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 - 04
Fundamentals of Food Processing and Preservation (Contd.)

Good morning, we have a done something on the preambles for the course, 'right' little bit we are trying to give you some exposure to what is food; what are the things required; how it is preserved all these, so that you can understand that the need of the course, 'right'. So, we are now trying to do that this is the class 4, 'right'. So, we have shown you different methods different techniques.

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Now, here again we are coming to the heat treatments by which the food is preserved, 'right'. So, we said of course, out of which a little blanching, we little pasteurization and also we started, but could not that is on sterilization, 'right'. Blanching we said that it is around 75 to 95 degree centigrade per 1 to 10 minutes if you recollect and this has many advantages, little disadvantage also those things we discussed.

Pasteurization we said that it is having both two types or rather three types one is LTLT, that is, Low Temperature Long Time that was 62 degree or 63 degree centigrade for half an hour 30 minute and another was 72 degree centigrade for 15 seconds and the third one was high temperatures very this was second one HTST High Temperature Short Time

and the third was Ultra High Temperature that is UHT. And, it is around 140 to 145 degree centigrade for virtually no hold, 'right', just you attain that temperature and there is no need of couple of seconds even and only holding is good enough and that is UHT that is Ultra High Temperature pasteurization. And we also said that in pasteurization we do kill only the pathogenic organism not the entire organism present in the food material.

Now, we come to another that is called sterilization as you see where heat to kill all bacteria and the other organisms, 'right'. It is free of microbes; this is the one where it is free of microbes sterilization, 'right'. It is done as we said we had given the example of pressure cooker. So, here also as similar it is called auto clave similar device used in the both laboratory as well as in commercial skill is called auto clave. And, the process is known as autoclaving and there it is heated at 121 degree centigrade, but this 121 degree centigrade corresponds to a pressure of 14.7 psig equivalent to one atmosphere gauge pressure, 'right', so these we know.

Now, we have to say that by doing this what you are doing you are killing in sterilization you are killing all types of organisms whether it is recitative, non-recitative or spore former any kind of organisms you are killing, 'right'. So, these are the three heat treatments which we have said.

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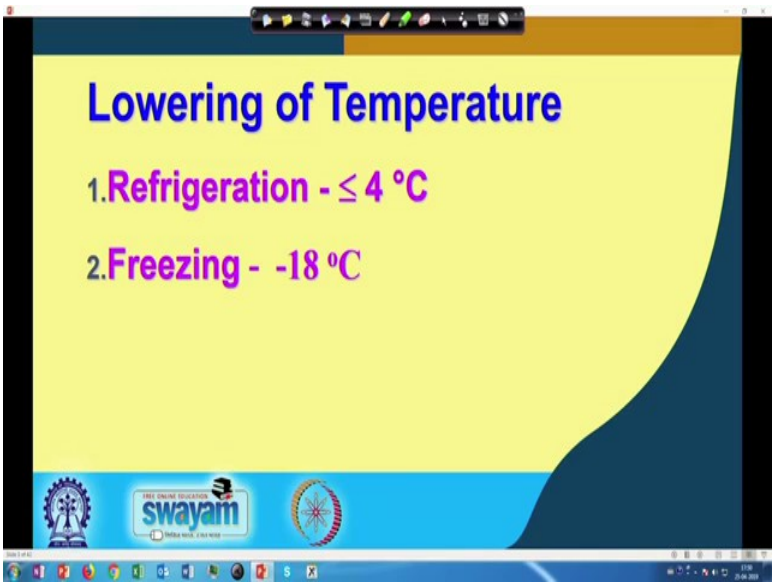

Now, the other one that was addition of heat now, it is removal of heat or lowering of temperature. Lowering of temperature we are said earlier that we can divide into many

classes; for example, refrigeration less than 4 degree centigrade or freezing which is less than minus 18 degree centigrade, this a little we had said.

