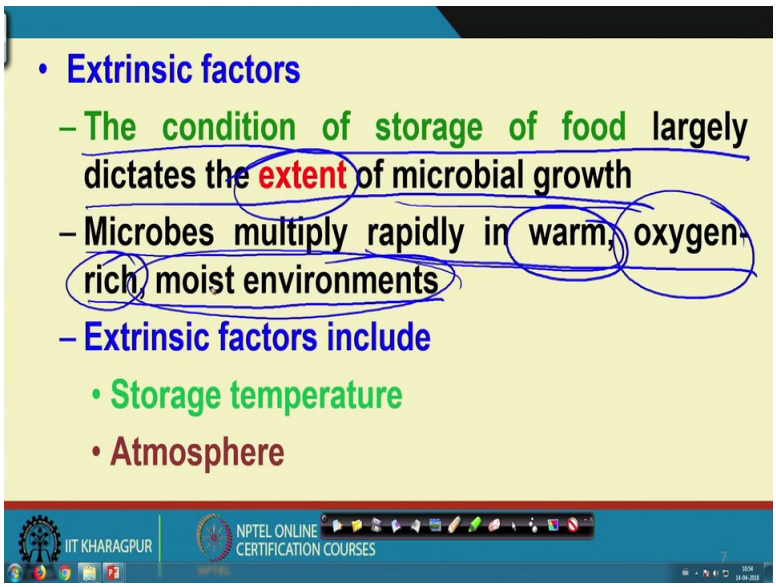
Dairy and Food Process & Products Technology
Prof. Tridib Kumar Goswami
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 38
Extrinsic Factors for Microbial Growth

So, for the extrinsic factors which we said the other the intrinsic factor in detail we have discussed for the growth of the organisms. So, in dairy and food process and products technology in our this lecture number 38 we discuss on the extrinsic factors for the growth of the microbes, right.



So, then what are those extrinsic factors which control or which moderate the growth of the organisms, right? So, that we can say that the condition of the storage of food largely dictates the extent of microbial growth. So, out of extrinsic factor one primary one is the condition under which you are keeping your food material, right. So, you will see that if you keep a food in a good condition it may last for sometime whereas, that food if it is surrounded with lot of lot of kachra what we call lot of lot of other things which are bad environment is bad so, there may be a cross contamination and the food may spoil very easily.

So, the condition where you are preserving where you are storing your food material that is one of the primary and in this regard many a times I have given example that your mummy at home you will learn that your mummy or seniors they always tell that you

keep anything if it is in a container that closely tighten that stopper or lid or whatever, right. So, that is one of the reason that will make your storage condition different, right. So, storage condition primarily this is one example, lot many are there examples are also there explanations are also there, but for easy understanding I gave this, right.

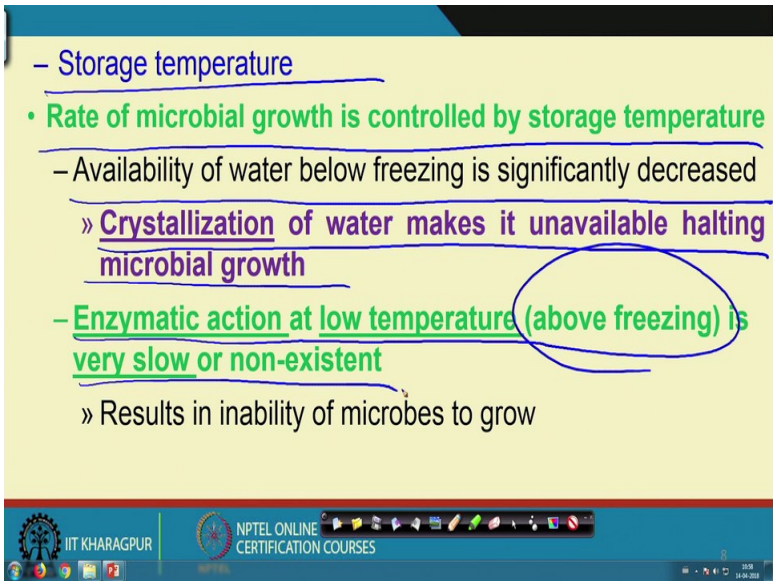
So, the largely the environmental condition or storage condition is dictating the microbial growth, right. Microbes multiply rapidly in warm oxygen rich moist warm oxygen rich and moist environment, right. So, again I give the example in the previous class I had given you that nuts which are being sold in the trains and other at local places, right and if the packaging is not good maybe some leakage or other things are there. And if, during rain rainy season where the outside high humidity is very high so that time easily it can migrate into that and that may cause you fungal growth very easily, right.

