**Nanotechnology in Agriculture**
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**Lecture-35**
**Nanomaterials in food processing and preservation-II**

Welcome back to the lecture series in application of nanotechnology in agriculture. So we are into the section where we are taking about food safety and security and preservation by using the nanomaterial based approach.

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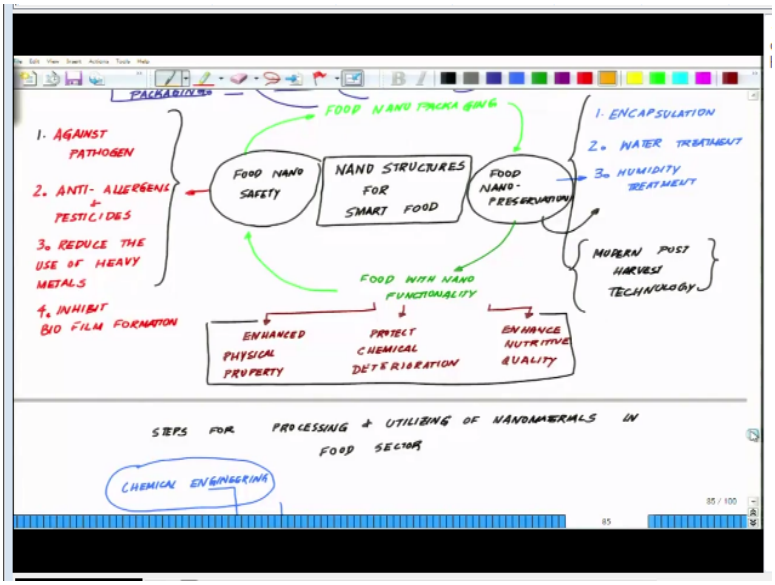


So, in the previous class if you recollect we have talked about the whole net or the applications of nanomaterials in food industry in terms of smart food.

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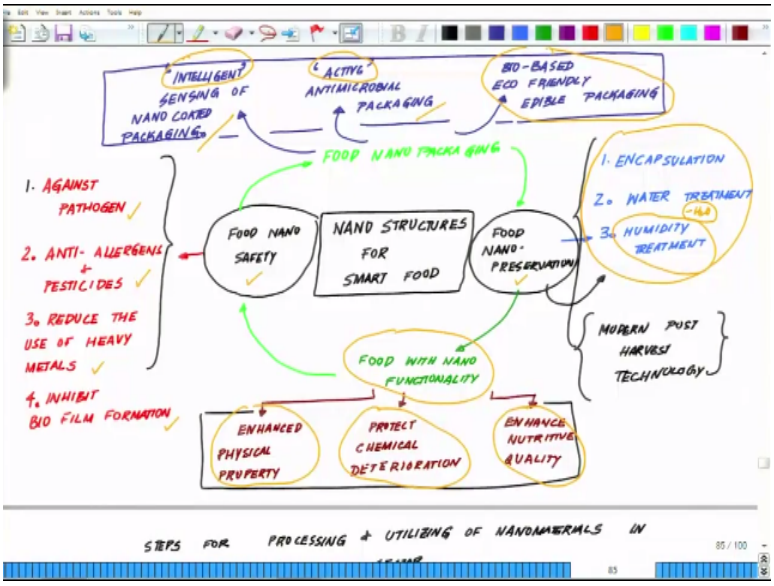


We talked about food nano processing, we talked about food nano safety against pathogen, against allergens, pesticides and reduce the use of heavy metals and inhibit biofilm formation. And how to do this we talked about encapsulating the food, water treatment, so in other word reducing the amount of water and keeping it in optimal water level and humidity treatment at what temperature you are doing without losing the quality of the food.

This is very important that you should not lose the quality of the food and food with nano functionalities when you talked about. We talked about enhance physical property, protection from chemical deterioration, enhance nutritional quality and in terms of food nano packaging, we talked about intelligent sensing of nano coated packaging, active anti-microbial packaging, bio based eco-friendly edible packaging ok, so these are the areas we have already talked.

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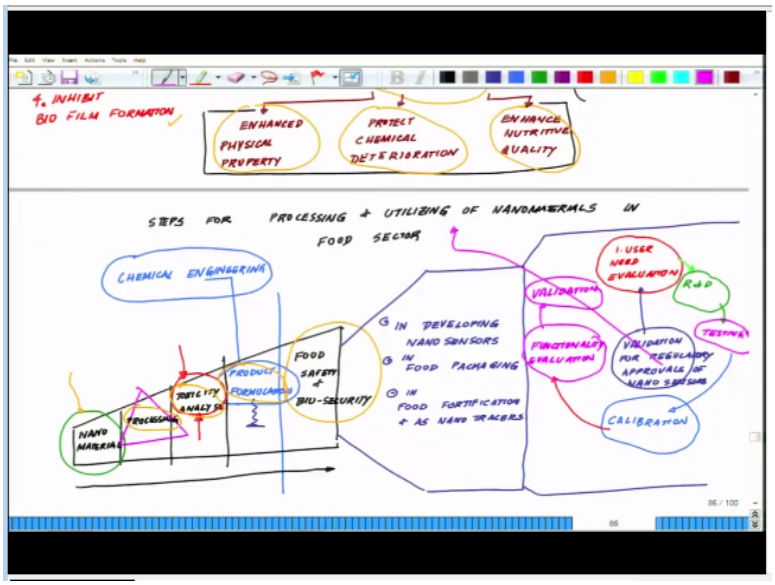