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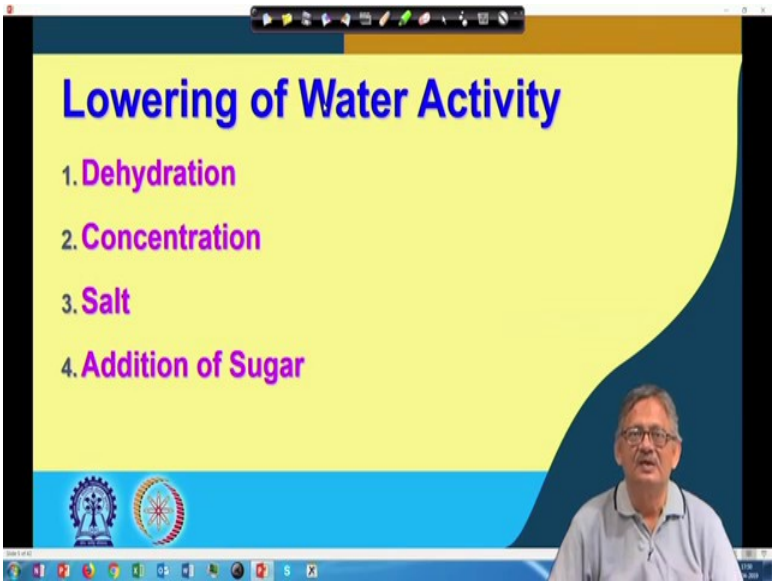

Now, if we go further that lowering of water activity. So, this is another way of extending the shelf life, we have defined, what is shelf life? So now we are not repeating. Lowering of water activity it is done and the processes are known as dehydration, concentration or by addition of chemicals like salts or addition of sugar. So, by these we can lower the water activity. Obviously, dehydration when it is being done that time you are adding heat and with this heat you are removing the water from the food material. This is how you are removing, both in dehydration as well as concentration.

But, the difference is that normally dehydration is associated with solid food; solid food when you are removing moisture or water then it is called dehydration. When it is in the liquid food from the liquid food then it is called concentration; from one concentration to another concentrations like you have 50 percent concentration of some solvent and or may be water or some food material then from there you want to make it 80 percent concentrated. So, you are removing this 30 percent from the food material or that material from where you are removing.

Some cases you are adding salt because salt is a good preservative because under the salt high salt concentration normally the organisms cannot. Yes, there are little organisms or few are bacteria or organisms which can tolerate a little high concentration of salt, but

they are very nominal beyond that the salt is used as one of the method of extending the shelf life or addition of sugar.

Sugar is a very good also preservative, 'right' because what is happening when sugar is there they between the outer material and the cellular material that is organism cell there is osmosis and thereby either hypertonic or hypotonic depending on the solution concentrations they are hypertonic or hypotonic. And, then either cells or cells of the organisms they go on bulging and then bust or they go on shrinkage and then with the also collapses.

So, in either of the cases the organisms die at high concentration of sugar depending on again the concentration of the solution outside and inside the bacteria or organism, 'right'. This is the way how you are extending the shelf life of jam, jelly, marmalade 'right' the in that process also heat transfer comes in.

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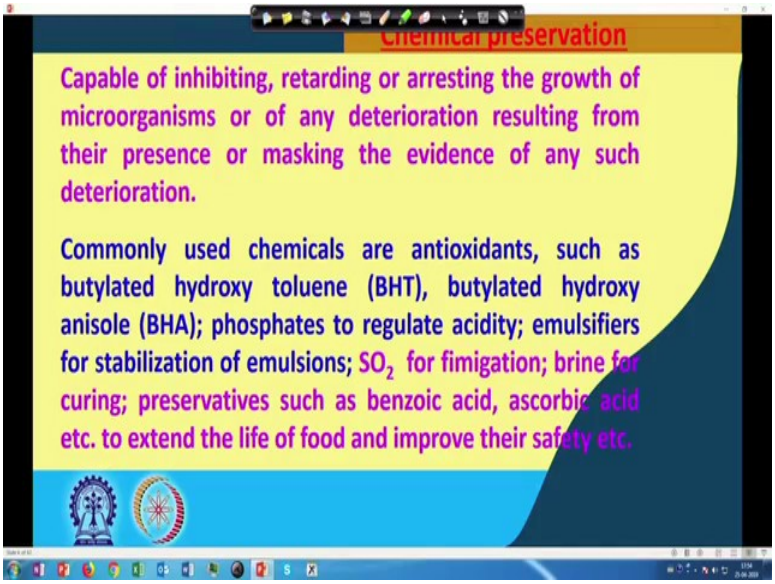

However, then we are again coming to that addition of sugar, ok, these are capable of inhibiting retarding or arresting the growth of microorganisms or of any deterioration resulting from their presence or masking the evidence of any such deterioration, 'right'.