So, there you will see maybe to yesterday you brought and the next day it got the rotten or some fungal infection was there which may be visible whereas, during winter where your this thing was so low humidity, was so low that the even though the it was there is some puncture in the container or in the packet then also nothing happen. So, environmental condition that is that condition where you are keeping, preserving your material largely it will dictate the extent to which microbes can grow or microbes can invade and then multiply, right.

So, microbes multiply rapidly in warm, oxygen-rich then moist environment all these three factors externally it helps to grow oxygen-rich. If it is that is why at high altitude it is not only warm there you are not getting I am very high altitude suppose people who are in Kashmir or Ladakh or this side some high altitude, right. So, those places other than temperature low temperature there they oxygen availabilities also low. If you go to Ladakh and other places you will see that you from where you are going from the plane level you will feel very much and comfortable for many many days or couple of days at least to start with because there oxygen is low availability is low.

So, normal growth of the organisms is affected, right. So, oxygen if it is plenty available that helps the organisms to grow, if it is warm that helps the organisms to grow and if that is why I give the example of winter and summer or rainy seasons, right. And also the moisture level in the environment that is dictated by the relative humidity number, right. Sometime in rainy season it may be 90 – 95 percent moisture whereas, sometime in this

cold condition winter season it maybe 40 – 50 percent moisture, right. So, these affect greatly the growth of the organisms so, and all of them consisting the extrinsic factors, right. So, they are storage temperature, atmospheric condition and, storage temperature storage temperature all these affect the growth of the organisms.

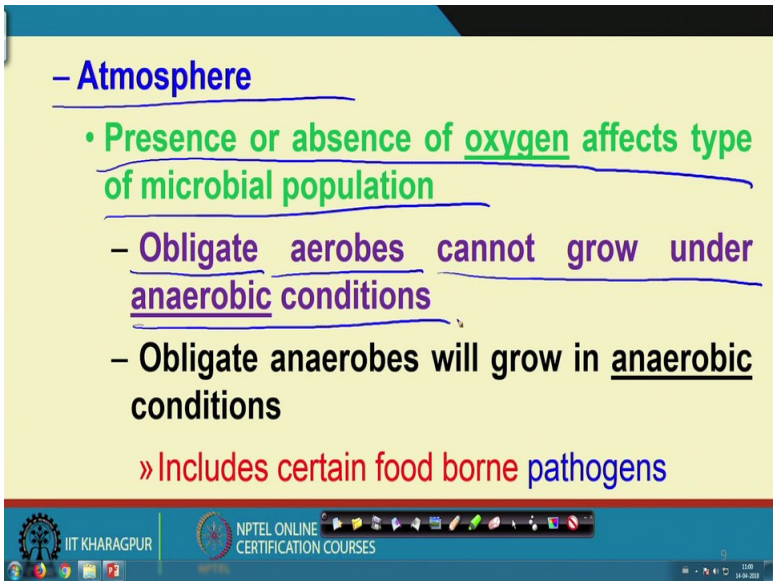


Then, rate of microbial growth is controlled by storage temperature; there is no ambiguity in that. Availability of water below freezing point is significantly decreased, right. If you if you if you freeze a food material if you freeze a food material so, that is below its freezing point then you will see that water which was in the food material is no longer water, it is converted into ice. So, now, this ice is not suitable for the organism to grow.

So, availability of moisture by freezing you have reduced, you have separated, now it will not grow. So, one that is why one of the primary method of preservation is freezing one such keeping the food material in intact. So, I am not going into that detail then we are stuck up, right so that availability of the water in the food material that is controlled by the state of the water. So, if it is in the frozen condition then availability is not there or minimum, also chances of organisms to invade or grow is much lower, right.

Crystallization of water makes it unavailable halting microbial growth. Enzymatic action at low temperature above freezing point is very slow or non-existent, very close to 0 degree. The enzymatic actions are also minimized right in cases it may be eliminated, in cases it may be minimized depending on the enzyme. So, we just cannot be said in one

word that it is eliminated in cases some enzymes may grow at around 0 degree or some enzymes do not grow or their activity is nullified at that temperature. So, it is either eliminated or nullified or minimized at around 0, that is the just above the freezing point. This results in inhibiting the growth of the microbes to a great extent.

