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

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Lecture – 02
Why Cooling is required?

Good morning. In the previous class, we had tried to make you understand what a refrigerator at your house is made of, right. Obviously, it is obvious that the refrigerator you bought is to keep the materials, may be either freshly prepared, or may be the left over of the previous lunch, or dinner for a few days more. So, today's class we would like to highlight on why cooling is required, right. As of now, no system has been developed where neither heating nor cooling is required to keep the materials and they will be kept for a long period. As of now, through science, you cannot predict, as of now, it has not been evolved.

In future, when you grow up to our age, we have no idea, what will happen during that time. But, as of today, yes, there is no substitute of either heating or cooling, right. Heating is beyond our scope because we are dealing with the cooling not the heating, but it is not that only cooling can do everything, it is also not that only heating can do everything, right. In many cases, it may be a combination, I, rather, in most of the cases, it may be a combination.

Now why we need to cool because we want to preserve it for a longer period. Now, if we want to preserve it for a longer period, what does it mean? This means that this should allow the destruction of microorganisms and spores or it should be inactivation of enzymes or it could be slowing the rate of chemical reactions such as oxidation and other things. So, if that be true, then we can say that keeping it for few more days than one day or half a day meaning you are preserving it for a longer period. So, if you are preserving it for a longer period, how you are doing? You are either destroying the microorganisms or spores, though this is not the class of microorganism, but still a new thing has come up like the word spore because most of you have heard the name of microorganism or word microorganism, but you might not have heard spores. Now in microorganisms there are vegetative cells and there are spores.

Vibrative cells can multiply into many in numbers, but normally spores they are resistant

to heat because any microorganism that can be killed by the application of heat only. Nowadays, many other things have come up, but by and large, I can say only that, heat is destroying the spores and the vegetative cells. Now these microorganisms could be detrimental or could be it is not. That in the world all microorganisms are not bad. There are many organisms which are good and when you are heating you do not know who is good or who is bad.

Heat will simply kill the organisms whichever is there and that is what is destruction of microorganism and spores. Yes, spores, what I was saying spores means, if this is a rod shaped, say microorganism then spore means that all around of it there will be some coating developed by the organism itself and that protects from heat or normal other factors. So they are very difficult to be destroyed. That is why that destruction of both the vegetative and spores together will keep the material, in this case we are dealing with food, right. Please mind it, we are dealing with food, right not the other materials.

So materials, which will be kept for a longer period, they will be having the organisms and spores killed or it may be required because we are talking about preservation. So it may be required to inactivate the enzymes. I hope, many of you have seen in your house that there are guava trees, mostly those who are in the village side or even in urban areas also that you might have seen the guava is growing in the tree, right. Some way of bruising happen to the guava and you will see the enzymes which are there they will start acting on the guava and you may get a rotten or spoiled guava after some days. This may be because of the enzymes which were available in the surface of the guava.

Similarly, the preservation meaning, it is slowing down the chemical reactions and chemical reactions meaning, like browning reaction, or this browning could be oxidative browning or enzymatic browning. For example, if you cut an apple and keep it for longer period you will see the apple colour has moved from its original colour to little blackish or rather blackish or many part of it is becoming black or blackish. This is due to the enzymatic browning of the cut apple when we cut the apple as we said. In the case of guava, similarly, in the case of the apple also, the enzymes act on the guava and these enzymes do act on the cut apple and destroy the apple by changing its colour it is called browning reaction or enzymatic browning reaction. Another browning is also there, though this is not part of it, but still you should know, that the sugar and amine present in the food material, they do also act or react that is called chemical browning which is the reaction of the both amine or amino group and the sugar present in the food material forming this brown colour, brownation, right.

So, this is called browning reaction and this kind of reaction happens in most of the food material, right. So, this is called sugar amine reaction or may the product which is

obtained called melanoidins. Melanoidin may also happen in browning reaction. So, this is another reason why or what we mean by food preservation. Now, preservation can also be done by many other ways like or it may be required for other safety reasons because now-a-days, it is also a more or less slogan that safe food, right safe food is the slogan of today.