Commonly used chemicals are this is the chemical preservatives 'right'. So, this chemical preservatives are commonly used antioxidants such as Butylated Hydroxyl Toluene or in short it is known as BHT or Butylated Hydroxyl Anisole in short it is

known as BHA or phosphor phosphates to regulate acidity; emulsifiers for stabilization of emulsions; sulfur dioxide for fumigation; brine for curing brine means solution the salt solution curing and then preservatives such as benzoic acid, ascorbic acid etcetera they are used as the preservatives to extend the life of the food material and improve their safety for consumption, 'right' .

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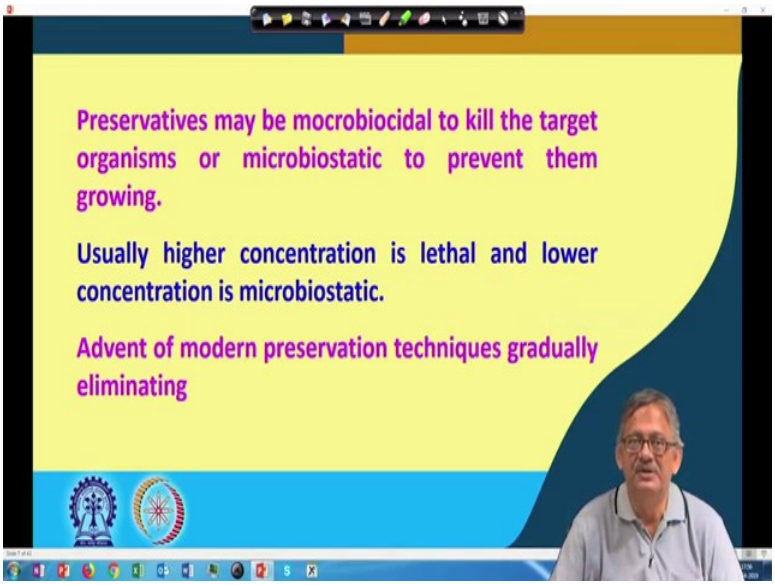

Then preservatives maybe microbiocidal or we have to kill the target organism or microbiostatic that is to prevent the growth of these organisms, 'right'. So, preservatives may be either microbiocidal that is that will kill the target organisms or microbiostatic that is it will prevent the growth of these organisms, 'right'.

Then usually higher concentration is lethal and lower concentration is microbiostatic; that means, lethal means it is the it is bad or if the organism cannot tolerate it will get killed, so that is called lethal. Lethal dose you have add that connotation lethal is mean meaning that it will kill, 'right'. So, that lethal dose is high concentration and that will act as a microbiocidal or if it is that lower concentration then it will be known as microbiostatic, 'right'.

Then advent of modern preservation techniques gradually eliminating let us go back gradually advent of this modern preservation techniques gradually eliminating this use of this chemicals of course, because using chemicals in many cases they are under the

prevention of adulteration act or many other acts on rules. So, it may be that the utilization or it is use is getting minimized.

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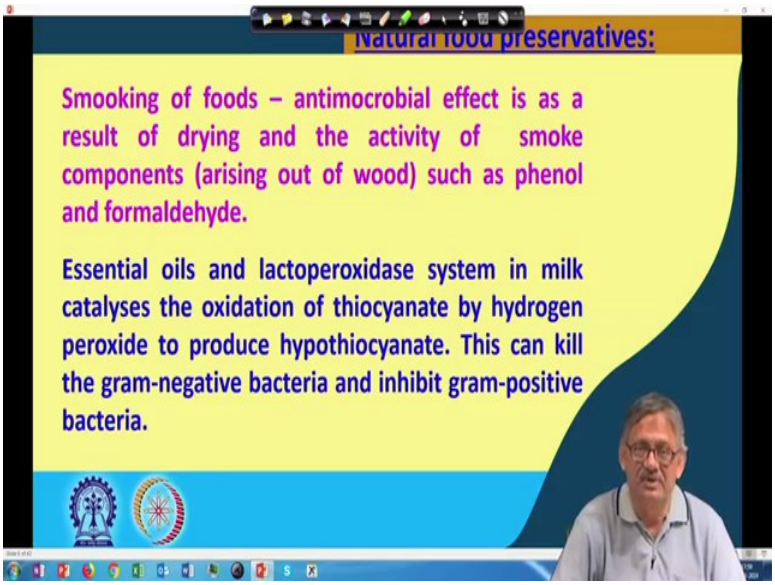

Then other way of extending the life is by if the use of smoking of foods. This smoking is which is antimicrobial effect the smoking process has antimicrobial effect and is as a result of drying and the activity of smoke concentration components for example, arising out of wood such as phenol and formaldehyde, 'right', so formaldehyde. So, these are the components which act as the smoking smoke during the smoking process they act on the organisms and extend their life, 'right'.