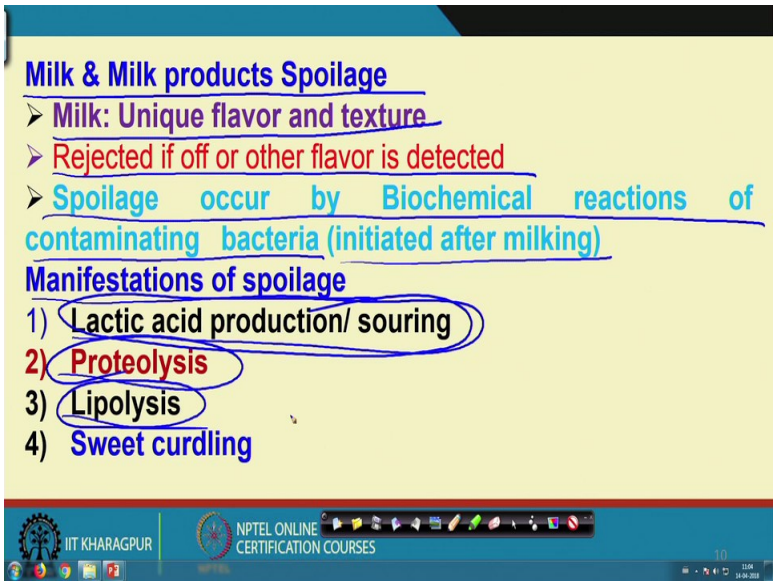


So, other that a none other extrinsic factors are that atmosphere, that is, the condition of the atmosphere surrounding. Presence or absence of oxygen affects type of microbial population greatly. Presence or absence of oxygen affects the type of microbial population greatly. Obligate from the word obligatory this word is very close obligate, right. So, obligate aerobes cannot grow under anaerobic conditions. So, for obligate aerobes you need to have oxygen. If it is under anaerobic condition that is if it is under carbon dioxide condition or maybe under nitrogen condition right then the anaerobe this aerobes obligates aerobes cannot grow, right. So, some organisms require very very much oxygen to grow.

Similarly, some organisms are oxygen is detrimental to them, they don't grow and if non oxygen non availability of oxygen or no oxygen or minimum oxygen is there, then some organisms to grow do grow rather and they are called anaerobics anaerobes, right. So, obligate anaerobes will grow in anaerobic conditions where the oxygen is not there, but the carbon dioxide or nitrogen other than oxygen, oxygen is not there that is anaerobic right. This includes certain food borne pathogens right certain food borne pathogens they some of them could be under aerobic conditions, some of them could be under anaerobic

conditions the pathogens depending on what you are handling with or what you are referring too.

So, we have both liking oxygen, disliking oxygen with oxygen without oxygen depending on what is the environment, what is the atmosphere that whether aerobic or aerobes or anaerobes will grow that will depend, right.



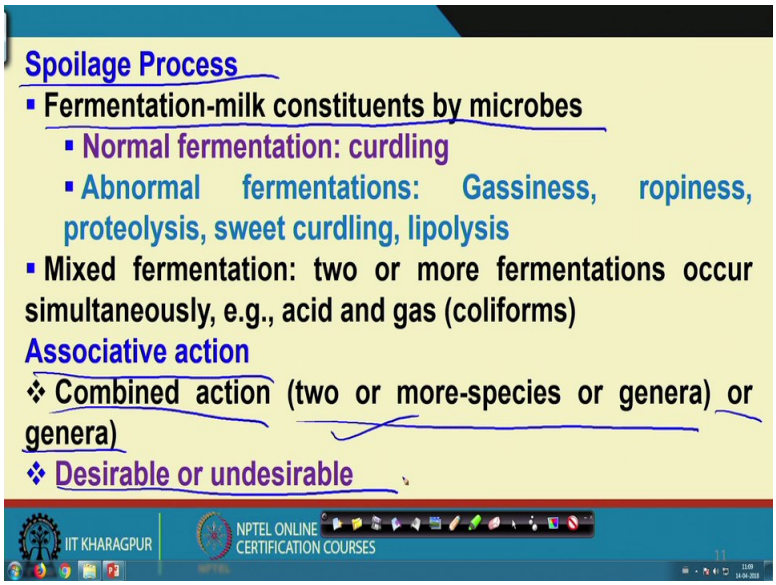
So, next we go to milk and milk products spoilage, right. So, milk and milk products spoilage if we look at then we see that milk is an unique flavor and texture material of the product and rejected if there is off flavor in the milk. You never like to drink milk if there is off flavor. The moment you take it before your nose or mouth if there is some off flavor is coming, obviously, then you will throw it, right. So, generally it is in good flavor or liked by people so, that is normal. So, if off flavor is developed you would not like, right.