So, there, that means, for the safety reason you are also preserving through processing, right, through processing and in that case you may need to destroy toxic materials or toxins or improving the properties like physicochemical sensory or aesthetic properties of the food material that may occur due to processing of the food material. Then we come to a very important aspect, that is called temperature quotient. Now, temperature quotient is a very important parameter in the sense that from there you may come to know the reactions which we have already told or the changes which are associated with the preservation techniques. The temperature coefficient or Q 10 that reflects to the factor by which the rate of any reaction such as chemical, biochemical, enzymatic, microbial any type of reactions the rate of which increases or decreases by increasing or decreasing 10 degree, right. So, this is a typical parameter which is known as temperature quotient and is expressed as Q 10 is equal to R 2 by R 1 to the power 10 by T 2 minus T 1 right.

$$Q_{10} = \left(\frac{R_2}{R_1}\right)^{\left(\frac{10}{T_2 - T_1}\right)}$$

So, temperature quotient can be said as Q 10 and which represents a factor by which the rate of a reaction increases for every 10 degree rise in this temperature it may fall also if we decrease the temperature. So, if we see what are the individual parameters like Q 10 is the factor by which the reaction rate increases when the temperature is used by or increased by 10 degree centigrade. So, Q 10 is a unit less quantity if you are asked what is the unit of Q 10 you have to say, because it is a ratio. So, ratio of the rates of reactions so, it is unit less. So, if you remember, we said R 2 and R 1 right.

So, that R 2 and R 1 is the measured reaction rate at temperature T 1 that is R 1 where T 1 is less than T 2, note that R 1 and R 2 must have the same unit otherwise it cannot be unit less. Q 10 and R 2 is the measured reaction rate at temperature T 2 where T 2 is greater than T 1 and here also you have to note that R 1 and R 2 must have the same units otherwise Q 10 cannot be a unit less quantity. So, the Q 10 is the temperature at

which the reaction rate R 1 is measured where of course, T 1 is less than T 2 the temperature unit must be either in Celsius or in Kelvin and many may not be any other unit, such as the Fahrenheit. Note that T 1 and T 2 must have the same units T 2 and T 1 do not need to be exactly 10 degree apart a little this or that side also will do means 8 degree or 9 degree you have increased you cannot increase it further then that 9 degree also will happen and you can use that. So, T 1 is the temperature at which reaction rate R 1 is measured where T 2 is greater than T 1 and the temperature unit must be either the Celsius or Kelvin and may not be any other unit such as the Fahrenheit.

ote that T 1 and T 2 have the same unit and T 1 and T 2 need to be exactly 10 degree apart. Now typically the values of Q 10 are available which is from the literature that for growth of organisms it can be 1.5 right. So, their Q R 2 by R 1 into 10 to the power R 2 minus R 1 10 to the power R 2 no 10 by 2 to the power 10 by T 2 minus T 1 is the Q 10. So, if you know R 1 and R 2 for Q 10 for growth it comes to around 1.

5 it is a ratio and Q 10 for imbibition, it could be 1.5 to 1.8 times Q 10 for photosynthesis could be 2.1 to 2.5 and Q 10 for respiration could be 2 and 3 or between 2 and 3.

So, this is typically units or typically the numbers which are used for Q 10 normally that may vary with temperature or any other thing, but we can say that in this we are taking a typical cycle of photosynthesis right and you know during photosynthesis it is always not that light is utilized for the photosynthesis and there is nothing else that is also not true. For those photosynthesis where light is utilized normally sunlight, there light is absorbed by chlorophyll and water splits or rather which splits with water and we get energy ATP and NADP and lastly the Calvin cycle or carbon dioxide water they are producing lot of energy where carbon dioxide is a bypass or by basic fundamentals of silica preparation silica. I hope you understand, but this is called daytime respiration of mango. Now, if we look at what happens during the night time because night time there is no sunlight. So, in that case this is called dark reactions and chloroplast with the help of ADP and NADP is using Calvin cycle and used energy to recycle.

So, one is with the help of sunlight and sunlight is producing water energy and carbon dioxide and in absence of sunlight this is just the reverse that is called light reaction and there oxygen and dark reactions are happening along with C 6 H 12 O 6. So, in the dark you are not allowed to go in the dark you are not allowed to go outside below the tree that is what the senior people at home they do tell that you cannot, you should not go during evening time below the big trees because they are using oxygen and in and they are using oxygen and producing C 6 H 12 O 6, right. So, this is what is a little photosynthesis. Similarly, we can also look at respiration cycles and there you see lot many cycles are there and they are called biochemical cycles and these biochemical

cycles are utilizing the oxygen or they are using oxygen. Protein amino acid they are coming to form the acetyl CoA or this is the cycle that is known as Krebs cycle and in the Krebs cycle the respiration rate can be easily determined by the acid.

So, thank you for today's class next day we will come with another opening. Thank you.