Then essential oils are also there obviously, they when the new term as come essential we will tell that essential in many cases you come across like essential fatty acids, like essential amino acids, 'right', so these things you have already come across. So, means these are the things which are essential for the body because body cannot produce, 'right' your human body cannot produce them that is why it is called essential. Similarly essential oils are also like that and lactoperoxidase.

Essential oils and lactoperoxidase system in milk catalyses the oxidation of thiocyanate by hydrogen peroxide to produce hypothiocyanate. This can kill the gram-negative bacteria and inhibit gram-positive bacteria also. So, as you know that bacteria of course, we can or going to microbiology, but still since it has come there are two types: one is called gram-positive and another is called gram negative. Obviously, both are very bad,

but gram negative is more dangerous as it is than gram positive of course, both are dangerous, but of the two gram-negative is more.

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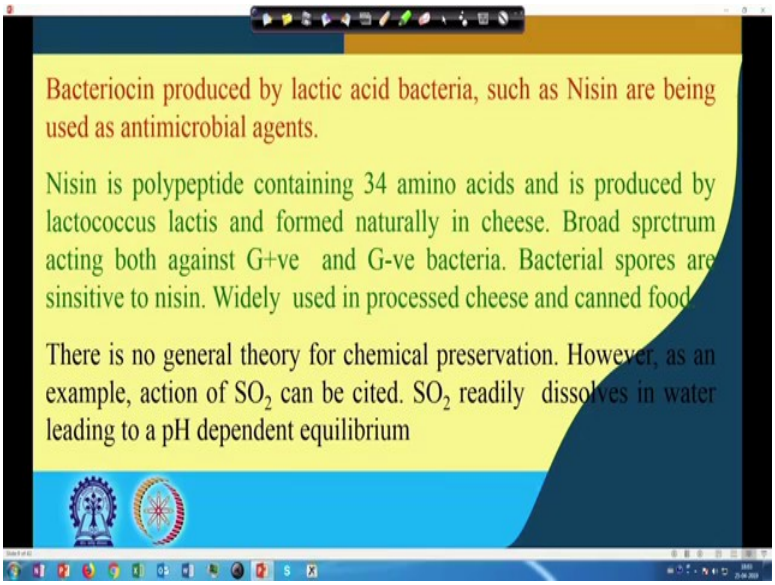

Bacteriocin produced by lactic acid bacteria, such as Nisin are being used as antimicrobial agents. Nisin is polypeptide containing 34 amino acids and is produced by lactococcus lactis lactococcus lactis and formed naturally in cheese. Broad spectrum acting both against gram-positive and gram-negative bacteria. And, bacterial spores are sensitive sensitive to nisin.

Widely used in processed cheese and canned food. In this part also a new thing has come up. So, I should also explain that that is the spore former. Earlier of course, also it came, but could not because of time constant or the continuation of that particular since it is come. Let me also say that spore formers are like suppose I hope you have seen you have seen that egg. Egg is one example can be which easily visualized, ‘right’.

If that shell of the egg can be can be thought that that is the shell on the bacteria, then this condition is known as spore forming; that means, some kind of coating is added to the organism by it by itself such that the normal bacteria which could be easily controlled or which could be easily killed or destroyed, now is very difficult because it has already found one coating over it like the egg shell as I gave the example. The interior being egg the shell interior being the bacteria itself and the outer coating is that the spore former or spore forming agent.

So, that thing is then very tough or difficult to destroy that is why if there are spore formers present in the bacteria, then it is very difficult or it is very tough to kill those organisms. So, spore formers even if they can be killed, then yes, that is very good a process.

Then there is no general theory for chemical preservation. However, examples are that action of sulfur dioxide can be cited, 'right'. Sulfur dioxide readily dissolves leading to pH dependent equilibrium, 'right'. So, sulfur dioxide dissolves in water, 'right', as an example we can say sulfur dioxide is dissolves in water and leading to a pH dependent equilibrium.

