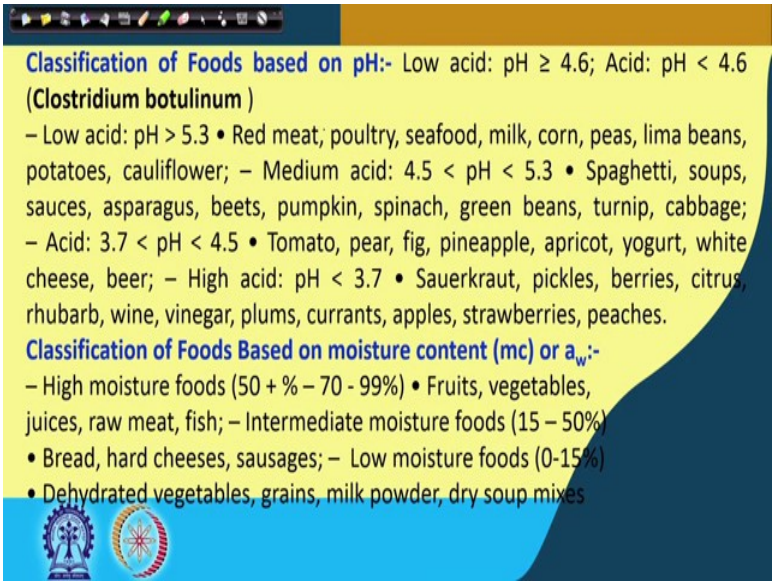
Thermal Operations In Food Process Engineering: Theory And Applications

Prof. Tridib Kumar Goswami
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture – 55
Preservation by High Temperature Processing

Good morning. Virtually we have finished the analysis of heat transfer right and now, we are looking for the application and first let us look at Preservation by High Temperature right. It is our lecture number 55. So, we are looking at Preservation By High Temperature Processing.

(Refer Slide Time: 01:00)



So, when we will look at that first we see that for this is of course, not little thermal, a little on the basic of the food which you would like to first give you otherwise you will mix up that everybody the that I told one story one day that one dumb fellow saw somebody that a hot iron was dipped into water and saw that hot red I mean red hot iron rather was dipped in water and that irons in no time was cooled. So, when you went back saw somebody at home was also sick highly high fever. So, thought that if can be dipped into water, then the temperature or fever will go off or heat basically it was heat thought of. So, there was that is not desirable.

So, that is why though we have said all about the heat transfer, but where to apply which because they are dependent on the temperature. So, to do that we should also know some

of the basic things like the classification of food based on the pH that is acidity based on the pH or acidity food can be classified in different zones and obviously, their treatment also will be varying accordingly right.

For example, low acid pH is generally considered when the pH is greater than or equal to 4.6. Acidic food is considered when pH is less than 4.6. Examples are given many examples are there. One of the organism is clostridium botulinum right so, that is also yes having some tolerance on the acidity. So, others for example, if it is low acid food where the pH is greater than 5.3 some examples of those foods are given here like red meat, poultry, seafood, milk, corn, peas, then beans lima beans one kind of bean then potato, cauliflower, then these are some of the examples of the low acid food whose pH is greater than 5.3.

Medium acid which is between 4.5 and 5.3 pH is between 4.5 and 5.3 right. Examples are example of the foods which come within this bracket are spaghetti, soups, sauces, asparagus, beets, pumpkin, spinach, green beans, turnip, cabbage etcetera right. Similarly, acid food medium acid then acid food whose pH lies between 3.7 and 4.5 right they are acidic food or acid food right; food having high acidity. For example, we can say tomato, pear, fig, pineapple, apricot, yogurt, white cheese, beer etcetera.

Then high acid food whose acidity is very high based on the pH less than 3.7 because the acidity we also can directly measure in terms of pH right. So, within this pH range you can say the extent of acidity right because we know the neutral is 0 sorry neutral is 7 neutral is 7 right. So, below that is acidic, above that is alkaline. So, below that when it is coming that thinks of acidic range it is like that. So, those we which are highly acidic whose pH is less than 3.7.

