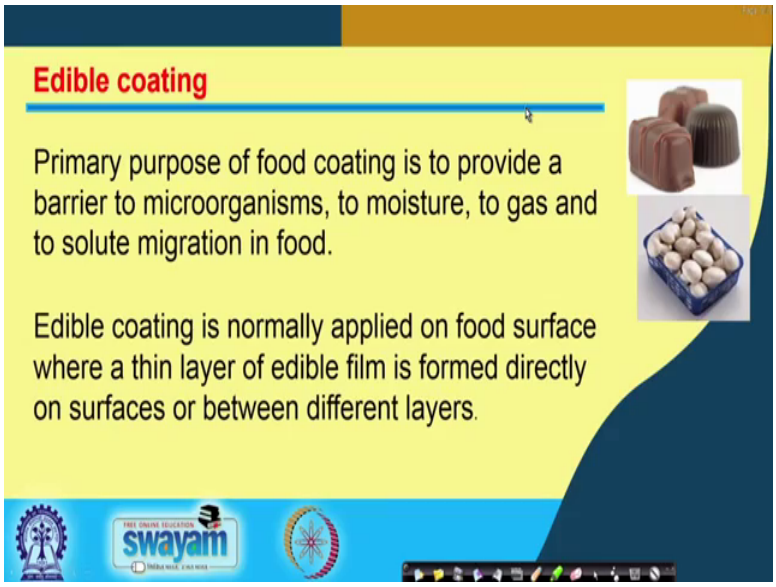
**Novel Technologies for Food Processing and Shelf Life Extension**

**Prof. Hari Niwas Mishra**
**Department of Agricultural and Food Engineering**
**Indian Institute of Technology, Kharagpur**

**Lecture – 43**
**Edible Coating**

Friends, we will now study another important method of extending shelf life of wide ranging food materials including fruits, vegetables, chocolates and etcetera etcetera, where we provide some sort of coating which commonly in tell edible coating to manipulate, the processes like respiration, transpiration, oxidation etcetera.

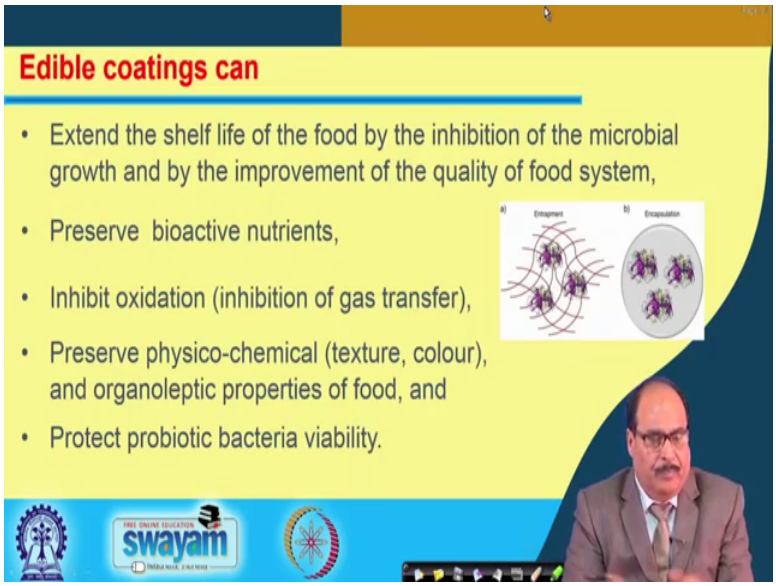
(Refer Slide Time: 00:58)




So, the Edible Coating as I told you the primary purpose is to provide a barrier by applying some sort of coating. That is the barrier to microorganisms, barrier to moisture, to provide barrier to gas and solute migration in the food and by controlling this processes, it increases the shelf life of food; it increases the quality of the food.

Edible coating is normally applied on the food surface where a thin layer of edible film is formed directly on the surface or in between the different layers of the food material as might be in the case of chocolate etcetera.

(Refer Slide Time: 01:51)

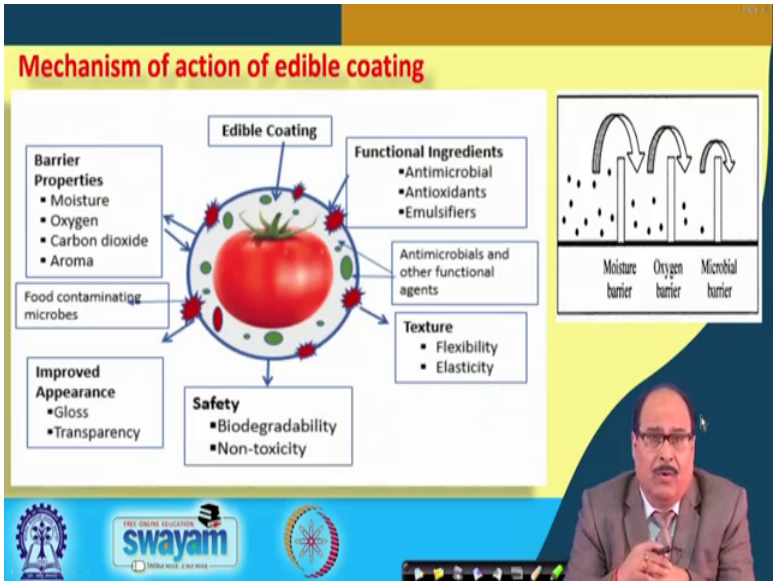



Edible coating can extend the shelf life of the food by inhibition of the microbial growth and by the improvement of the quality of the food system. It can also do or preserve bioactive nutrients present in the food. It can inhibit chemical processes like deteriorative chemical processes like oxidation etcetera. Edible coating can preserve physic-chemical characteristics of the food such as texture, colour and organoleptic properties. And it is also used more commonly nowadays to protect probiotic bacteria or application of probiotic bacteria or to protect their viability during storage and during processing.