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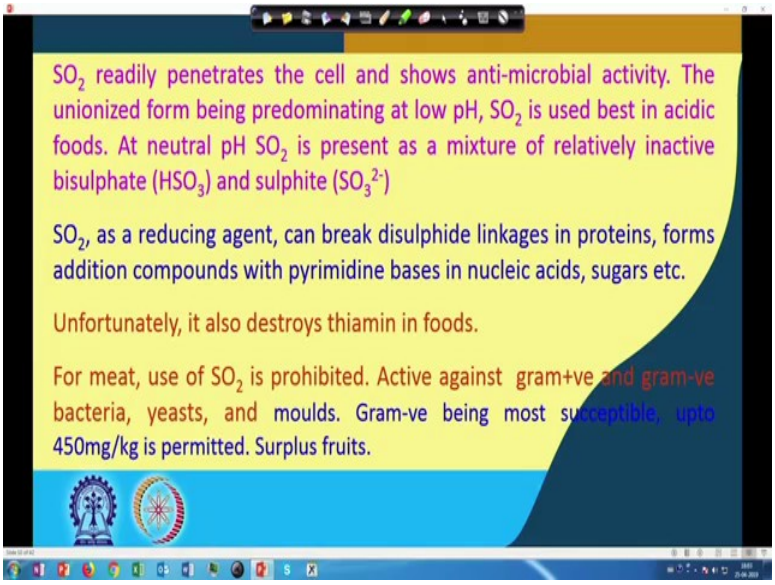

Now, this pH dependent equilibrium which makes sulfur dioxide readily penetrates into the cell and shows antimicrobial and shows anti-microbial activity. The unionized form being predominantly or predominating at low pH, sulfur dioxide is used best in acidic foods. At neutral pH sulfur dioxide is present as a mixture of relatively in a relatively inactive bisulphate or HSO_3 and sulphite SO_3 ion, sulphite ion or SO_3^{2-} .

Sulfur dioxide as a reducing agent can break disulphide linkages in proteins forms addition compounds with pyrimidine or pyrimidine bases or in nucleic acids sugars etcetera. Unfortunately, it also destroys thiamine in foods thiamin is a vitamin, 'right'. For meat, use of sulfur dioxide is prohibited, 'right'. Active agent like gram-positive and gram-negative bacteria, yeasts and molds. Gram-negative being most susceptible up to

450 milligram per kg is permitted. So, surplus and it is it is available surplus in food, 'right'.

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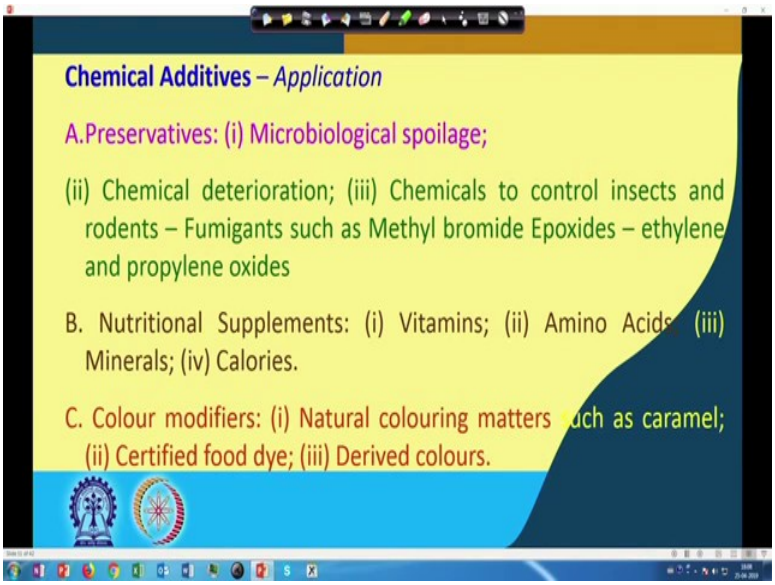

So, it is not that easy that chemical the way the chemicals are used as the preservative. The function of heat is different for different chemicals, that is why there is no pronouns theory by which it can be said. It all depends on the specific chemical which is acting, 'right'.

So, there are also some chemical additives, 'right', which may be acting as preservative or it may be acting as microbiological spoilage, biggest microbiological spoilage or it could be chemical deterioration. It could be used against chemical deterioration, could be used against chemicals to control insects and rodents. For example, fumigants such as methyl bromide epoxide, ethylene and propylene oxides; so, these are some which are used as the chemicals to control the insects or rodents.