For example, sauerkraut – sauerkraut is one which is popular in the western countries made from cabbage fermented right; pickles again a little fermented and there also acidity is very high; then berries – many berries are very very what should I say when you are you are you are taking those berries you feel very much acidic right you feel very much savoury. So, those are because of the high acidity berries.

Then citrus fruits – many citrus fruits also you will see that that is why when seniors at home they buy such kind of foods they ask whether it will be sweet or sour before asking before buying this is asked right. So, citrus fruit also come under that category. Then

rhubarb, wine, vinegar, plum, then currants, apple, strawberries, peaches etcetera there are many more. So, we have given the example quite a lot. So, there are many more and this is how acidic food is classified right.

So, another classification also can be made of the food that is based on the moisture content which we know moisture content is also synonym of a w right. What is a w; a w is that hopefully you know that it varies up to 1 right. So, that is water activity. I was just waiting whether you could recollect or not. So, water activity right. So, high moisture foods for example, 50 plus minus or 50 plus percent they are called generally high moisture maybe between 70 to 99 % right.

For example, fruits, vegetables, juices, raw meat, fish, intermediate moisture etcetera right. Then for intermediate moisture foods for example, moisture content varies within 15 to 50 %. So, if it is between 15 to 50 % the examples are bread, hard cheese, sausage etcetera. Then low moisture foods whose moisture content could be between 0 to 15 percent right and the examples of those kind of foods it could be dehydrated vegetables, grains, milk powder, dry soup mix etcetera.

Out of which perhaps during this course I had also given many times when examples were given, but still maybe a recapitulation or maybe a repetition also, but still it is better you know you do not forget that is grains and I get this example that at home you ask your seniors not nowadays in 2000, when it was in 90s. So, mid of 90s or earlier or maybe post even 18 19s means I mean 1990 or earlier to that people used to buy lot many lot many quantity of your rice and they used to keep at in I mean at home somewhere and that used to be taken throughout the year or maybe because that time it was seen that maybe as certain point price of rice was lowest, when it was bought in bulk and gradually afterwards it went up. So, then made lot of savings.

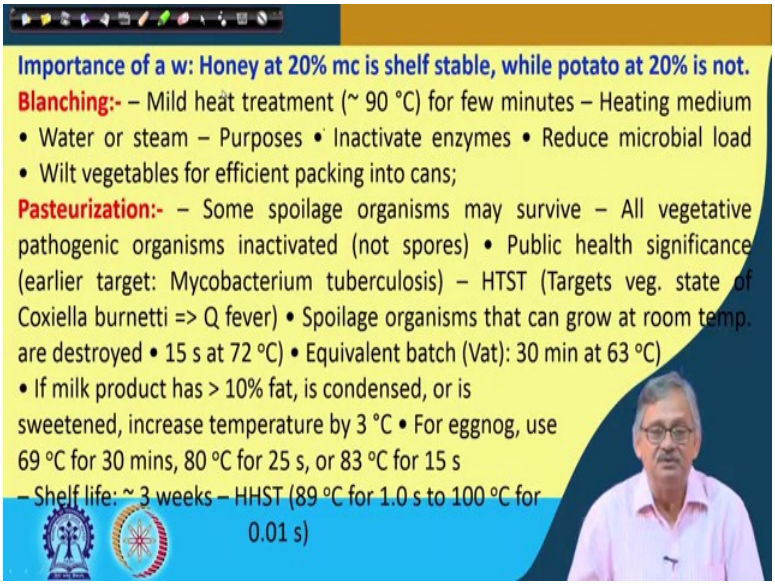
But, savings was not in many cases primary goal it could have been that availability. So, all whatever be the reasoning it was, but nowadays since people have very small got small family etcetera etcetera so, for that people do not buy so, large quantity in at a time but the thing which I would like to highlight here is that rice is one such low low quantity of moisture where which is less than required water activity level for organisms to grow. So, that is why rice could be kept for a long period. So, rice is one such.