(Refer Slide Time: 02:47)

Increasing consumer demand for ready to eat foods and the foods which are processed or preserved with low additives etcetera; environmental issues such as recycling and biodegradability of the convention used packaging films. Changes in the retail and distribution practices associated with the globalization. And stricter a regulatory requirements regarding consumer health and safety are some of the drivers for edible coating innovations. These are the usual which have encouraged the manufacturer or industry to follow edible coating.

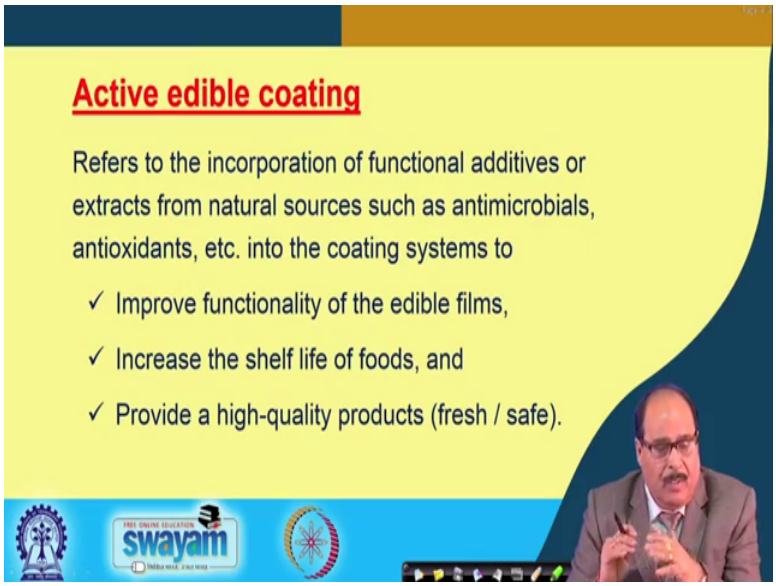
(Refer Slide Time: 03:36)




So, you can see here. In this there is a tomato is shown in the picture. So obviously, there are various agents like microbial agents or some that biological agents etcetera which from the environment all those thing they cannot universally they contacted they come in contact with the tomato here in this case or in general the other food materials and they hasted that it will be a processes. So, now some sort of coating is you can see here that is the edible coating.

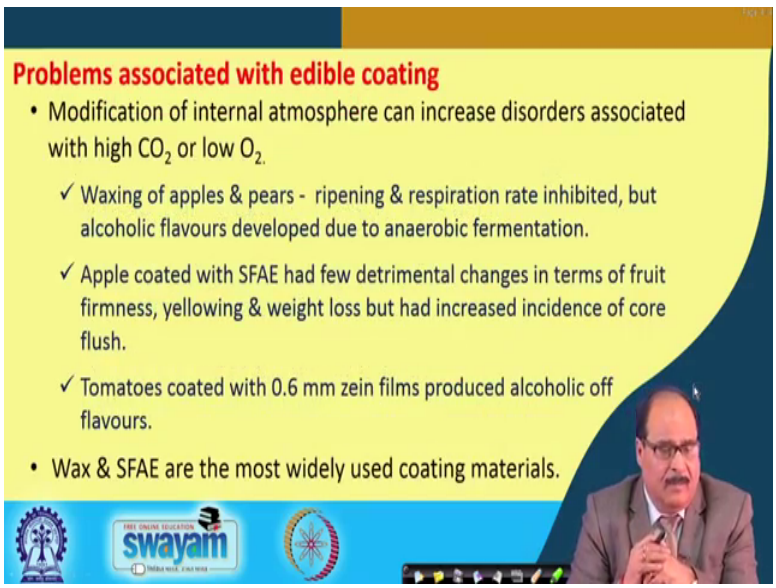
So, this coating provides barrier maybe to moisture; it provides barrier to oxygen; it provides barrier to the microorganism; it may provide barrier to the antioxidant etcetera. And accordingly their contact, their growth, their activity and the food surface is controlled or sometimes stopped totally and this ultimately results into the extension of the shelf life of the food material as well as in increasing in the safety of the product or improving its quality or as the case may be.

(Refer Slide Time: 05:03)




So, also there is another term active edible coating that is this active edible coating refers to the incorporation of functional additives or extracts from the natural sources such as antimicrobials etcetera or antioxidants etcetera to the coating system. And this that is in order to make the polymer which is to be coated or the coating system to be more functional to make it more to improve its functionality; to make the edible fill more functional to increase the shelf life of the food and to provide a high quality product maybe both fresh produce or it retains its freshness or it improves its safety. So, this films can be functionalized to perform these actions.

(Refer Slide Time: 06:06)



There are certain problems associated with the edible coating which you need to be resolved to make the technology successful. Of course, there is a modification of internal atmosphere in this edible coating and this modification of the internal atmosphere can increase the disorders associated with high carbon dioxide or low O 2.

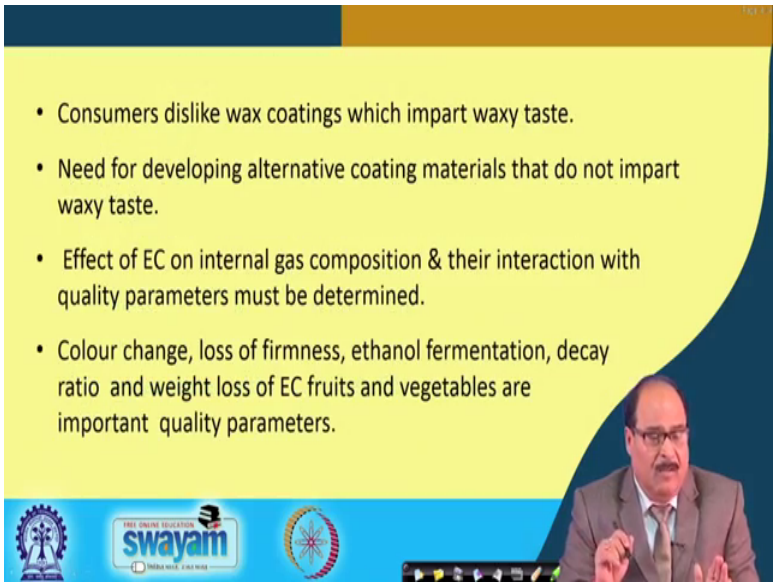
If the coating applied is not proper; if the coating becomes too thick; if the coating becomes too thin; if it does not have proper strength; if does not it does not provide proper permeability etcetera, then these problems might because the oxygen concentration might be too low or high carbon dioxide concentration maybe too high and this will rather doing rather doing a good job, it will rather create problems.