Similarly, the activities of chemicals as additives could be nutritional supplements that it chemicals can be used as nutritional supplements. So, as you know by this time that vitamins are also by nature chemicals, it is also a chemical formulation, 'right', amino acid it is also chemical formulation. So, all these are chemical, basic things are that these are also coming from the chemicals. Minerals, 'right', or it is acting as a calorie supplement, 'right'. So, these nutritional supplements can be chemicals can be used for nutritional supplements also, 'right'.

Then colour modifiers in many cases it can be used as natural colouring matters such as caramel; the certified food dye or derived colours they are used as colouring materials. In many cases colouring materials are used, 'right'; in many cases colouring materials are used.

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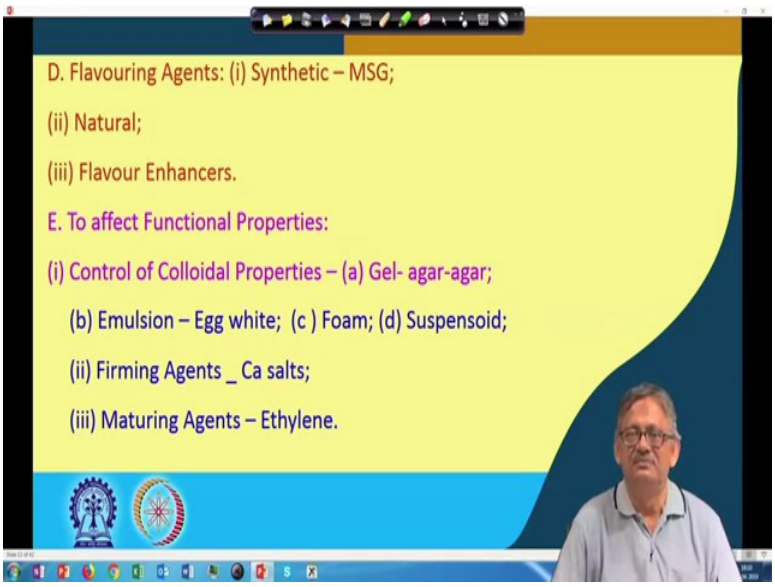

And; obviously, one thing you has to be kept in mind that it should be permitted colour, 'right'. There are in the previous class previous not in this course in the other another course we had said that there are agents or there are governing bodies which control the usage of this chemicals. So, it has to be permitted under the permission of the controlling body then only it is usable, ok.

Then another application could be as a chemical additive is flavouring agent like synthetic MSG, 'right' Monosodium Glutamine that can be used or maybe natural or may be flavouring enhancer or maybe it can be used to affect functional properties such as control of colloidal properties for example, gel formation where agar-agar is used as one of them many others are also there; agar-agar is one of them .

Then emulsification for emulsification for example, in egg white or in foam forming or in suspensoid, this can be used. Fermenting agents where calcium also can be used or calcium salts can be used or maturing agents they are ethylene. In many cases you have come across that fruits which are sold in the market they are ripened by this chemical agent called ethylene, 'right'.

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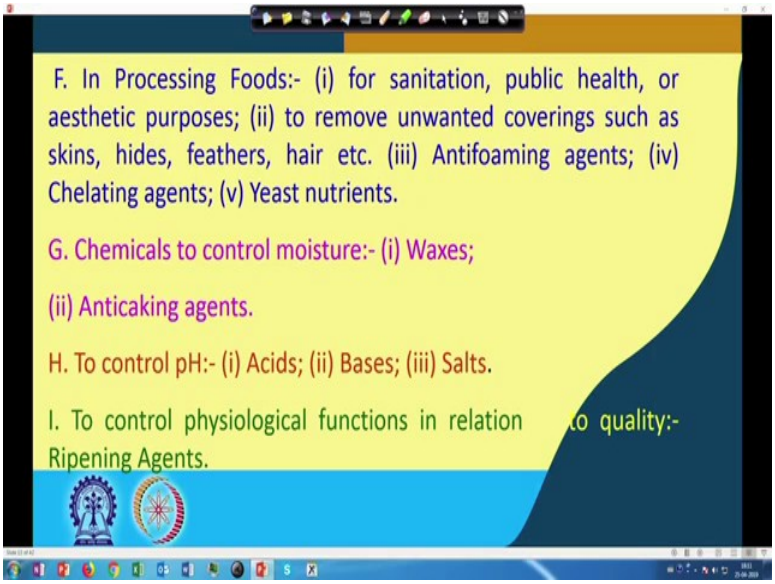

Then we in processing of foods for sanitation public health or aesthetic purposes this can be used; to remove unwanted covering such as skins, hides, feathers, hair etcetera chemicals can be used. Antifoaming agents as antifoaming agents it can be used; chemical agents also it can be used or nutrients to yeast.