Then, milk powder baby food; every house there will be some baby coming up or has come or yet to come. So, people have this experience this baby food or dry milk powder they do have moisture content of around 2.52 at the most 4, but generally it is 2.5 ± because if there is any moisture content which is suitable for the organism to invade and since it is being fed to the very very infant or young then it will be detrimental.

So, that is why that moisture content is around plus minus 2.5 because we take an corresponds to what is the water activity which we said moisture content or a w that is water activity right. And, in the beginning we had said water activity between between point between between rather up to 1 up to 1 point that is maximum between 0.9 to 1 is favourable for bacteria, 0.8 to 0.9 favourable for yeast and 0.7 to 0.8 is favourable for more to grow.

So, anything less than 0.6 could be said more or less sip or even if it is lower than absolutely it is sip right. So, that if you keep in mind that if you are very much if you are very much concerned then make it as low, but obviously, the lower you have to pay for that.

(Refer Slide Time: 15:17)



Now we come to that importance of water activity right a w unfortunately it has gone out it should have been subscript right this is a w that is a suffix w. So, honey at 20 %moisture content is shelf stable. You see the problem honey at 20 % moisture content is self stable while potato at 20 % is not.

What a beautiful thing that in one case one food is very safe as far as stability of the food is concerned. 20 % moisture content is also there, but in other case they are also 20 % moisture content, but that is not favourable for consumption or it does not I do not mean that favourable for consumption it does not last for long under the same condition that is room temperature or similar right why?

Then it comes to that question of water activity a w right. Since a w though both are having 20 % moisture, but the water activity level for and water activity as we said earlier is the it means that how much water is available for the organisms to grow or that what we call free moisture things like that. So, how much moisture can be made available to the organisms for their growth or multiplication. So, that is indicator for whatever activity is that indicator right.

So, this is the very very vital thing that water activity level has to be lower than the level where organisms any be it bacteria yeast or more, it is not that food material got bacterial infection is very bad and another food material got fungal infection is not bad both are bad because we are not going to take them, we are not going to consume them right. So, it is obvious that the level of water activity will dictate how long the life of the food material will be.

Some processes which are associated to increase the shelf life or stability of the food are like this one very simple blanching right where mild heat treatment around 90 °C for few minutes are done right. Heating medium is water or steam; purpose is to inactivate enzymes, reduce microbial load and wilt vegetables for efficient packaging into cans right.

Then another method of extension of the life is pasteurization. Some spoilage organisms may survive in this because it is not that in the previous class we are said that thermal death time or thermal death candidates of course, I do not claim that we had done it absolutely thoroughly, no. We had given some peripheral knowledge from where we could see that the organisms which are or which are killed totally then they could be said sterile or sterilization right.

So, but even sterile we have seen that there could be some organisms still surviving, but sterilization it is likely that very minimal and we also came to this level that it cannot be 0 because all are coming down under log cycle. So, there is no number taking the log of

that will become 1 or 0, not 1 will become 0 right no number with log comes to 0. So, whatever minimum number you can think of if you make it will never be 0, but approaches 0 and that is why that whenever you are doing 12 D to 15 D or whatever so, that time it comes to that level that how many number of survivability of the organisms could be or possibility of the organism survived could be there right.