There are certain reports in the literature like waxing of apples and pears they are been commercially used, but it results into the inhibition of ripening processes or controlling the respiration rates. But there also certain reports particularly when the waxing, wax coating was not proper, it resulted to the alcoholic flavor development due to anaerobic fermentation. Maybe in that case very low oxygen concentration or coating become too thick that oxygen availability was completely stopped oxygen over the.

So, material respired anaerobically anaerobic fermentation took place. Similarly, the apple coated with sucrose fatty acid esters had few detrimental changes in terms of fruit firmness, yellowing and weight loss that is these were all maintained, but the fruit has increased incidence of core flush. Tomatoes coated with 0.6 mm zein films produced alcoholic off flavours. So, these are these report indicates that if the coating is not proper the material may spoil quickly; it maybe inferior in colour, in flavour or such others.

So, that is very important that is coating should be properly done. Wax and Sucrose Fatty Acid Esters although they are most widely used coating materials, but consumers do not like it.

(Refer Slide Time: 08:49)



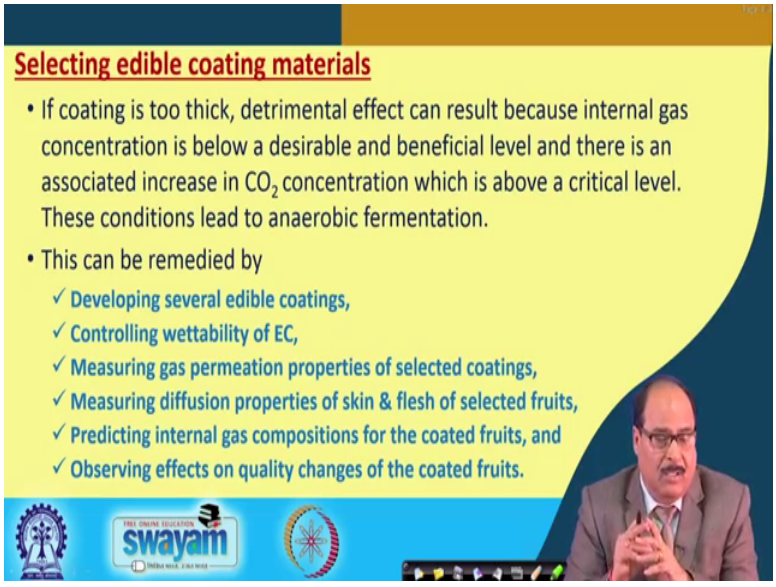

Because particularly the wax coatings, impart waxy taste; so, this has lead to the development of the new coating material or alternative coating materials that is fully edible and that do not impart any undesirable taint, taste, odors etcetera and also which is easy to apply. And where, it is easy to maintain the characteristics of the coating materials or characteristics of the coating. So, that you can maintain the desired effect; desired concentration of gaseous all those thing to get the desired benefits.

Effect of edible coating on internal gas composition and their interaction with the quality parameters of course, must be determined in order to meet the edible coating effective. Colour change, loss of firmness, ethanol fermentation, decay ratio and weight loss of edible coated fruits and vegetables are the important quality parameters which means there is edible coating should of such order that is these materials should be intact; these characteristics of the material should be intact or to just ensure to make sure that whether your coating was good or bad, materials can be analyzed for these quality parameters.

(Refer Slide Time: 10:22)


So, there is one important thing that is a success of edible coating of fruits and vegetable depends mainly on selecting films or coatings which can give a desirable gas consumption that is appropriate for a specific product. As I told you that is the; that is very important and there are various factors which govern to this.

(Refer Slide Time: 10:45)

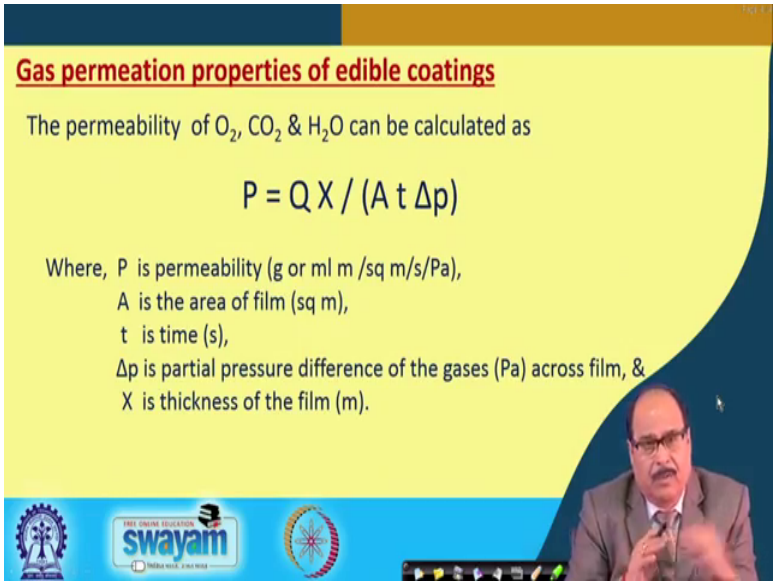



So, let us first see for the what are the consideration for selecting edible coating material because that is very very important. If coating as I told you if coating is too thick, it may lead to the detrimental effect; that is detrimental effect can result increase in the internal

gas concentration. The internal gas concentration maybe below to that required or to that of a desirable limit or even the beneficial level and there is a associated increase in the CO 2 concentration. If the thickness is not proper, the CO 2 concentration maybe high; O 2 concentration maybe low and these conditions as you have seen in the earlier case in the case of apple and pears etcetera report and literature say that this results into the problems or anaerobic fermentations etcetera.

