Dairy and Food Process & Products Technology

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Lecture - 41
Milk Pasteurization

In the previous class, we have said how the whole milk is being processed. So, in this Dairy and Food Process and Products Technology, in lecture number 41, we come to this level of Milk Pasteurization. So, milk pasteurization because we have said in that flowchart; if you remember that after the milk is received from different sources, then they are tested and after testing, if they are found ok. Then they are standardized, and after standardization, they undergo pasteurization, then homogenization, and then sealing, and then it goes for packaging. And we have dealt this packaging and other parts in detail earlier.

Now you come to individual processes right. So, before you go to standardization let us first look into pasteurization. Milk pasteurization of course, this we have said earlier also that the pasteurization word came, or this coin came from the name of the one of the famous and biggest scientist Louis Pasteur, on his basis on his development on his discovery, this was given him the honor, that pasteurization process anything which is undergoing the process this type of they are called pasteurization right. So, now, let us look into what is that right.

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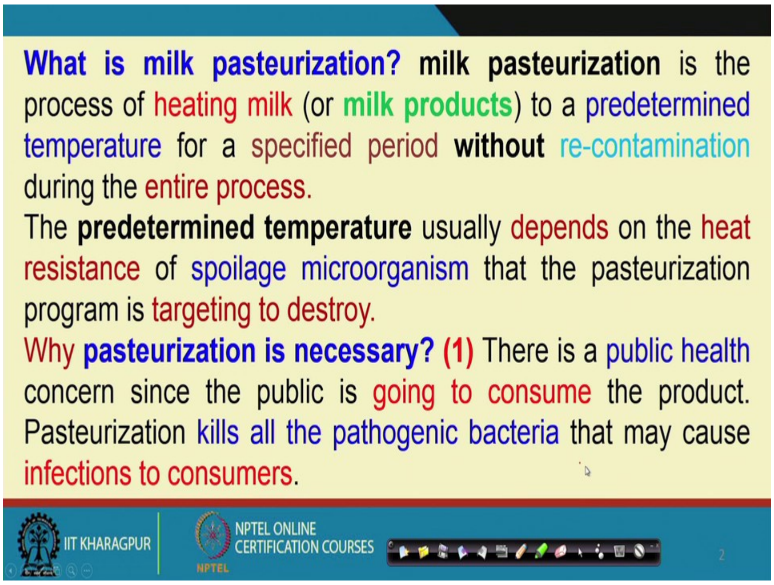

So, what is milk pasteurization? We say milk pasteurization is the process of milk pasteurization is the process of heating milk, or milk products whatever it be to a predetermined temperature for a specified period without recontamination during the entire process. So, lots of things have been said right: so that means, a predetermined temperature you have to know that which temperature and I always said that this is not only temperature, but also the time. So, any heating is a combination of time temperature right. Similarly cooling is also time temperature heating, or cooling, or thermal process is mixture, or is a product of both heating temperature as well as time, cooling temperature as well as time.

So, there the predetermined temperature and the time for heating, that is predetermined provided during the process, you do not inculcate lot of other contaminants, or contamination that is a must, that during that process you should not get it further contaminated, once it is pasteurized that is why by definition it is said. The predetermined temperature usually depends on the heat resistance of the spoilage microorganism that the pasteurization program is targeting to destroy.

So, depend in many cases depending on the locality depending on the initial contamination, this depending on the nature of contaminants, the target organisms changes right. There are many target organisms out of which one the most provide is *Clostridium botulinum* right. So, that is one and in many cases *Mycrobacter tuberculosis* also could be, but that is also not that much is heat resistant, but this one botulinum is definitely one, where this is taken as and there are many other also right. So, you determined pre this heat determined in advance that, what is your target organism which should be destroyed and if it is destroyed, then it tells that all other pathogenic organisms are destroyed and killed.