And now we are developing what are the steps for processing at utilization of nanomaterial in the food sector. So we talked about the selection of the nanomaterial if you recollect. We talked about the processing, toxicity analysis, product formulation and food and safety and bio security. Now what are the areas where this whole thing could be used, so the areas includes in developing nano sensors for food applications in developing nano sensors 1 when I take 1.

One critical area for food processing in food packaging and in food fortification and as nano tracers ok. Now when we talk about food fortification this is one area I have not talked to you. So that essentially means that you are supplementing a specific food with some additional functionality, say for example suppose you are having a vegetable, you are fortifying it with say vitamin D.

In a way we you know that particular vegetable or that particular food is consumed by human being. So and you are supplying it to a location where there is deficiency of vitamin D you can supply it with vitamin D in a such a way that a person eats that fruit as well as gets necessary amount of that particular vitamin or similarly for vitamin A or certain minerals ok. So these kind of aspects where we talk about food fortification nanomaterials are coming up as one of the futuristic tools which if you could convert.

Say for example you have converted vitamin D into it is nano formulation, you really can inject them in the food and which people will consume just the same way if you think of iodide salt which was not something it is just you can say 4 decades old possibly. So, iodide salts it is a trace amount of iodine which is added to the salt and which could you know take care of so many problems across the country including (()) (04:57) and all other relative issues which happens in the hilly regions of the country.

So, that is where, so it is not something we are doing out of the world it is already there we are just kind of you know making the spectrum bigger. So ok talking about in developing the nano sensors in food packaging and in food fortifications the areas one has to be careful there are so validation of regulatory approvals of nano sensors. So this is these are the technical aspects whenever we talk about the food industry one has to understand.

So, the central part is the validation, this is the procedure it goes through validation for regulatory approvals of nano sensors, then user need evaluation. So this is all done based on step one which is user need evaluation because one has to first of all understand the need of the user without that and of course acceptance of the user ok.

So the next is the documentation of R and D works research and development which will happened in that area, third one is the testing part whether animal trial, human trial and water level of usage we are talking about, next part is the calibration, post testing at what quantity you wanted to inject or you wanted to introduced it in the food chain ok. Then next come the functionality evaluation ok for the intended purpose, say for example one claims that this particular food is fortified with say vitamin D.

So one has to do a functionality evaluation and then next comes the validation and that is where comes major approval. So this is what a food material goes through in terms of acceptability, in terms of going through the whole basic research in a lab all the way to the industry and then to the end-user. Because one has to realize the 2 areas of nanomaterials but actually is a matter fact all the areas of in a materials has to go through these approval agencies.

Because they can be incorporated into our day to day usage ok, now we will talk about some of the examples where nanomaterial has been used for packaging.

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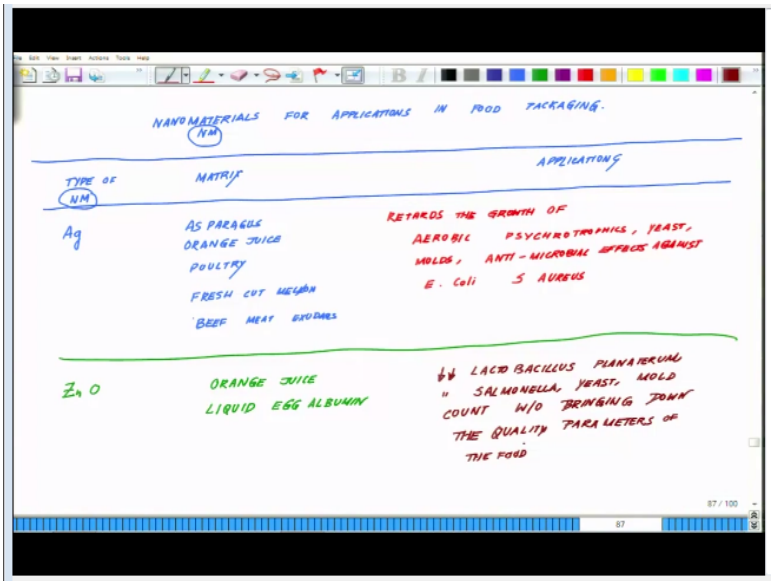


So, let us move on nanomaterials for application in food packaging. So one of the major ones which are being used is, so let us make a table, so that you can identify the function of each one of them, the type of nanomaterial**,** next is the matrix in which is being used, third one is the applications ok. So, first one is silver Ag, so the matrix where it is being used are asparagus, orange juice.