Spoilage occur by my biochemical reactions of contaminating bacteria which is initiated after milking. So, there are many ways by which it can be contaminated and these contaminated bacteria or organisms spoil the milk, right and then it produces the off flavor and which is not desirable and that is why if the off flavor is developed you throw it, right, you don't drink, ok. What are those? Manifestations of spoilage are by lactic acid producing bacteria or by causing souring by proteolysis that is by degrading protein lipolysis that is by the lipid degradation or hydrolysis of lipid or degradation of lipid or

sweet curdling, right. So, there could be curdling that is the casein that protein may come out because of the acidity, right.

So, these are some of the manifestations of this spoilage in milk that lactic acid producing bacteria causing sour or it may be not only milk, but milk products also give example in deep summer now summer is there. So, in deep summer if you go to some sweet or confectionery shop and if by chance they have no refrigerator and if you buy some say rasogolla you more in many cases if it is prepared day before or one day before, then next day when you are consuming you feel it be sour may not be it is so bad that you are throwing out, but you felt the sour test and that time you complain to the owner that what kind of material you have given and primary result is this souring is for the acid producing bacteria, right. So, that is one; second could be off flavor may be developed by the hydrolysis or degradation of protein or off flavour developed due to hydrolysis or degradation of lipid, right or could be the protein has that has come out that is casein that has entirely come out that is called curdling.

So, these are the some of the manifestations by which we say that milk has spoiled, right.

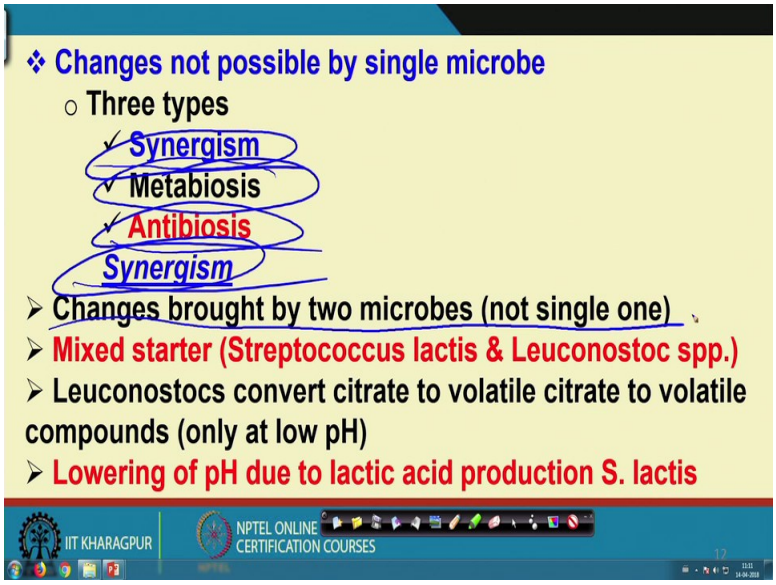


Now, the spoilage process is like this that during spoilage fermentation of milk that is that is initiated by microbes if it is normal fermentation then it could be to the extent of curdling, if it is abnormal fermentation then it could be it could cause or it could produce gas gaseous or ropiness or gassiness; gassiness gas maybe produced or some rope like

structures may be there in the in the in the product say it could be milk or milk product rope like structures are there, right.

Then could be some proteolysis that is protein degradation or could be some sour curdling or sweet curdling and also by lipolysis. So, one by normal fermentation, that is, curdling another by abnormal fermentation causing gasification or gassiness, ropiness or proteolysis, lipolysis. So, it curdling all this may happen there could be mixed fermentation that is two or more fermentations occur simultaneously. For example, acid forming bacteria that is acid being produced or and gas is also being produced and this is done simultaneously, maybe some coli forming bacteria, right. So, I coli forming bacteria they are responsible for doing both, that is, it is producing some gaseous as well it is producing some your acid, right. So, both acid and gaseous are being produced by coli form, right; then associative action that is that combined action that is two or more species or genera or different genera, right that may cause desirable or undesirable changes right.