The primary objective of pasteurization is to kill the pathogen. That is the primary objective. So, that after drinking milk nobody is infected with any disease that is the primary ok. Then pasteurization is necessary number one, there is a public health concern. Since the public is going to consume the product pasteurization kills all the pathogenic organisms, or bacteria that may cause infection to consumers. So, this is number one why pasteurization is required, that it will since the milk product, or milk raw milk, or liquid milk is normally consumed all over the world by all over the world lot of people.

So, it is public concern. So, if it is a public concern, then after consumption they should not fall sick that is the primary requirement for the regulating body to look after, that any food product like this milk, if consumed by consumer they should not fall under sick, or if it is then that company which the consumer is consuming will be taken to the court, or will be penalized that is afterwards, but first thing they should not be in any way, they should not be contaminated, or infected, or fall sick after consuming that is the first thing. So, that is what why pasteurization is primarily required right.

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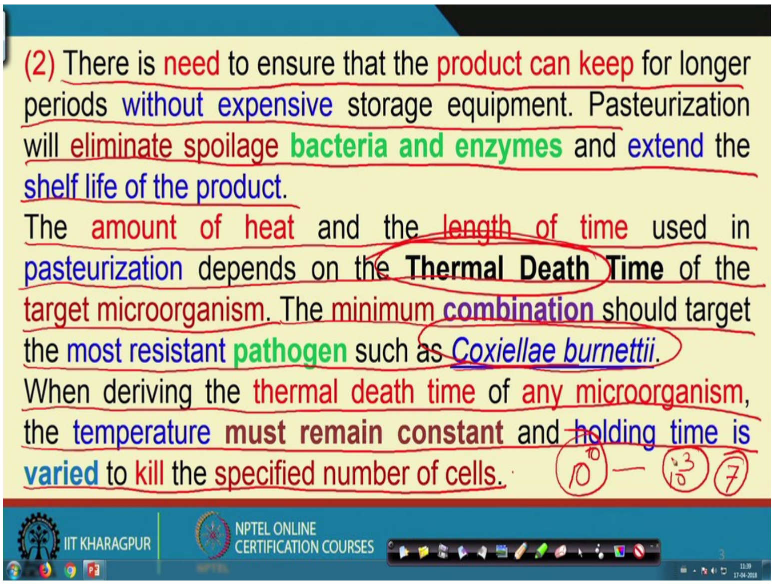

Then the other reason for this is that, there is no need to ensure that the product can keep for a longer period without expensive storage equipment. Pasteurization will eliminate spoilage bacteria and, enzymes and extend the shelf life of the product. So, second thing this is one side which the controlling body has looked into the aspect of the consumer, then the controlling body also should look into the aspect of the processor, because if after processing, if it needs severe storage facility, severe cost involvement, then the entire process may not be commercially viable/feasible.

So, that is why next step is that to ensure, that the product can keep for long periods, without much expensive storage equipment right. So, you should kill also not only the organisms, which are causing the disease, but also some spoilage organisms that also should not be they are eliminated. So, that minimum storage facility or conditions good enough to keep it for some time of course, it is cannot be claimed that a pasteurized milk can last for several days several weeks, several months like that right, it is for a temporary period short period, where your extension of the life of the milk is given or extended right.

Then the amount of heat and length of time used in pasteurization depends on the thermal death time of the target organisms, another thing which we have come across is the thermal death time right. So, how much heat you need, for a given quantum of the milk, how much you need to heat, that depends on the thermal death time right. So, thermal death time of the target microorganisms, the you have already targeted to what microorganism you want to make the sure that it is no longer, there after pasteurization and for that you are supposed to look into the thermal death time of that organism.

That will dictate that will tell you how much heat has to be supplied. So, you have to then look into the how much energy, you have to spend right. The minimum combination should target, the most resistant pathogenic organism such as *Coxiellae burnettii*, *Coxiellae burnettii* that is the where again I said target organisms are different for different cases, many places many target organisms are set. And this depends on the country to country, place to place and source to source; source from where it is being collected, all these factors will dictate which should be the target organism.