So, these problems can be a remedied by taking appropriate steps such as developing several edible coatings, controlling wettability of the edible coating, measuring gas permeation properties of the selected coatings, by measuring diffusion properties of skin and flesh of the selected fruits, predicting the internal gas composition for the coated fruit and observing effects of the coating on the quality changes in the fruit or in the coated fruits.

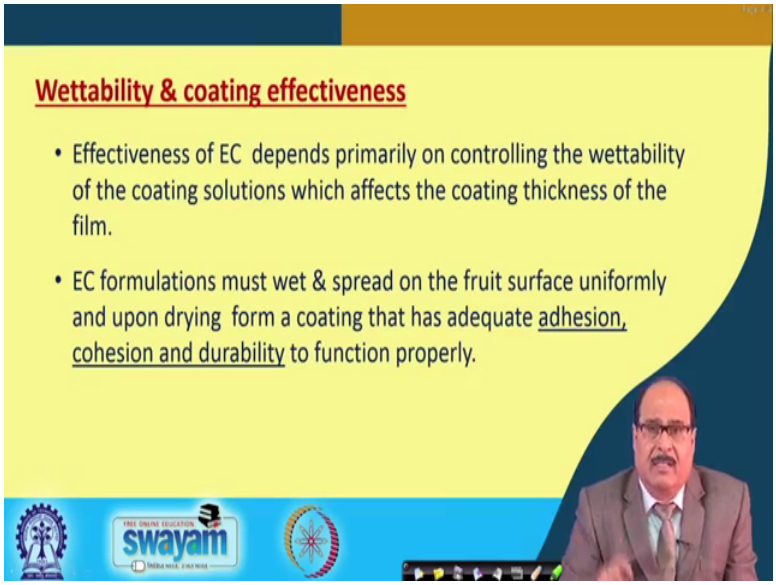
(Refer Slide Time: 12:31)




So, that are the parameter which one should take into consideration while selecting the edible coating material. Then, how to get the desired permeation properties of edible coating like permeability of oxygen, carbon dioxide, water vapour. the It can be calculated using this equation P is equal to QX by A t delta p, where P is the required permeability; required permeability of O 2, required permeability of CO 2, water vapour as the case may be.

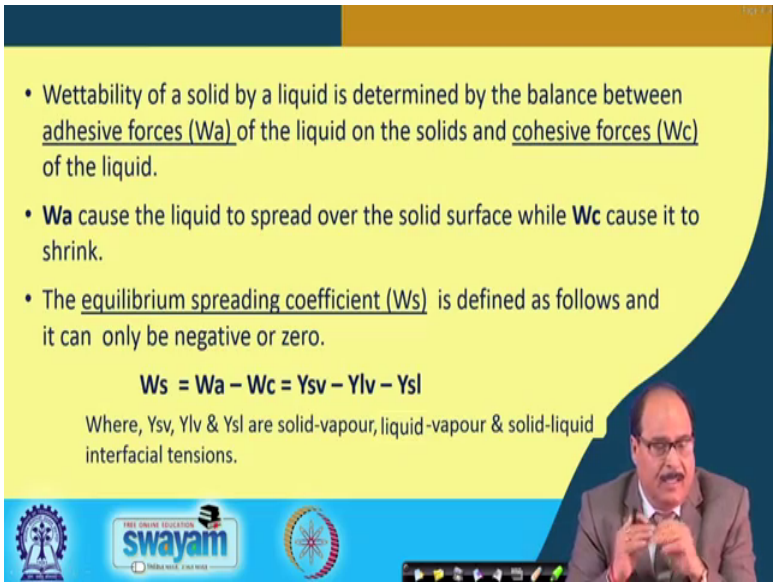
A is the area of the film in square meter; t is the time; delta p is partial pressure difference of the gases present across the film and X is the thickness of the edible film which is to be maintained. So, by this parameter one can control the permeability or gas permeation property. And that is very very important aspect as far as this required for the success of the edible coating.

(Refer Slide Time: 13:34)




Another important property is the wettability and coating effectiveness. In fact, effectiveness of edible coating depends primarily on controlling the wettability of the coating solutions which effects the coating thickness of the film edible coating formulations must wet and spread on the fruit surface uniformly and upon drying, this should form a coating that has adequate adhesion, cohesion and durability for proper functionality; for proper functionality of the coated films. So, that is important consideration.

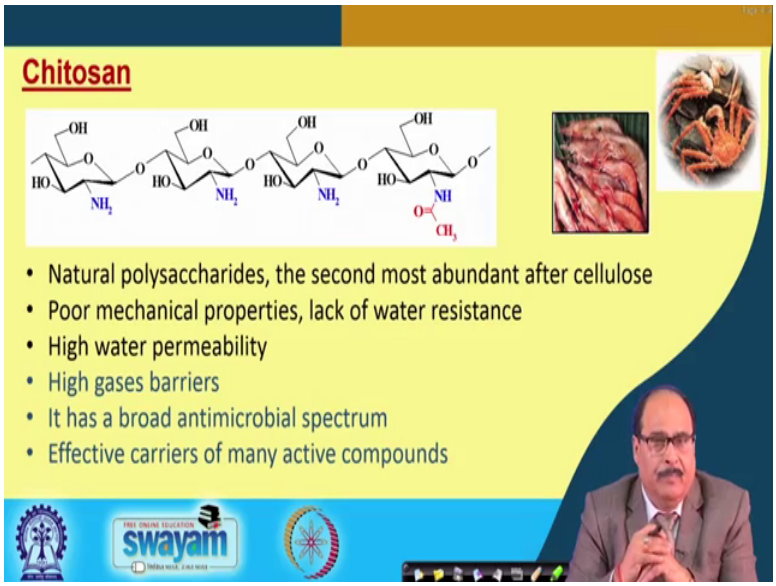
(Refer Slide Time: 14:25)




The wettability of a solid by a liquid is determined by the balance between the adhesive forces that is Wa of the liquid on the solid and cohesive forces that is Wc of the liquid. So, that has to be maintained Wa that is the adhesive forces. They cause the liquid to spread over the solid surface, while Wc causes it to shrink.

