Cooling Technology: Why and How utilized in Food Processing and allied Industries

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Lecture 05
How to produce Safe Foods? (Contd.)

Good afternoon. Perhaps in the previous class we were talking about thermal how to produce safe food right and we said that application of thermal energy is one of them and we came to the point where we said blanching is one of the techniques to reduce the both microbial as well as enzymatic load. And there we came back to the pathogen how they are killed and we said this is by application of heat which is known as the pasteurization. Now how we understand pasteurization is over or good? It is done by a test which organism which is very very heat resistant is selected for example, micro bacterium tuberculosis or brucella avatars these organisms are selected and the test is done for the for the I mean examination of whether the pasteurization was sufficient or not that is all test all pathogenic organisms have been killed or not. And the name of the test is called phosphatase test with methylene blue, right, phosphatase test with methylene blue that is done, right. Now, this is to kill the pathogen organisms at 121 degree centigrade and 15 minute, but there are other techniques by which these organisms can be killed.

For example, ultra high temperature or UHT, and that UHT is at150 degree centigrade for 1, 2, 3 second and we also said earlier that appartization, that is canning, that also creates sterilized food and you do not need afterwards to keep it under refrigerated condition. It can be kept at room temperature and that is how the can materials are kept at room temperatures, right. So, this way the safe foods can be preserved. Now, coming back to our old the basic thing, which we are started with that how cold preservation can be done.

Now, cold preservation can be done as we said earlier the temperature quotient, that is Q 10, what we said earlier is, it is at a temperature, it is a ratio of rates of reactions at temperature of T plus 10 degree to that at the temperature T. So, this is, this was our definition of temperature quotient. Now, it is not necessarily, it has to be every time 10 degree plus or minus it can be somewhere 7, 8 degrees also depending on the cases. Now, 10 degree centigrade rise means you see whatever reactions, were at say temperature 20, and if you make the temperature 30 then the rates of reaction becomes almost double which we have shown earlier. Similarly, if it is from 30 to 40 then again

rates of reaction becomes even more double than that of 30.

But if you do the reverse, that is, if we go back to temperature which was 30 degree centigrade, now brought back to 20 degree centigrade, that rates of reactions at 20 becomes half of that at 30 degree centigrade. Same is true if we make from 10 degree centigrade to 0 degree centigrade, then whatever rates of reactions were there that will become half of 10 degree, right. So, this way if we lower down the temperature, the rates of reactions will be lower and lower in each 10 degree, half. So, we can say that the lower the temperature lower is the rates of reaction, better is the quality of the food product, right. Because, we have seen, increasing the temperature is increasing the temperature quotient value, which means that all the rates of reactions are increasing whereas, if we decrease the temperature by 10 degree, it is lowering down the rates of reactions almost half of the previous one.

So, we are stopping the rates of reactions to the extent that it becomes almost halt or there is no further, I mean reactions at that temperature. So, in this case we would like to know that, again a little different kind of thing, that civil or rather chill storage, which is generally between 0 to 5 degree centigrade, where only psychrotrophs, we already said, psychrotrophs are low temperature loving organisms and that can grow relatively slowly. For example, generation time for pseudo monas, available in fish is 6 to 8 hours at 5 degree centigrade compared to 26 hour at 0 degree centigrade, right. So, from here, you are able to see that if you are lowering the temperature the rates of reaction for example, that pseudo monas, available in fish, it takes 6 to 8 hours, whereas, the same if it is at 0 degree centigrade it takes around 26 hours which means that the lowering of temperature is increasing the storage life. In other word, increasing the quality of the food, than that at the previous 10 degree centigrade right.

In this case it is everything like a color change, right a color change that also is restricted or minimized by lowering the temperature by 10 degree, right. So, at the temperature, it is lowered, the plasma membrane of organism that undergoes phase transition from liquid crystalline to the gel in which transportation of solutes is extremely difficult because from solute from solution or from liquid the migration of solutes is much more easier than if by lowering it, if by lowering the temperature you can create a gel like liquid, then in that gel, the migration of the solutes is very difficult for which the organisms do not grow or do not multiply, right that is why 0 degree is much better than that of 6 to 8 degree, right. Mesophiles can grow at chilling temperature, but not necessarily be killed, Certain Mesophiles such as pseudomonas do grow and cause food poisoning, this is typical. Typical means we can say it is exception out of many Mesophiles only pseudomonas can do such. So, there are exceptions of course, it is not only pseudomonas, many more others also.

Other microbiologist may tell much better what are the other organisms which even grow at lower temperature, but it is in general, likely that the organisms do not grow, do not have the activity at very low temperature compared to that at high temperature. Large pieces of meat are often packed in plastic bags or sprayed with various moisture resistant things. Eggs are coated with edible oil which fills the minute pores in egg shells. I have no idea whether you have observed it or not at home, perhaps you have a small weighing machine not the bigger one where you take your personal weight not that a small weighing machine around 2 kg, otherwise you will not be able to detect the changes. You keep a, you keep an egg, all right, buy a fresh egg and weigh it and keep it outside maybe for 5-7 days.