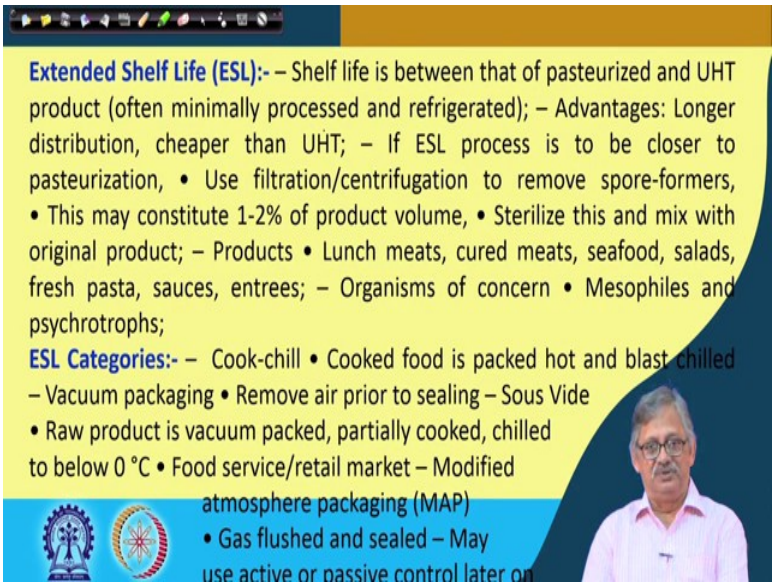
So, like that whenever you are doing it for pasteurization then there the purpose of pasteurization is to kill the pathogenic organisms absolutely primarily that. So, in that case non-pathogen, for example; spoiling organisms also can be survived. So, there may be some spoiling organisms though there is no harmful or medically harmful or health wise harmful organisms are there but still spoiling organisms spoil of the food material it may survive.

However, all vegetative pathogenic organisms are inactivated excluding non-spore former; public health significance is like that. Earlier target was it is a public health significance what of that, earlier target was mycobacterium tuberculosis and which was done with HTST or high temperature short time – target where vegetative state up coxiella coxiella buranti; sorry burnetti coxiella burnetti or not burnetti right may be which can lead to Q fever right.

Similarly, other spoilage organisms that can grow at room temperature are normally destroyed right. This is another one that it could be 15 s spores 72 °C 7 or rather at 72 °C for 15 s normally HTST has done. An equivalency batch equivalent batch type it could be for 30 min at 63 °C that is called that is the one was HTST high temperature short time it is low temperature long time LTLT right.

So, if milk product has more than 10 % fat it condensed or is sweetened increased temperature by 3 point °C and then it could be first raise better for eggnog you can use 69 °C for 30 min or 80 °C for 25 s or 83 °C for 15 s; shelf life roughly around 3 weeks and for HTST 89 °C for 1 s to 100 °C for 0.1 s.

(Refer Slide Time: 24:35)



Extended shelf life, another thing – ESL right. This is shelf life is between that of pasteurized and UHT product often called minimally processed and refrigerated. Advantages are that longer distribution cheap cheaper than UHT that is ultra high temperature. If ESL that it extended shelf life process is to be closer to pasteurization then use filtration or centrifugation to remove spore formers.

And, these may constitute around 1 to 2 % of the product volume. So, that is removed. Sterilize this and mix with original product and or products whatever. For example, products like lunch meats, cured meats, seafood, salads, fresh pasta, sauces, entrees; or organisms of concern are mesophiles and psychrotrophs. Obviously, mesophile which are of the middle temperature zone and psychrotrophs of the low temperature zone, we have told earlier if you recollect.

ESL categories for example, cook-chill it is cook and then chilled. So, cook food is packed hot and blast and blast chilled right or it is chilled with blast of cold. Vacuum packaging could be a greater one. Remove air prior to sealing because if air is there; there is a chance of oxidation. Sous vide yeah, is there and raw product is vacuum packed partially cooked chilled to below 0 °C. Food service their retail market sometimes modified atmosphere packaging or MAP is also used or maybe gas flushed and sealed may use active or passive control which could be later on.

So, there are many such processes which we could not finish in this class, maybe in the subsequent classes we will try to finish it up but the thing is that wherever extension of the life is associated mostly it is with the respect to the thermal processing right and you are applying heat and the way you can that depends on the process as we said for different processes different time temperature combination.

It is not only temperature I said earlier also, again I repeat or again I put the stress that it is not temperature alone it is time and temperature both together is acting on the organisms right. So, today we have come to the end of this class, perhaps there is no more time. So, let us call it a day and in the next class we will look at some other processing through the thermal process right.

Thank you.