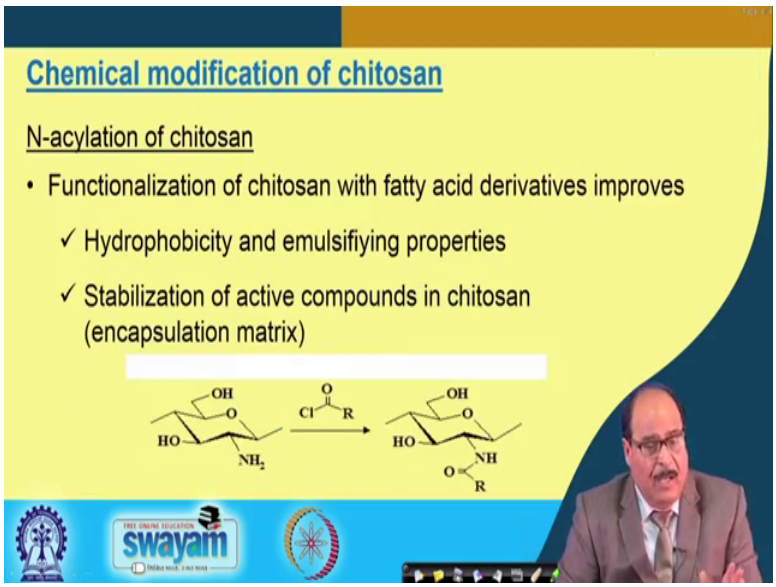
So, the equilibrium spreading coefficient Ws is can be calculated using this formula like Ws is equal to Wa minus Wc or another terms Ysv minus Ylv minus Ysl; that is Ysv Ylv and Ysl are the solid vapour, liquid vapour or solid liquid interfacial tension. So, from this one can calculate equilibrium spreading coefficient and this is always should be this should always be either negative or 0 .

(Refer Slide Time: 15:47)



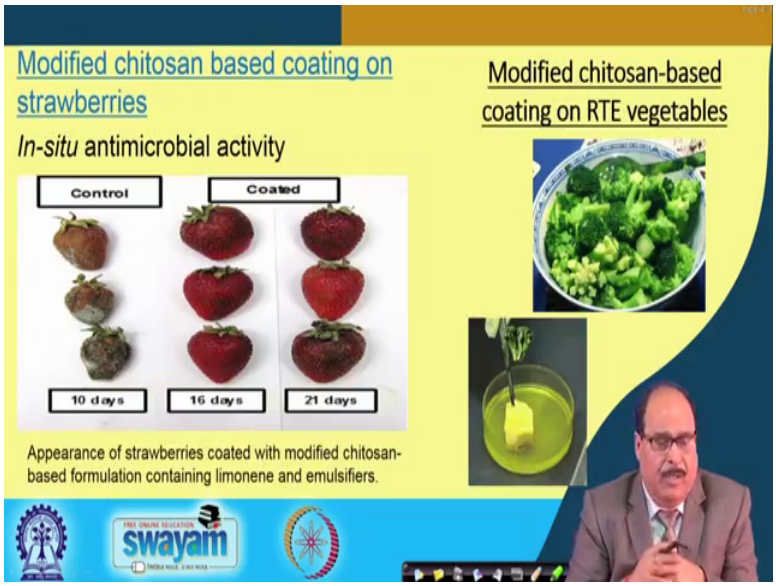

So, after having and let us where there is the some of the coating material which is good quality coating material. Chitosan is the one such material which is used for the coating of the several products. It is a natural polysaccharide; the second most abundant after cellulose. Although, it has poor mechanical properties, lack of water resistance; but it has high water permeability high gases barrier, it has a broad antimicrobial spectrum and it has effective carrier of many active compounds. So, because of these property, this Chitosan chitosan is used for edible coating of a variety of materials.

(Refer Slide Time: 16:34)



And in fact, this sometime this Chitosan is modified by acetylation processes to improve its Hydrophobicity and emulsifying properties or for the stabilization of active compounds in chitosan that is. So, the modified chitosan; chitosan depending upon the food material, it is used and it is at present. It is used is a good edible coating material.

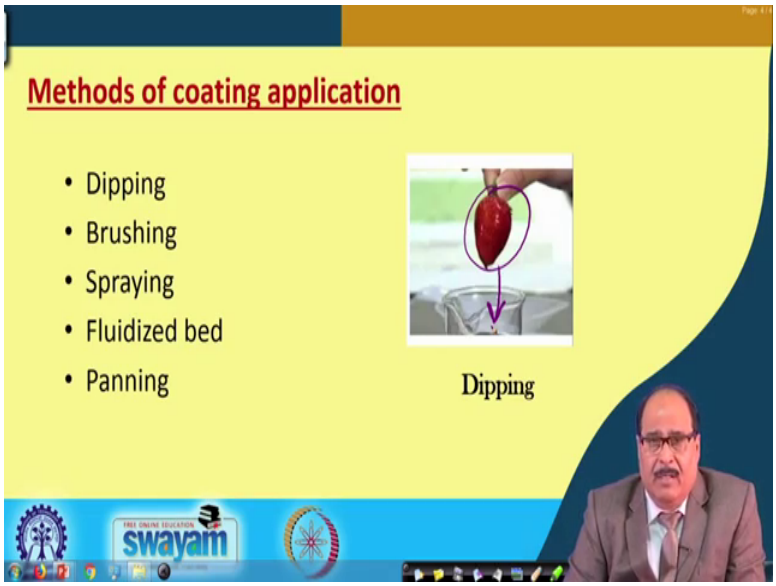
(Refer Slide Time: 17:01)




You can see here, this is a case we have taken from the literature that is where it has been shown that appearance of a strawberry coated with modified chitosan based formulation containing limonene and emulsifiers. Was improved drastically, there is a control. It says spoil only in 10 days, but the other coated depending upon the type of the coating differences even up to 16 days or in other test after 21 days.