If the temperature is not very high again and again. So, now it is coming winter so, it may be easier that you keep it outside and every day you take the, at the same time, maybe 10 o'clock in the morning every day, you take the weight of the egg. You will see that the egg weight is gradually decreasing may not be substantially, but it is gradually decreasing. Then the question comes how and why because you, in the egg, the outer shell is very hard, right, basically some calcium salt coating, then where it is going? The moisture is going away, moving away from the egg inside to the outside, thereby decreasing the weight. That means, it says that there are some pores in the egg, right.

So, it is very micro pore, it is not that big by which fresh air can go in and something may come out, no. It is very micro pore and if this is coated with edible oils, then the minute pores in egg shells, that gets coated and this loss may be prevented. Beaf ageing at 90 percent relative humidity for several weeks at 2 degree centigrade is treated with UV rays, right. So, with high relative humidity beafs can be stored for several weeks and again at 2 degree centigrade, if it is treated with ultraviolet ray then it becomes very good, or it can be kept for a longer period of time. Now, this will come in detail afterwards when we are coming to the application of the cooling there the fundamental application is the freezing, right.

Will come in detail in freezing because that is one very very important process or we can say that fundamental unit operation. So, that will come across afterwards in detail, but here as a preamble we say that the most of the popular method is the freezing and is brought conveniences at home and rather it brings conveniences at home. Food material begins to freeze and decreases the loss or spoilage at that condition. Simple foods are stored at minus 18 or below degree centigrade. Why it is minus 18, I hope, I had said in detail earlier, that it is almost equivalent to 0 Fahrenheit and when there was only Fahrenheit scale available no centigrade, it was observed that 0 Fahrenheit is the best, 0 or lower of course, Fahrenheit is the best for keeping the food materials intact that is how

this minus 18 number came up.

Now, in case of microbial growth, if the freezing temperature is prevailed, then it is not possible. At this temperature, the growth of the organisms, but enzymatic and non enzymatic reactions are not stopped, but the rest of reactions are slowed down. So, if you bring down the temperature to the freezing point level then it may not be possible to kill the microbes, but the growth of the microbes can be prevented and the temperature at which this freezing takes place may be sufficient to lower down the rates of reactions by the enzyme, that is one of the fundamental thing, because enzymes deactivation is again you need to heat and is not possible here to discuss. So, the rates of reactions can be minimized, that is the enzymatic reactions also and the growth of the microbes can be minimized or it can be withheld or it can be stopped at that level. so that no further growth of the organisms are possible.

This is again with respect to the freezing temperature. A study has been made, where different temperatures were used for the same product and the shelf life was found out and I hope, you know that there are many ways of determining the shelf life of the food materials. And in that case, different temperatures like minus 18, minus 12, minus, it could have been 6 because 18, 12 and 6, but unfortunately, it was 7, all these 3 temperatures, the food materials like cauliflower or chicken, they were kept and it was seen that at minus 18 degree centigrade the storage period of cauliflower or chicken was 12 months or 27 months, right. For cauliflower it is only 12 months whereas, for chicken it was 27 months means more than 2 year, whereas, at minus 12 degree centigrade the cauliflower could have been stored for 2 and half months. Now, if you are doing the same with chicken, that at minus 12 degree centigrade it could be stored for the 15 months.

You see by changing the temperature of 6 degree, both, rather, that the chicken could be stored for 15 months compared to minus 18 degree centigrade where it was stored for 27 months, right. But, if you take it to minus 7 degree centigrade then cauliflower could have been stored for 10 days only that means, 1 week, in this again started with weeks. So, 1 or 1 and half weeks depending on what is the situation, what is the condition, right. So, at minus 7 degree centigrade cauliflower could be stored for 10 days only whereas, for chicken it could have been stored for 8 months. That means, if you take from chicken the different storage temperatures of minus 18 to minus 7 the time span of storage, though it is in months, but it got changed from few months to several months, with that lowering of temperature even from minus 7 to minus 18.

That means, if you are coming lower than the freezing temperature then also it is the temperature which is minus 18 or below is dictating and saying that the temperature to

store the frozen food is the best when the temperature outside or within the material is minus18 degree centigrade. Now, other than that, the cauliflower also, you see, from 1 year to only few days by lowering down the temperature. This change can happen by lowering down the temperature, it can be 10 days at minus 7 or 12 months at minus 12, minus 18 degree centigrade it can be stored, right. Hopefully, this we are concluding and in the next class we will start with some other topics, but before we end let me tell you that this is the course which is used or which may be required both for commercial as well as for academic, including the experience at home. So, all put together, the course has been designed, so that the normal questions which come up regularly can be addressed to. Thank you very much.