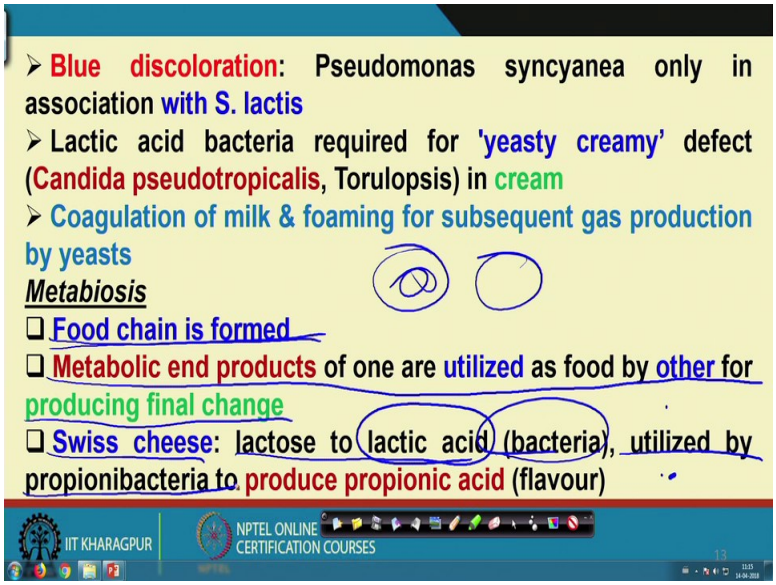
So, combined action means two types of organisms may do simultaneously, right; genera means family is different from two family. So, they can invade and cause the degradation, right. And, as we said and some case l l b that l l b is producing the acid which is not allowing others to grow. So, different situations are arising and we are handling them, right.



So, if we look at that changes not possible by single microbe are three types of that are; one is synergism, second is metabiosis and third is antibiosis, right. These three are the changes not possible by single microorganisms or single microbe, right and three types of such changes may happen one by synergism or by metabiosis or some antibiosis right. So, let us look into in detail of it.

Synergism, what is that? Synergism is changes brought by two microbes not a single one, right. Synergis, synergistic, synergisis all these word has come along with it that synergism that it is not one it is done by more than one organism simultaneously, at the same condition same everything remaining same they or two organisms residing simultaneously, that is called synergism like friendly two friend staying together synergism, right. So, changes brought by two microbes not a single one.

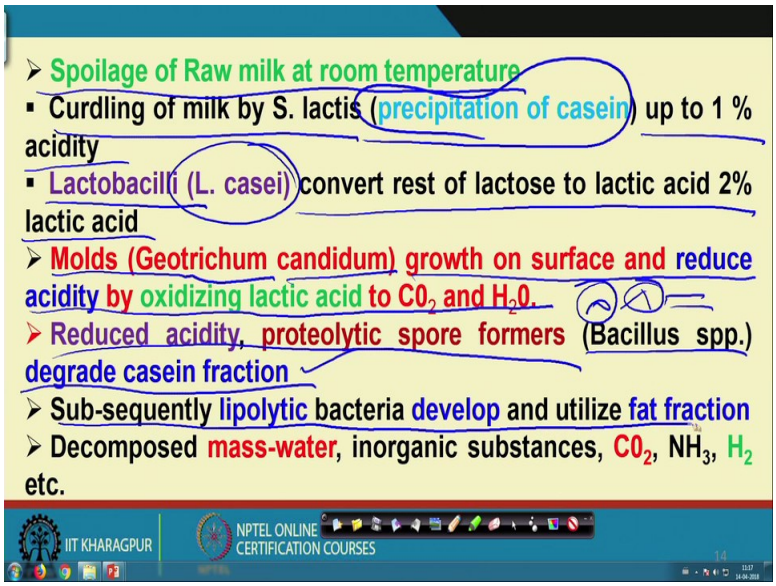
Mixed starter, that is, streptococcus lactis and leuconostoc species they can do this change simultaneously, one example mixed starter that is streptococcus lactis and leuconostoc species, right. Leuconostoc convert citrate to volatile citrate to volatile compounds only at low pH and the other one lowering of pH due to lactic acid production is done by streptococcus lactis, right.