So, we said one is *Clostridium botulinum* another is that this one *Coxiellae burnettii* right. So, this target organism can be killed by the pasteurization process. So, you must know the thermal death time of this organism that it *Coxiellae burnettii* ok. Then when deriving the thermal death time of any microorganism, the temperature must remain constant and, holding time is varied to kill the specified number of cells. So, lot many words again we have said, specified number of cells right. So, initially you started with a number of cells of say 10^{10}, right that was your initial concentration.

Now, you want to make it to 10^{3} right. So, a 7 times / 7 log reduction you want to undertake. So, in that case you are finding out before hand, what is the thermal death time of that particular target organism and, then if you know then you fix up the temperature, at this temperature for such time you will be heating. So, that will tell you how much energy is required right. So, energy requirement here it is nothing, but '$mc_p\Delta t$' because there is no phase change nothing. So, that it is a sensible heat right.

From this temperature to that temperature for such a long time, you want to heat and then maintain at that temperature. So, you know how much you have to supply heat or energy. So, that is determined by the thermal death time combination and, you must get first the thermal death time of the organism right.

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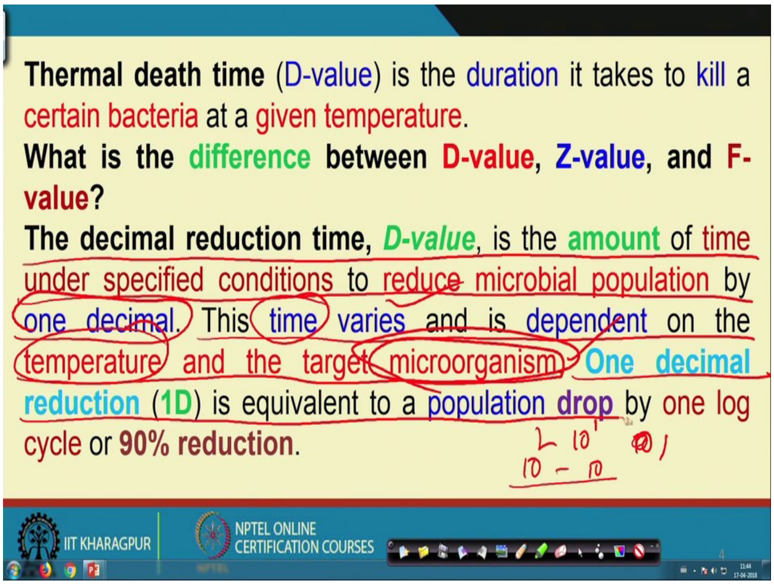

So, we come to the new word thermal death time. So, thermal death time or D value is the duration it takes to kill, a certain bacteria at a given temperature right. So, thermal death time normally it is denoted by the term D value right.

So, that is nothing but the duration it takes to kill a certain bacteria at a given temperature right. So, the time required to kill a organism at the given temperature is the D value right. So, what is the difference between the D value and another value, which is z value or F value right, you might have heard these D value z value F value what are they and what is their difference right. Automatically it comes to the mind, then the decimal reduction time that is the D value, that is called decimal reduction time is the amount of time, under specified conditions to reduce microbial population by one decimal that is 1 log cycle right.

