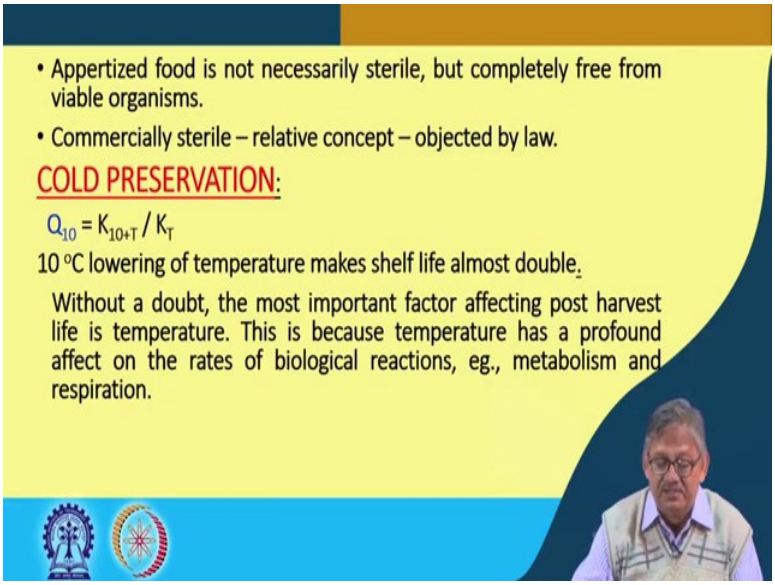

Another process appertization, this is a part of canning. I am not going into it. So, these things are given now, the one which you are saying for Q_{10} or that this is called temperature quotient Q_{10}. Generally, this is a directive or this is an indicator, not directive, this is an indicator for how quickly the changes may occur or may not occur. 'right'. So, this is associated with cool preservation.

So, $Q_{10} = K_{10+T}/K_{10}$ or K_T 'right' T is any temperature. So, 10 degree centigrade lowering of temperature makes shelf life almost double. Without a doubt, the most important factor affecting post harvest life is temperature. This is because temperature has a profound affects on the rates of biological reactions, for example, metabolism and respiration.

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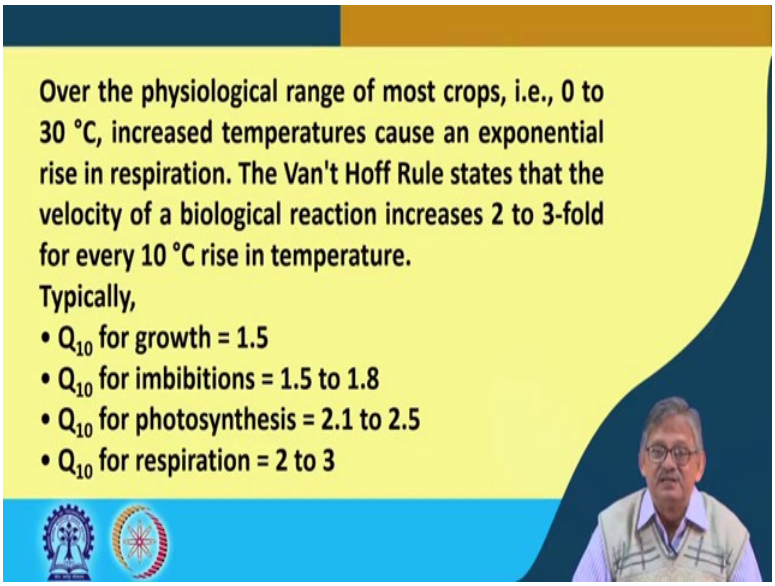

Over the physiological range of most crops, that is 0 to 30 degree centigrade increased temperature cause an exponential rise in respiration. The Van't Hoff Rule states that the velocity of a biological reaction increases 2 to 3 fold for every 10 degree centigrade rise in temperature, 'right'. Typically Q_{10} for growth is around 1.5 Q_{10}, for imbibitions is 1.5 to 1.8, Q_{10} for photosynthesis around 2.1 to 2.5, Q_{10} for respiration is around 2 to 3; that means, you are saying that as we said that every 10 degree is rise or lowering, then the temperature say we get the example of 20 degree centigrade.