Yeast as you know is one of the basic microorganism used for bread making, 'right'. In bread making yeast is used, so that has to be kept in mind. Chemicals to control moisture normally wax is used because if wax coating is used, then that acts as the preventing or preventing mechanism for the water or moisture to get removed, 'right'. So, that waxes can be used. Then some anticaking agents it can be used. To control pH for example; acid, base or salts they are used for controlling pH. To control physiological functions, in relation to quality, for example, ripening agents, 'right'.

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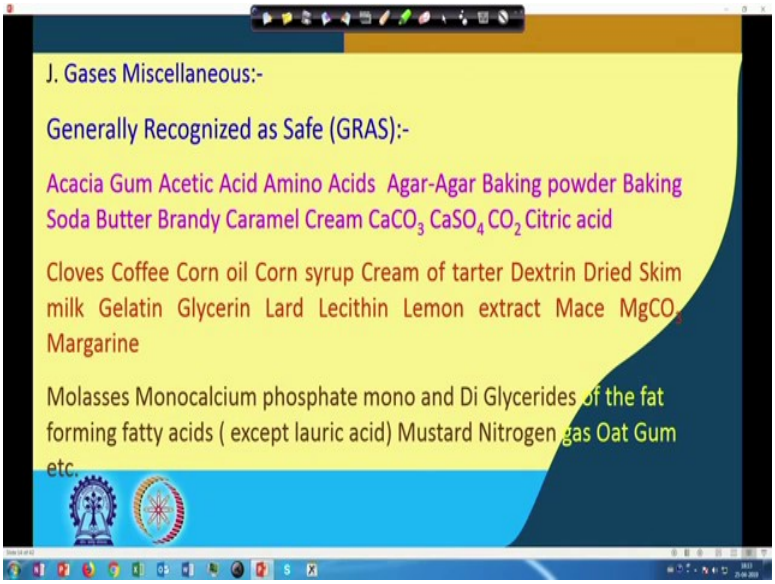

And, gases miscellaneous gases are used Generally Recognized as Safe or GRAS in short it is called GRAS generally recognized as safe. So, a acacia gum, acetic acid, amino acid, amino acids, agar-agar, baking powder, baking soda, butter, bread brandy, caramel, cream, calcium carbonate, calcium sulphate, carbon dioxide, citric acid these are all used as these are known as generally recognized as Safe .

Cloves, coffee, corn oil, corn syrup, cream of tartar, dextrin, dried skim milk, gelatin, glycerin, lard lecithin, lemon extract, mace, magnesium carbonate and margarine these are used as generally recognized. Others are molasses, then monocalcium phosphate, mono and di glycerides of the fat forming fatty acids except lauric acid mustard nitrogen gas, oat gum etcetera they are also used.

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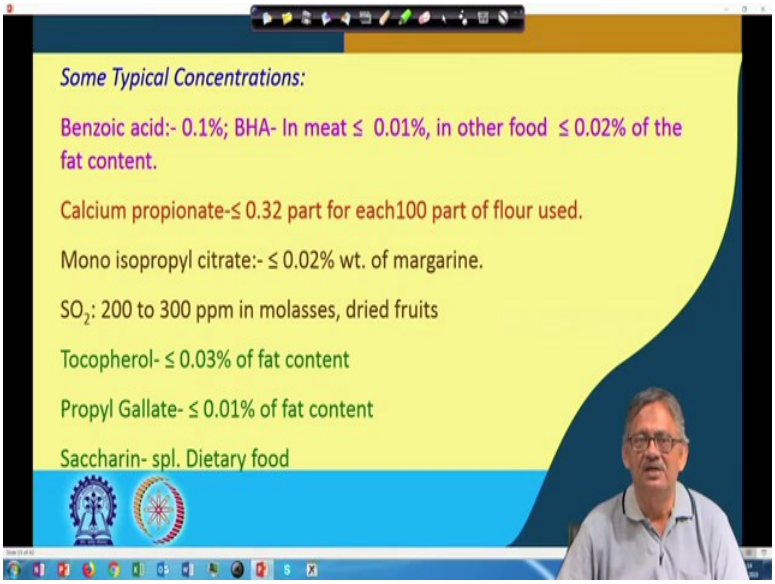

Some typical concentrations are like this, benzoic acid is around 0.1 percent, BHA or butylated hydroxyanisole in meat is less than 0.01 percent, in other food less than 0.02 percent of the fat content. Calcium propionate which is less than equal to 0.32 part for each 100 part of flour used. Then mono isopropyl citrate which is used less than 0.02 percent by weight of margarine, in sulfur dioxide is around 200 to 300 ppm in molasses or in dried fruits. Then tocopherol is less than 0.03 percent of fat content and propyl gallate less than 0.01 percent of the fat content normally used. Saccharin specially dietary is used specially for dietary food, 'right'.