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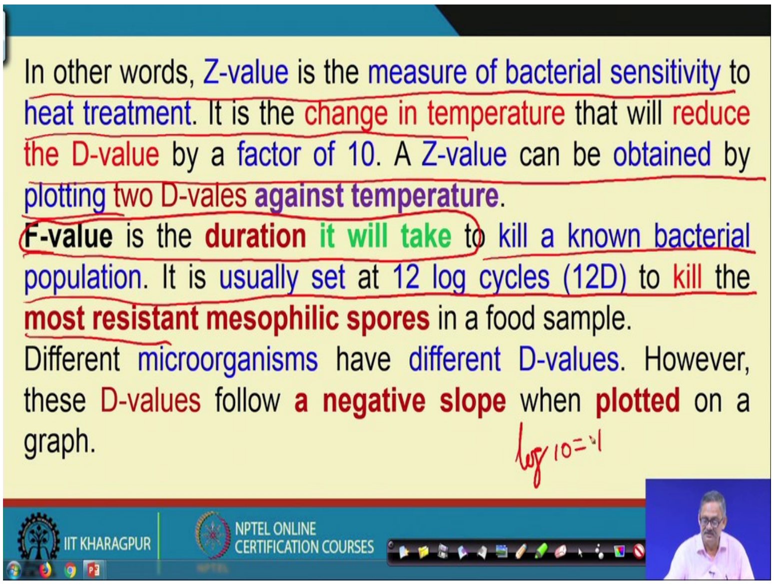

Log10 is equals to 1. So, if you want to make it one log cycle difference, then you have to so. The decimal reduction time is that is the D value, is the amount of time under specified conditions to reduce microbial population by one decimal right.

So, this is one decimal we are reducing right, time this time varies and is dependent on the temperature and the target microorganisms, what is the target microorganism that will dictate, what is the temperature and how much time it will require. So, these varies on the organism selected, one decimal reduction or one D is equivalent to a population drop by one log cycle or 90% reduction right.

So, one log cycle reduction means 90% reduction survivality is only 10% right. So, automatically.

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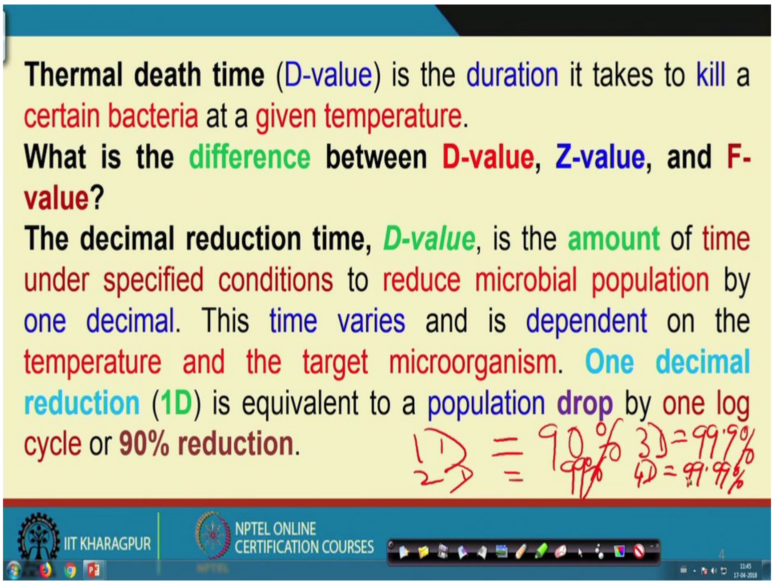

If 1D is equals to 90% reduction, then what is the reduction in percentage if it is 2D, then it becomes 99%. If it is 3 D, then it becomes 99.9%, if it is 4D, then it becomes 99.99% and so, on right. So, if 1D corresponds to 90% reduction, then 2D corresponds to 99% reduction 3D corresponds to 99.9% reduction 4D corresponds to 99.9% reduction.

Now, here one thing you should keep in mind, mathematically the number is so, close that 99.9 purity if it is there, then that 0.1% right, 0.1% means one in 1% means 1 in 100. So, 0.1% means 1 in 1000 right so; that means, in out of 1000 sales, if 1 is surviving that 1 is good enough to further again multiply right. So, if that is why mathematically it appears that 99.9% is killed. So, we have achieved it is not.