So, if it is increased by 10 degree 30 degree centigrade, or increased by another 10 degree 40 degree centigrade, then whatever the rates were at 30 degree centigrade at 40 degree centigrade rates will be almost double, you see these values are almost around 2, 'right'. So, that is why roughly it can be said, that these rates of reactions will be almost double if the temperature is raised by around 10 degree centigrade, 'right'. So, this is the beauty of Q_{10} that you can you can predict.

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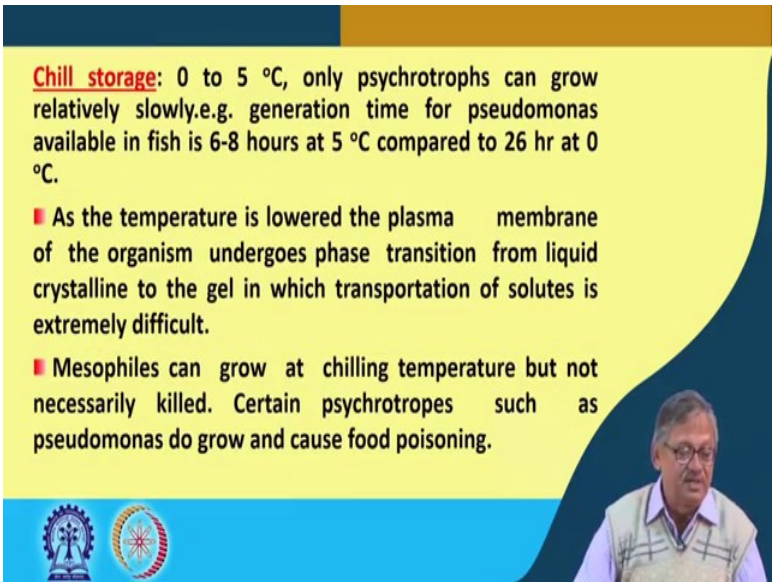

Chill storage another was 0 to 5 degree centigrade, ok.

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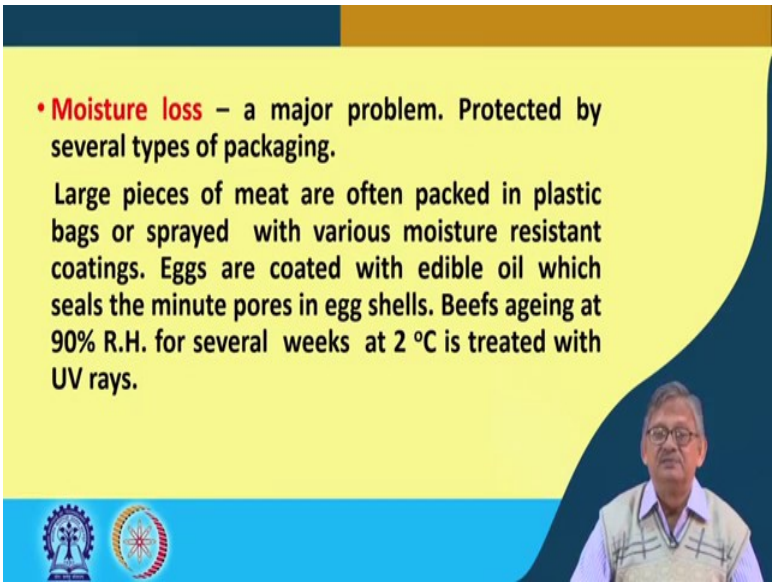

Then moisture loss a major problem protected by the several types of packaging, yeah this is another thing, but of course, this is not the major part of power. So, you can skip little. So, that, but the information is given to you so, you can go through it.

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And, freezing another technique by which it is preserved, the most popular method and brought convenience in at homes. Food material begins to freeze as temperature decreases. Perishable foods are stored at minus 18 or below degree centigrade below minus 18 or below temperature.