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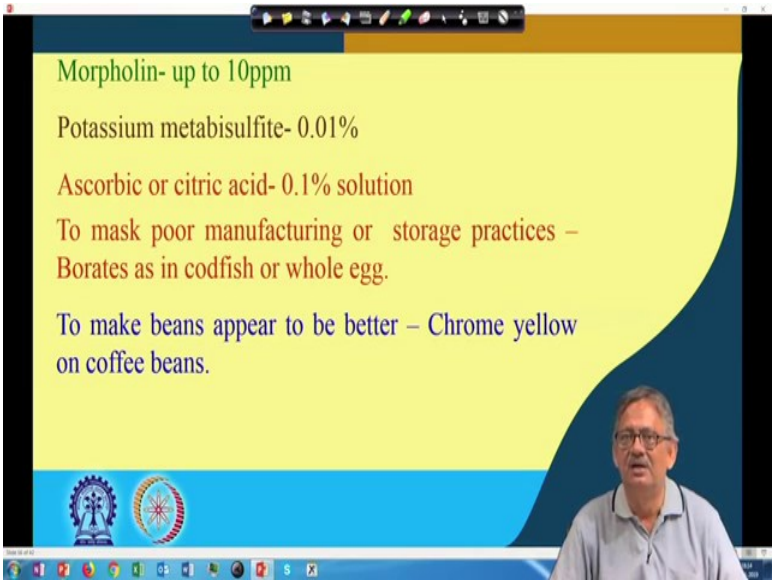

Then, morpholin up to 10 ppm, potassium metabisulfite up to 0.01 percent, ascorbic or citric acid 0.1 percent in solution. Then to mask poor manufacturing or storage practices borates as in codfish or whole egg is used. To make beans appear to be better chrome yellow on coffee beans are used, 'right'.

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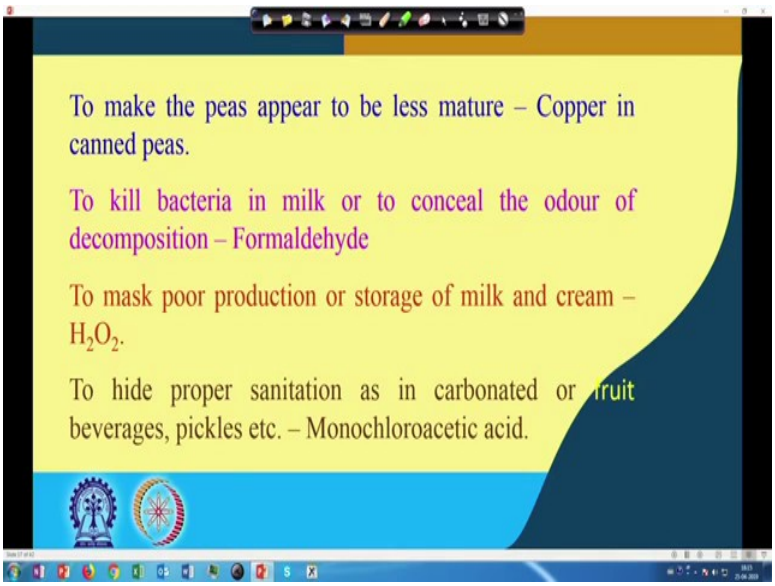

To make the peas appear to be less mature copper in canned peas are used. To kill bacteria in milk or to conceal the odour of decomposition little formaldehyde is used which is obviously, formaldehyde is not a accepted one. To mask poor production or storage of milk and cream a little hydrogen peroxide is also used. To hide proper sanitation as in carbonated or fruit beverages, pickles etcetera for example; monochloroacetic acid is also used.

So, in this class we have come to know that how the different chemicals are used for the storage of the food material, 'right'. So, as this is a part of our this course we now come to the end of this class and perhaps in the next class we will continue for this which we could not complete till now, 'right' as a preamble of the course.

Thank you.