Because that 0.1% that is 1 in 1000 is good enough. So, if out of 1000 people consuming 1% will be affected statistically right. So, that is not desirable. So, you should not take that chance, that it is 1 out of 1000 you will be infected no your target should be as much maybe 1000000 people out of 1000000 lakhs people 1 percent can be affected, or out of 1crore 1 percent could be affected. So, your target should be like that. So, that will be dictated how many Ds you will be bringing, or how many Ds you will perform right. So, that is why the D value is so, much D value is so much important that to know the thermal death time these the decimal reduction time is very much important right.

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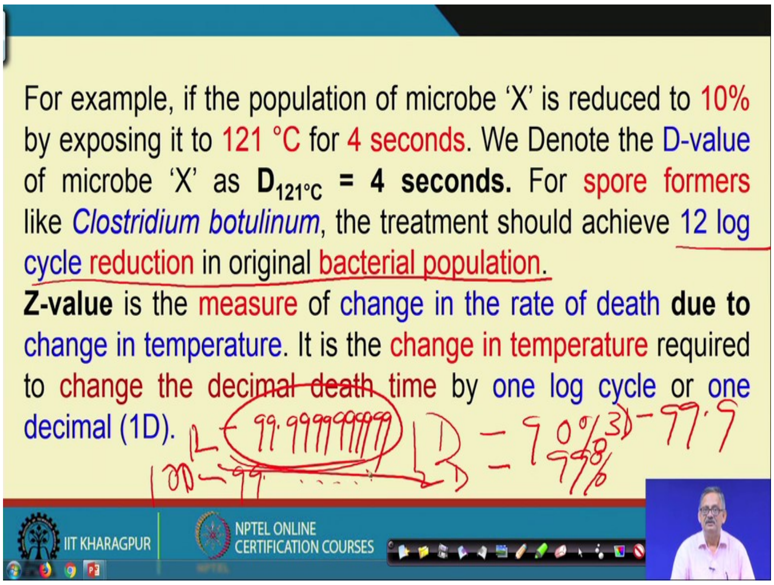

Next we see that for example, if the population of microbe, if the population of microbe is microbe X right, we have taken no name. If the population of microbe X is reduced to 10 percent by exposing it to 101 degree centigrade for 4 seconds, if it is like that we denote the D value of the microbe x as D_{121}, this 121 corresponds to the temperature at which you are subjecting is equal to 4 seconds.

So, the time required is 4 second at 121°C right. So, D_{121} is 4 seconds that is the thermal death time is 4 seconds corresponding to 121°C that is why you have mentioned the suffix 121 right. So, for spore formers it could be more because spore formers is now, again this is out of the way that vegetative cells are those which multiply under normal condition vary and, which can be killed also with the minimum effort.

But spore formers the other day I said perhaps that, that like that like that coating is being formed by some of the insects. So, they make a covering out of it. So, that protects it from the surrounding under unfavorable condition also it survives, snail is one such right. So, these organisms also there are certain, which who are spore formers, they do for one coating around it. And this coating is so, much that it is very much heat resistant and in unlike vegetative cells, which can be killed with some energy, they need much more energy than that of the vegetative cell. So, spore formers if they are at all present. So, you have to be doubly cautious, doubly careful about the killing of the spore former.

So, for spore formers like, *Clostridium botulinum* which is a spore former the treatment should be achieved by the treatment should be achieved by so, here you write D and here achieved, or treatment should achieve ok, should achieve 12 D 12 log cycle reduction in original bacterial population right, 12 log cycle reduction. So, 1 D if you remember we said 90 percent 2 D you remember, we said 99%, then 3 D we said 99.9% right; so with one decimal 2 D right.

So, then 12 log cycle 12D will be how much. So, that killing will be 99.9999999999. So, these many right. So, 1 out of that you may survive. So, that survivability is chance is very poor. So, you are taking the trace of course, you cannot by decimal reduction you cannot come to 0.