Microbial growth is not possible at this temperature, but enzymatic and non enzymatic reactions are not stopped, but the rates are slow down. So, for example, we are giving if the temperature is minus 18, if it is cauliflower it can be stored for around 12 months. If it is minus 12 degree centigrade could be stored for 2.5 months or at minus 7 degree centigrade could be stored for 10 days.

So, minus 7 to minus 18 you see the lifespan of cauliflower is increasing from days to months or year days to month or year, 'right'. So, minus 7 10 days, minus 12 2.5 months, and minus 18 it is almost 12 months. Chicken another example, cauliflower given annual plant source, 'right' and animal source is chicken we again minus 18 it 27 months minus 12 15 months and minus 7 8 months.

So, normally as we said earlier also, that animal source is of food are preserved at or below 0 degree centigrade, usually around minus 18 degree centigrade. The lower the temperature more is the shelf life that is obvious, that also comes from the definition of the temperature quotient or Q_{10}, 'right'.

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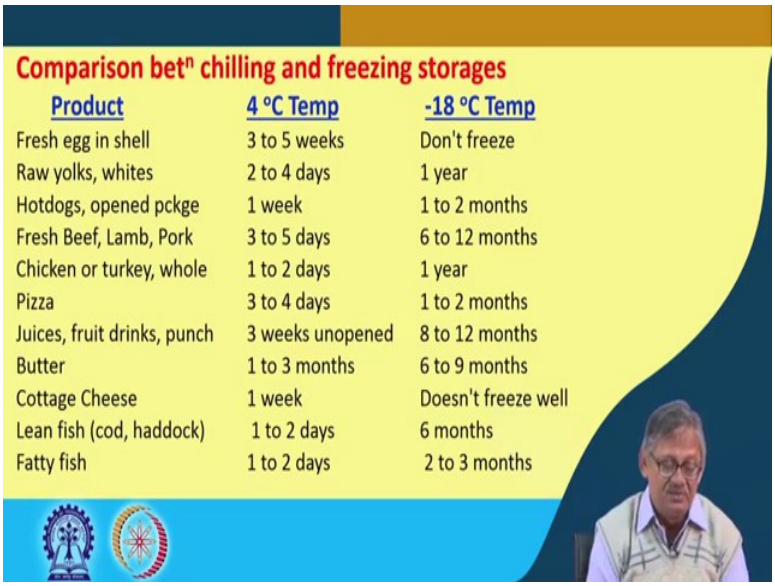

So, we can say that comparison between chilling and freezing storages are like this. If the products are like, fresh egg or in shell, at 4 degree centigrade 3 to 5 weeks or minus 18 degree centigrade it does not freeze of course. Then, raw yolks white yolk or whites that 2 to 4 days at 4 degree centigrade whereas, at minus 18 it can be stored for a year. Hotdogs opened package it could be 1 week or 1 to 2 months at 4 and minus 18 degree centigrade respectively. Fresh beef or lamb or pork it could be 3 to 5 days at 4 degree centigrade whereas, 6 to 12 months at minus 18 degree centigrade.

Chicken or turkey, whole it is it could be stored at 1 to 2 degree 2 days for 1 year at minus 18 degrees centigrade. Pizza it is 3 to 4 days at 4 degrees centigrade whereas, 1 to 2 months if it is stored at minus 18 degree centigrade. Juices fruit drinks punch, this is a different kind types of liquid foods 'right' juices, fruit drinks, or punch. So, they can be stored at 4 degree centigrade up to 3 weeks unopened and around 8 to 12 months, if it is at minus 18 degree centigrade. Butter, if it is 1 to 3 months at 4 degree centigrade and 6 to 9 months or even more at minus 18 degree centigrade.

Normally, butter is solid at room temperature, but that room temperature normally we say around 25 degree centigrade. You will see butter in hot summer, when the temperature many parts of the country temperature goes as high as my plus 50 degree centigrade or even higher. So, there you cannot keep butter outside, it gets melted, 'right' that many of you I do not know how many of you, but many of few have observed it,

'right'. If, the temperature goes to plus 50 or somewhere close to that the butter is normally not kept outside. Though in most of the student hostels this butter lies on the table in most of the hostels, but that is true when the temperature is around 20 25 even 30 degree, then also it become soft, but not melts.