Its appearance was very good. Similarly, modified chitosan based coating and ready to eat vegetables considering that is the other material, they are all the how they are looking good. So, appearance is improved their shelf life is improved.

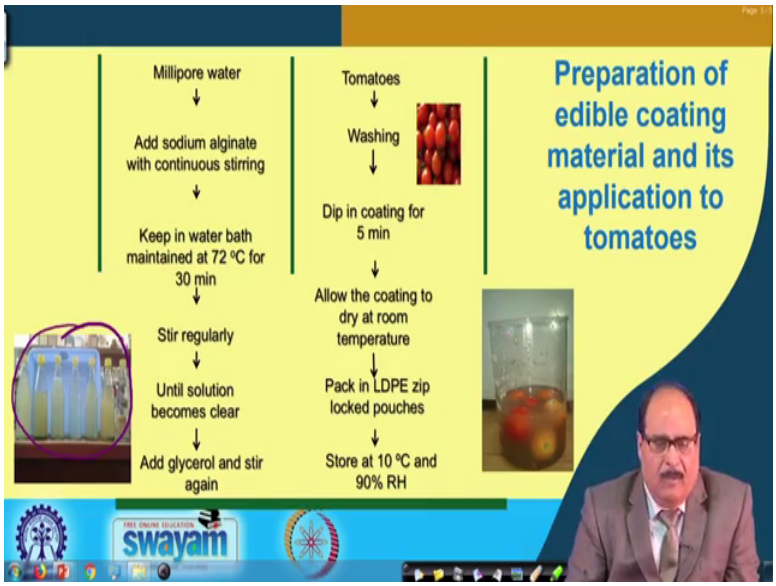
(Refer Slide Time: 17:51)




So, next important aspect is that is the method of coating application. How to apply this coating, once you have a suitable coating material, you have developed the formulation, you know the important thing is to apply it. Because the application method will greatly influence that is what is the thickness you are getting; how their uniformity of the coating that is it should be proper of you know. So, and accordingly, it would get the desired benefits.

So, different methods which are used for coating application include Dipping, Brushing method, Spraying method, Fluidized bed method and Panning method. So, I will briefly explain this one by one.

(Refer Slide Time: 18:44)




In the Dipping method, as you can see here in this picture also that is the simple that is you prepare a coating solution and in the coating solution, the material is dipped for desired duration of time. And then, after that it is taken out so and dried. So, this allows the deposition of the and of course, the layer etcetera here in this case is controlled by controlling the concentration of the solution by controlling the time by the dipping and so on. .

Here in this slide, I have shown you that is the preparation of edible coating material and its application to tomatoes by dipping method and this is the work which we have done in our laboratory on the basis of that the method. What we will take? Millipore water, then sodium alginate is added into the Millipore water with continuous stirring and then, this solution is kept in water bath which is maintained at 72 degree Celsius for 30 minutes. It is heated little bit stirred continuously or regularly until the solution becomes clear.

So, once the sodium alginate solution becomes clear, where glycerol and other formulations we have developed several formulations for the edible coating of material like tomato, guava, mushroom and so on. So, this you can see here in this bottle in the picture. Thus, these are the coating solutions made in the laboratory.

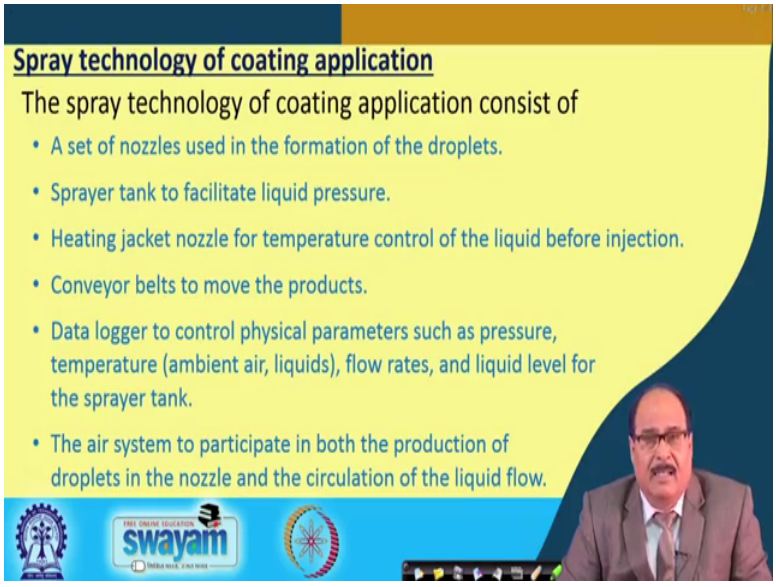
So, once you have the coating solutions of the desired consistency, of the desired concentration, the next step is that is we take here in the beaker that is their laboratory

process just to I am explaining to demonstrate you how it can be done that by dipping method, if you on or a larger scale pilot scale accordingly you one can have a suitable instrumentation and equipments for doing this.

So, this tomatoes obviously, they are washed right sorted graded and ensure that they are of uniform size, good, colour etcetera. They here in this case, they are dipped in coating solution of a desired concentration, of desired strength for 5 minutes. One can dip it for 2 minutes, for 10 minutes, for 9 minutes. Of course, depending upon the coating spreading required, thickness of the coating required, other parameter that is required.

So, after the required time, the material is taken out of the coating solution right. It is allowed to dry at room temperature and then, finally, it is packed in suitable packaging material or kept in the cottons etcetera as the case may be and is stored or at under proper conditions. So, that is then how you can perform edible coating of the by dipping method.