You never can come to 0 mathematically you cannot come to 0 right nothing is equal to 0 for that in the decimal. So, in the log cycle, then if you are not able to come to 0, then you must come as close. Now, that close is as I said yes 1 out of 10^{10}, 1 out of 10^{8}. So, that is why 12 log cycle is required that is 12D is performed for these spore former like *Clostridium botulinum* right. So, this is how z value D value we are defining.

So, then other that is the z value is a measure of the change in the rate of death due to change in temperature, z value is the measure of change in the rate of death due to change in temperature. It is the change in temperature required, to change the decimal death time right one log cycle, or one decimal 1 D. So, to bring down 1 D what is the temperature required, that will tell us the z value right to bring down 1 D right, that 1 D log cycle, or 1 D number to reduce the number by 1D/ one log cycle what is the temperature requirement or change in temperature requirement that is the that is the z value right.

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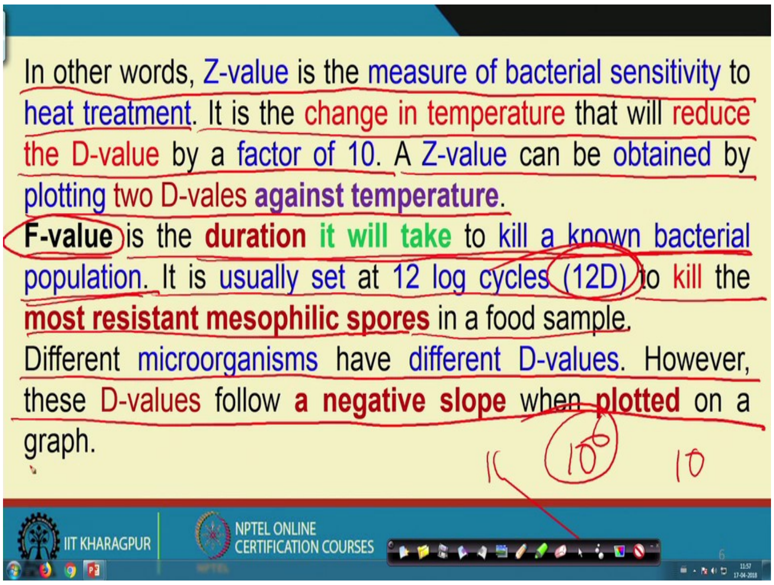

So, if that be the z value then in order so, in other words we can say that in other words we can say z value is the measure of bacterial sensitivity to heat treatment, it is the change in temperature that will reduce, the D value by a factor of 10, a z value can be obtained by plotting two D values against temperature right. So, by plotting two D values against temperature, you can find out the z value. So, another thing value which we said F value, F value is the duration it will take to kill a non-bacterial population.

So, non-bacterial population means, you know initially sorry, you know initially you have 10 to the power 6 number of organisms right. Now, you want to bring that to 10. So, known that 10 to the power 6 that is what we are saying, if the duration it will take to kill a known bacterial population right, it is the F value the duration, it will take to kill a known bacterial population is the F value. It is usually set at 12 log cycle, or 12 D to kill the most resistant micro most resistant mesophilic spore in a food sample right.

So, again another new word mesophilic has come in. So, in this respect let me also tell, that there are 3 types of bacterial population, one is psychrophilic, then mesophilic and then thermophilic, psychrophilic they love low temperature to survive to multiply mesophilic, they love moderate temperature, to survive and multiply and act whatever actions, they have and thermophilic they love high temperature, or relatively high temperature around 45-50 say 55°C that temperature range, they do love and multiply at that high temperature right.

So, the depending on which organism, you are targeting your F value z value and D values are also dependent. So, different microorganisms have different D values; however, the D values follow a negative slope, when plotted on a graph right.

So, we will come to that next time because today our time is over. So, next time we will do on TDT that is thermal death time ok. We will try to plot also and see.

Thank you.