But, if it is plus 50 degree centigrade then it gets melted. So, it can be stored at 4 degree centigrade for couple of months 1 to 3 months and if it is at minus 18 degree centigrade can be stored for 6 to 9 months or even higher. Then, cottage cheese of course, is a variety or is a product, or is a milk oriented product, that is mostly popular in western countries. In our country butter is much better popular as well dahi or similar kind of milk products are more popular than cheese, but still cheese in our country is gradually penetrating and people are liking a little and if cheese is there, then it can be stored at 4 degree centigrade for 1 week, and it does not freeze well at minus 18 degree centigrade, 'right'. Lean fish that is earlier we said lean fish is low fat fishes, 'right'.

So, low fat fishes it is for example cod, haddock, zebra it is 1 to 2 days at 4 degree centigrade, but for 6 months if it is at minus 18 degree centigrade. Whereas, fatty fish where fat content is high it is again 1 to 2 days at 4 degree centigrade, but 2 to 3 month if it is at minus 18. So, there since fat content is high fat becomes the primary things which gets converted, 'right', which is affected, ok.

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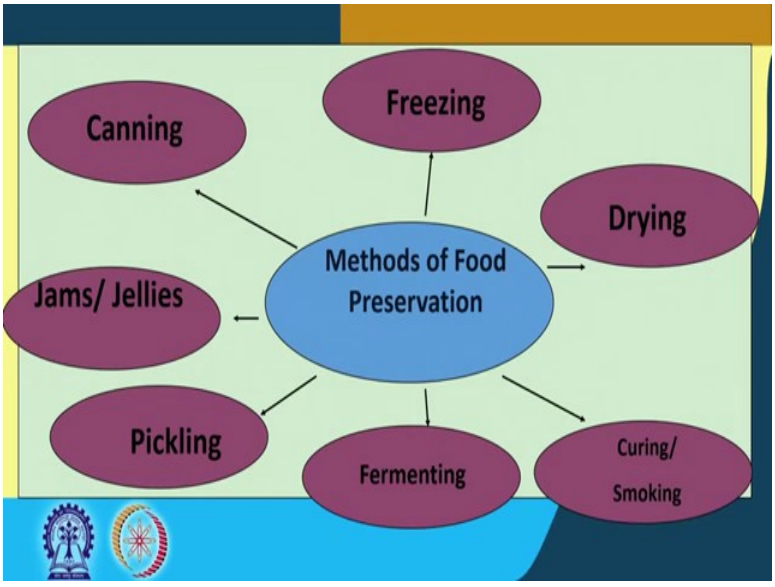

Then, we can see that the methods of food preservations could be said like that freezing, ok; one drying, another then curing or smoking and curing and smoking is such that when you are curing or smoking means some smoke flavors are coming. So, that time and during that curing also some fermentation takes place these are the good. For example, pickles etcetera, 'right'. Then, fermentation is also another method of preservation pickling, jam jelly marmalade preparations they are also are canning.

So, different ways either chemical non chemical or heat thermal this can be some your ways by which you can preserve the food materials, 'right', for a longer period. Longer means to the tune of 6 to 8 months or even years, 'right'. So, our time is getting over. So, let us say let us just recapitulate that there are many ways of preserving our point of interest is thermal. So, heat treatment is one of them. So, or fundamental and we will talk about after these preambles are over then we will come to the basic thermal courses.

So, here what we learnt primarily that term this is very-very important that Q_{10} or temperature quotient where it is the it can be said is the parameter or it can be said is the tool by which you can understand, you can think of that how long or how less the food material can be stored. So, every 10 degree rise increases all the reaction rates whereas, every 10 degree lowering decreases all the reaction rates almost double or half, 'right' respectively.

Double if it is increased or half if it decrease then the base temperature, base temperature we get the example say 20 degree, then doubling will be at 30 degree, then it is doubling will be at 40 degree, then that at 30 degree, 'right', it becomes then quadratic of 20, 'right'. So, similarly half will be a 10 and one fourth will be at 0. So, Q_{10} has very-very long term implication and it is very-very important, 'right'. So, let us now conclude this class.

Thank you all.