(Refer Slide Time: 22:16)

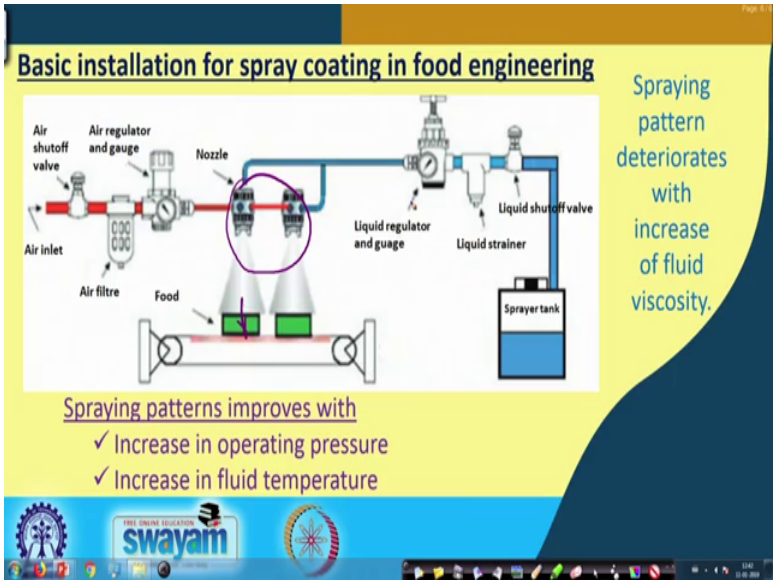



The other technology which is the most commonly used technology for the coating of the fruits, vegetables or many other food materials etcetera is the Spray technology. This spray technology for application of coating consists of a set of nozzles used in the formation of the droplet are used for the formation of the obviously, it has to be sprayed; so some arrangement for spraying of the coating solution over the surface of the food material ok.

Then, it there is a spray tank to facilitate liquid pressure etcetera so that to facilitate the spraying process, there might be some heating jacket nozzle for temperature control of the liquid before its injection, conveyor belts to improve the products, data logger to control physical parameter such as pressure, temperature, ambient air, liquid, flow rates, liquid level for the sprayer tank and so on.

And then, air system to participate in both the production of the droplets in the nozzle and the circulation of the liquid flow. So, these are the accessories or instrumentation system required for the spay drying system.

(Refer Slide Time: 23:47)



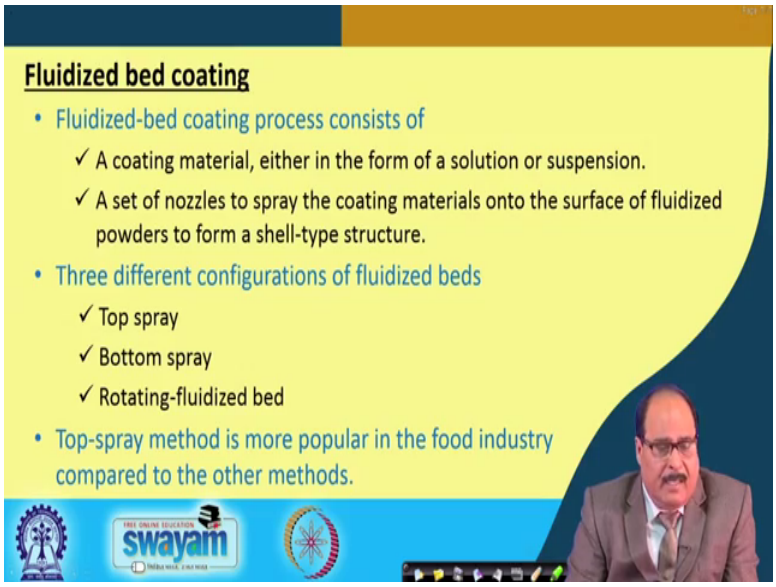

In this picture, you can see here that is in the where here these are the spray nozzles and the food material. It comes over the conveyor belt alright or by appropriate arrangement the thing is that the coating solution is spread over here that there is a sprayer tank by suitable piping. Another instrument that is the liquid regulator and gauge etcetera; so, you can control the pressure of the spray that is how much a required concentration, required quantity of the liquid or edible coating formulation to be sprayed.

And from other side air is coming. So, this air that you can regulate the air also. So, having proper balance between the air as well as the material which is coming here, one can ensure that or you can apply the coating from one side or two sides to make sure that this material is spread uniformly over the surface of the fruit or vegetable or other. In spraying patterns improves with increase in the operating pressure as well as increase in

the fluid temperature. However, spraying pattern deteriorates with increase of fluid viscosity.

So, by controlling this operating pressure, fluid temperature, fluid viscosity and having a proper optimization of this, having proper experimentation; one can definitely that is it is a much better process than the manual dipping process. One can control here the thickness and other characteristics.

(Refer Slide Time: 25:38)

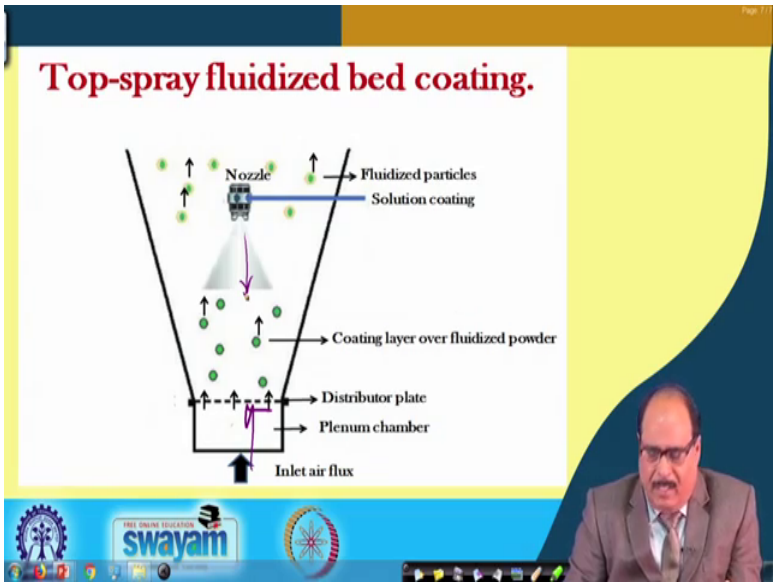



Another method is the Fluidized bed coating. Fluidized-bed coating process consists of obviously, a coating material. The solution of the coating and it may be either in the form of a solution or in the form of a suspension and then a set of nozzles to spray the coating material on to the surface of fluidized powder to form a cell type of structure.