This is the some of the examples using poultry, fresh cut melon you must have all seen the silver foils which is nothing but these kind of packaging ok beef meat exudates beef exudates, orange juice ok. We have already talk about orange juice ok. Now the applications are retards the growth of now this is critical retards the growth of aerobic psychrotrophics ok, next retards the growth of yeast molds and antimicrobial effects against E-coli**.**

And staphylococcus aureus S-aureus, so talking about silver you all must have seen it some point or other in which part of India you are it does not matter wherever there is packaging of sweet which is the common stuff in India. You will see people have been using silver foils for long period of time North India this is fairly common. In South also it is fairly common, West also it is common, East also it is common who taught them to use silver foil.

I always wondered if go to the marriages you will see this laddus coming with little bit of a shining silver who taught them. It is the traditional knowledge which is tribal from generations to generations and today if you ask me we are rediscovering that well what we have learn from our ancestors in a new format nanotechnology. So it is not the nanotechnology something all of us sudden we are like know oh wow we are so smart today.

It was there and it will be there and it is there, so many times whenever I had discussions about nano toxicity and all these things kind of wondered that you know whether you take a grape water, whether we talk about bio chart meat, roasted and barbeques and everything is fairly it is very clear that we have been eating nanomaterials since time in memorial, of course there is some which are exceptionally toxic.

But those are we have never being using them but in food products we have being using nanomaterial or for a long period of time. And here is an example classic examples silver nanomaterials may be using silver but yet whenever it comes to you know oh this is toxic we have been using it right. So the next one we will about is zinc, zinc oxide ZnO, so ZnO has a matrix we talking about orange juice, liquid, egg albumin ok.

Liquid, egg, albumin which is the major protein of the egg and it effectively reduces lactobacillus planetarium and Salmonella yeast mold count without changing. So introduces Salmonella yeast mold count without bringing down the quality parameters of the food. So, zinc oxide, zinc oxide has multiple applications.

Zinc oxide is being used for water purification will be coming later about this just like titanium oxide forted catalytically can split or you can take here of much of the purification of water. But zinc oxides simultaneously can bring down the Salmonella yeast or mold infestation, lactobacillus planetarium and without destroying the quality of the food. So, this is one of the second contender in the food packaging industry ok. The same line if you talk about the third one is titanium oxide and silver oxide ok.

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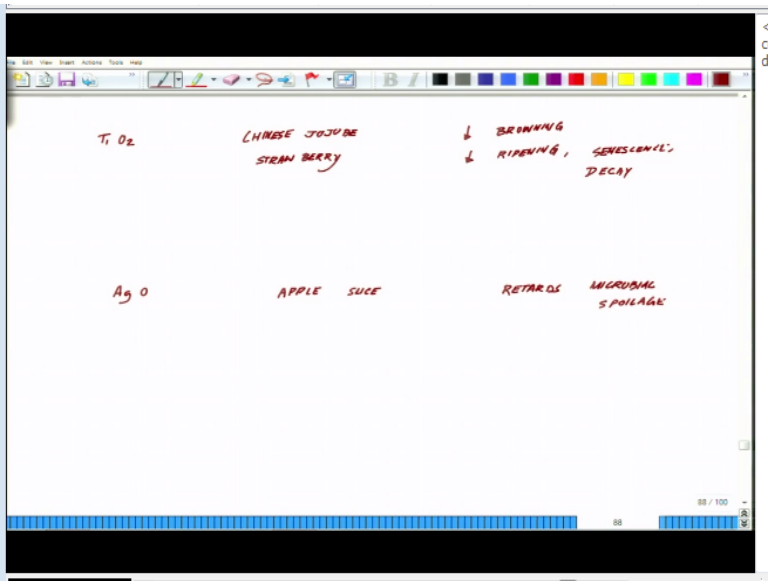


TiO2 titanium oxide and silver oxide, so titanium oxide is used in Chinese Jujube and strawberry as a matrix and strawberry where silver oxide is used in apple suce and titanium oxide reduces browning slow down ripening. So, it reduces browning, slow down ripening, so you can use this as effective packaging material to transport fruits, reduces senescence and the decay where as in case of silver oxide it retards microbial spoilage.

So what I wanted to highlight here is trace amount of titanium oxide or silver oxide could help in ensuring that you can transport these materials at a distance, but then one has to be careful that how to wash these products, correct instructions has to be there and it has to be followed before the consumer uses it, yet there are materials which are pretty benign to the body. They do not affect the body and those could be used without any issues ok.

So, closing here and will prolong this journey subsequently and will talked about water purification by photo catalytic methods and other techniques, thank you.