So, blue discoloration that pseudomonas species, pseudomonas species may or pseudomonas sync syncyanea syncyanea syncyanea only in association with streptococcus lactis can for the blue discoloration. Lactic acid bacteria required for yeast creaminess yeast creamy defect that is done by candida pseudotropicalis or torulopis

sorry torulopsis in cream, they produce these are the yeast which is called creamy yeast or yeasty creamy rather yeasty creamy, right. So, that kind of condition happens. Then coagulation of milk and foaming for subsequent gas production by yeasts. So, these are all under symbiosism or that right. So, when they are doing together staying together then that maybe because of symbiosis symbiosism, right. So, if we look at then if you look at synergism, right it could be like that.

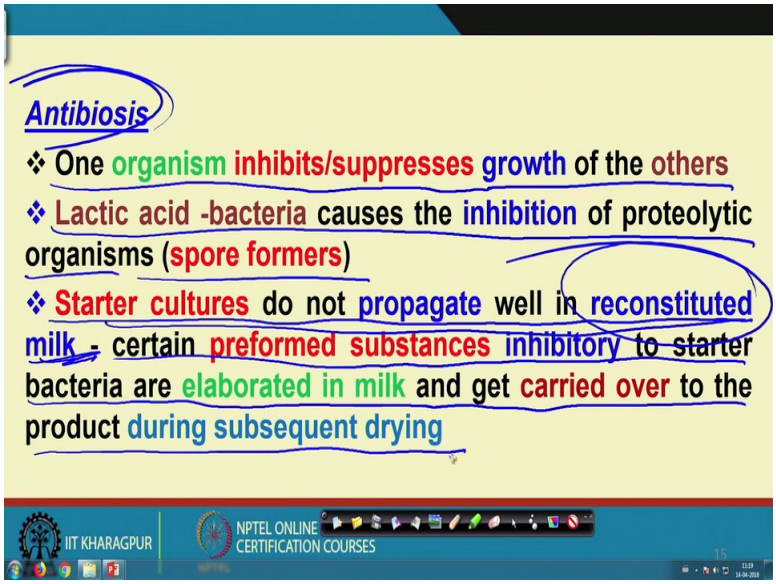
Then metabiosis; metabiosis is a process where food chain is formed that is one organism has produced one product another organism is using this and producing another product that is called food chain is formed. Metabolic end products of one are utilized as food by the other or producing final change, right. Swiss cheese where lactose is produced by lactic acid lactose is used to produce lactic acid by bacteria which is utilized by propion propionibacteria to produce propionic acid which is nothing, but a flavour producing compound in cheese or typically swiss cheese, right.



Then, spoilage of raw milk spoilage of raw milk at room temperature that could be by this, right that then curdling of milk by streptococcus lactis which is because the precipitation of the casein because of that up to 1 percent it is acidity or lactobacilli which is by lactobacillus casei that convert rest of the lactose to lactic acid which is around 2 percent lactic acid.

Molds generally say geotrichum candidum growth on surface and reduce acidity by oxidizing lactic acid to carbon dioxide and water. So, one is producing one food that food

is utilized by another organism producing another right or chains reduced acidity proteolytic spore formers like bacillus degrade casein fraction. So, reduce the acidity proteolytic spore formers degrade casein fraction subsequently lipolytic bacteria develop and utilize fat fraction and decomposed mass-water inorganic substances carbon dioxide, ammonia, hydrogen etcetera are also produced, right.



I would like to complete that antibiosis and this otherwise we will be lacking lot of time. So, in antibiosis that is one organism inhibits or suppresses the growth of the other organisms which I said that lactic acid is being produced by lactic acid bacteria. So, that product is inhibiting the growth of other organisms, right. So, it is called competitive inhibition. This is called competitive inhibition, right. If you have I gave the exam I gave that reference leininger if you have seen that there Michael's maintain reaction is there. So, there according to that this is competitive inhibition that inhibitions of the growth organisms are done by the two and one is suppressing the other, right.

So, lactic acid bacteria cause the inhibition of proteolytic organisms that is spore formers. Starter cultures do not propagate well in constituted milk reconstituted milk that milk which is reconstituted milks from the dry powder it is constituted, right. Certain quantity of dry powder is taken and some that proportion of water is added and mixed so, this is called the reconstitution of milk. So, their starter cultures do not propagate well in reconstituted milk. Certain preformed substances inhibitory to starter bacteria are elaborated in milk and get carried over to the product during subsequent drying, right.

So, with this and all three we finished this class and subsequently we will also continue on this aspect, ok.

Thank you.