So, in the as is common in the fluidization technology that the material is fluidized in the air and then, coating solution is surface sprayed on the surface of the material. Three different configurations of fluidized bed coatings processes are there that is the Top spray method, Bottom spray method or Rotating-fluidized beds techniques.

Top spray method is the more popular one which is used in the food industry for coating of various material like chocolate or fruit of course, application of coating on fruits or some smaller alright material or powders etcetera ok.

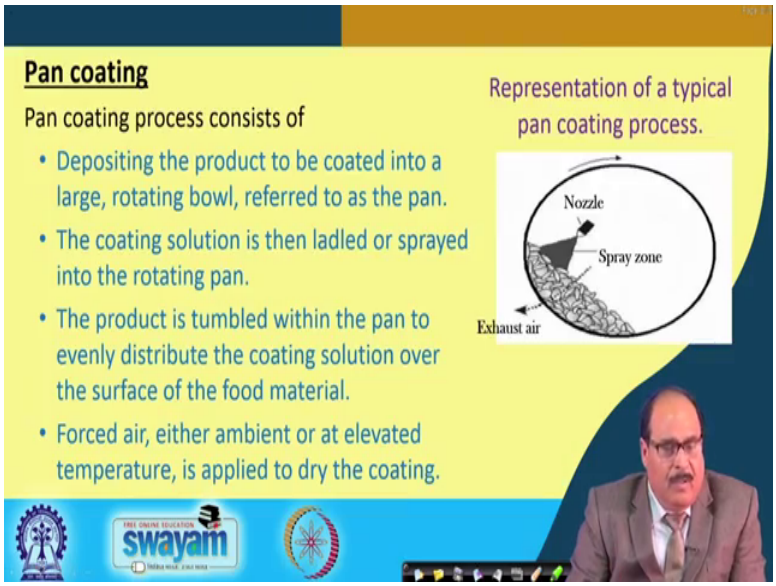
(Refer Slide Time: 26:49)




You see here that is a top spray fluidized-bed coating, the in this bed the inlet air flux. The material powdering material or fluidized powder, it gets fluidized and then the coating; coating solution is sprayed on the top through help of these nozzles and of course, this spray again there is the other arrangement which you have seen in the case of spray technology that.

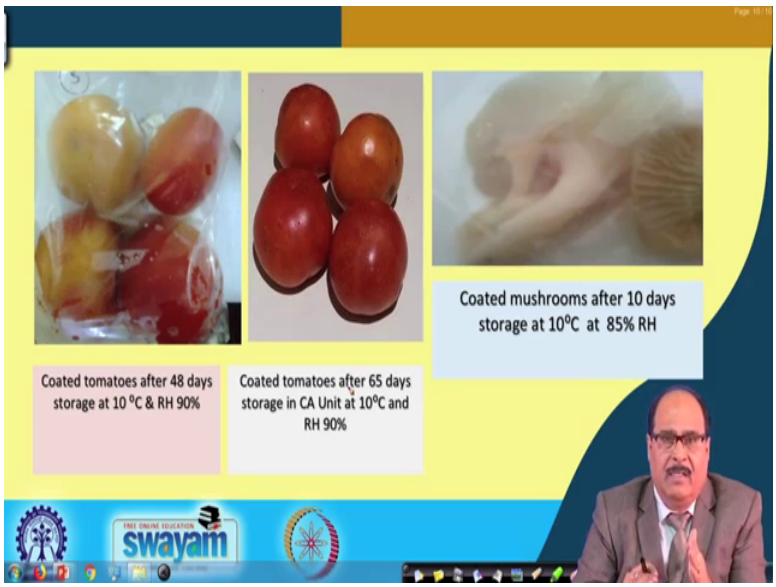
So, major difference between the spray technology and this is that in that case the material was coming may be on the through the conveyor belt and all those things. Here, the material is fluidized that is. So, it is more special that is inside this time the fluidized by the air nozzle etcetera and the material moves fluidized. So, it may result in sometime better coating or uniform coating.

(Refer Slide Time: 27:52)




Similarly, the bottom spray or other can be done. Pan coating as you can see in this figure here, it consists of depositing the product to be coated on to a large rotating bowl referred to as pan. So, in this pan, the material is put here. This pan rotates and pan rotates and with the help of suitable spray nozzle, the coating solution is sprayed over. That is the product is tumbled within the pan to evenly distribute the coating solution over the surface of the food material. Forced air, either ambient or at elevated temperature, is applied to dry the coating.

(Refer Slide Time: 28:46)



This gives you the some of the pictures that is our experimental sample in our laboratory that is the first case see here coated tomato after 48 days of storage at 10 degree Celsius and 90 percent relative humidity. This case here with the coated tomato after 65 days of storage in control atmosphere at 10 degree Celsius and 90 percent relative humidity. So, this results in significant that is the coating edible coating technology results in significant increase in the shelf life of the tomatoes.

In the case of mushroom also that is you can see here, these are the coated mushroom and the picture taken after 10 days of their storage at 10 percent relative humidity and 85 percent. 10 degree Celsius temperature and 85 percent relative humidity. So, this has become a very good technology the our laboratory experimental results says that the coating solution which we have formulated, even we have done it by dipping method. So, it has a good potential that is edible coating technology has a vast potential of increasing the shelf life of fruits, vegetables while maintaining their quality.

(Refer Slide Time: 30:19)


So, finally, you can say that yes, edible coating can be used to protect the quality of the food, to carry natural antimicrobial compounds, to the functionality of the polymer can improve the protection and the release rate of the immobilized active compounds. Even crosslinking reactions of natural polymers can improve the physic-chemical properties of the films and their stability during a storage period of the packaged food. Even edible active coating could be used in combination with modified atmosphere packaging and

pasteurization treatments to reduce the bacterial growth rates as well as to assure food safety.

So, this edible coating has a very good application in the extending the shelf life of whole fruits and vegetable and many other product and for products it is used commercially.

Thank you very much.