Novel Technologies for Food Processing and Shelf Life Extension

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Lecture – 55
Functional Foods and Nutraceuticals

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Hello friends in this lecture today we shall study about Functional Foods and Nutraceuticals. You know that the concept about food in earlier days was that we were taking the food as a source of energy and nutrients and the focus was on balanced diet.

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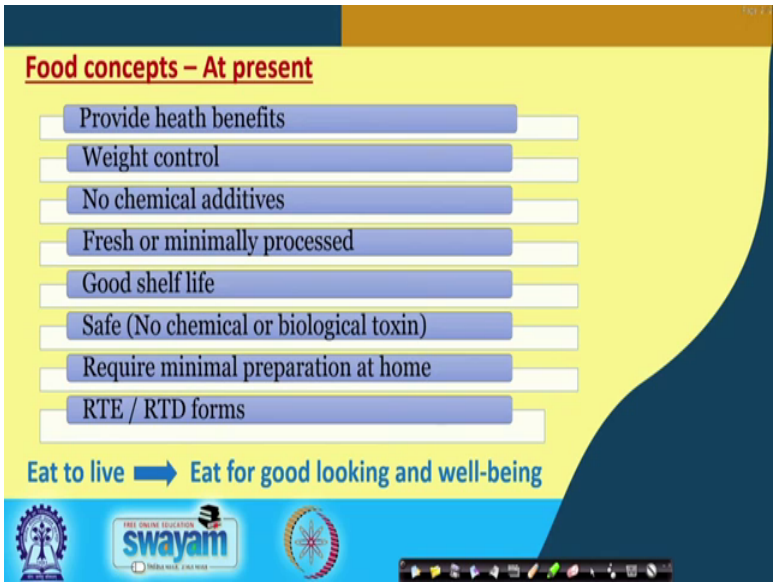

But nowadays at present the food concepts are changing or it has changed in many effects. Now we look the food to provide health benefits. We want to take the food to have a weight control in our body, the food should not have any chemical additives in it our concept about food now is that it should be fresh and it should be minimally processed. It should have good shelf life, it should be safe to consume.

That is it should not contain any chemical or microbiological toxins in it and more importantly it should require minimum preparation at home. So, it means that the food should be in ready to eat form, in ready to drink form etcetera. So, the earlier concept about the food which was eat to live concept now it has changed that eat for good looking and well being.

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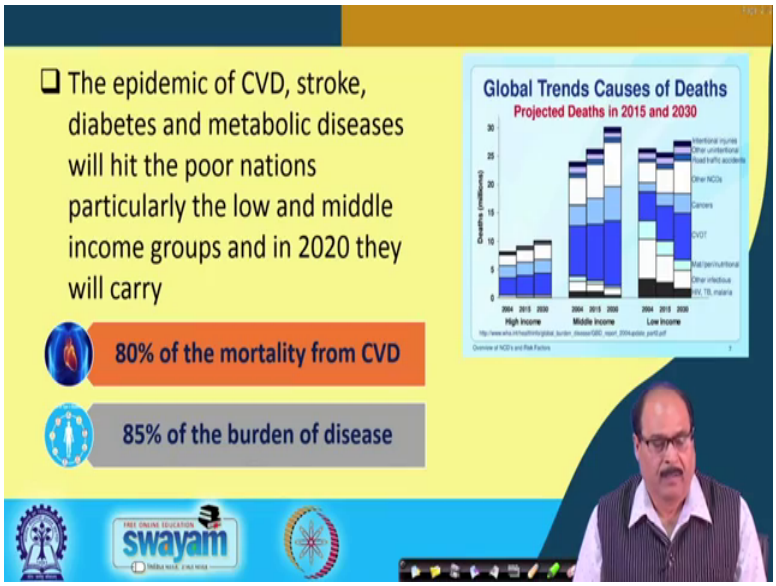

The WHO have reports state that the epidemic of cardiovascular diseases, stroke, diabetes and metabolic diseases will hit the poor nations particularly the low and middle income groups. And in the year or by the year 2020 they will carry 80 percent of the mortality from cardiovascular diseases, 85 percent of the burden of diseases.

In this bar diagram I have taken the material from the literature to show you how the high-income group, middle group or low income group their deaths are affected by various diseases in different nations.

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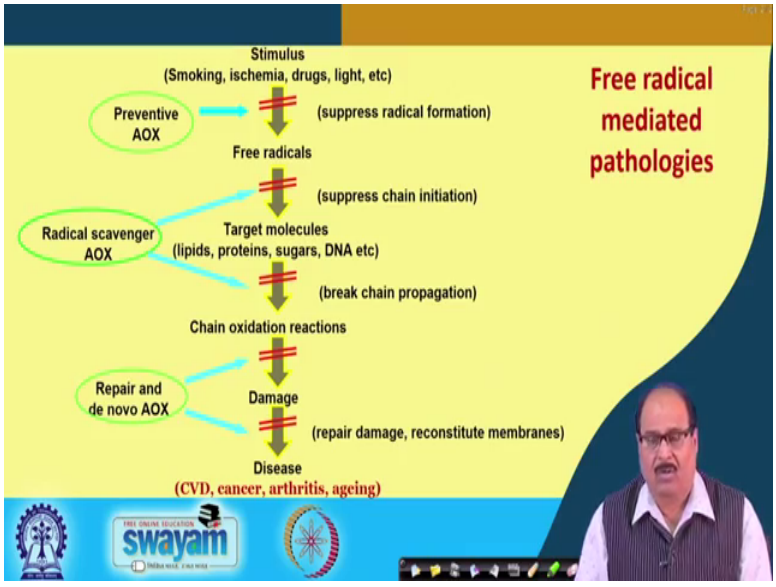

So, what happens when our body gets exposure to various stimulating agents like smoking, ischemia, drugs, light, UV radiation and we come across sun lights sunlight has UV radiation and etcetera. So, all these stimulants they cause generation of free radicals in the body and these free radicals if they are not taken care of they will start that is initiate the chain reaction alright. They will target molecules, they will attack the target molecules like lipids, proteins, sugar DNA etcetera in the body.

And the chain oxidation reaction will progress proceed, it will propagate and ultimately it will dictate the process of those target molecule and their functioning normal functioning get affected or it the target molecules get damaged which ultimately is finally, manifested in terms of various diseases like cardiovascular diseases, cancer, arthritis, ageing etcetera.

So, this is considered that free radical mediated pathologies; however, there are different remedial measures like antioxidants are there in earlier classes, we have we studied that what is the role of antioxidants. So, these antioxidants there are different types like preventive antioxidants, radical scavenger antioxidants or repair and de novo antioxidants.

So, they can be used at any stage in the process either to suppress the radical formation itself in the beginning itself or that radically scavenger antioxidants such they can suppress the chain reaction or finally, repair and de novo antioxidant. They can cause some they can repair some of the damage or reconstitute membranes etcetera.

So, here when we talk about functional foods or nutraceutical or health food. So, it is that preventive antioxidants in the next slide I will show you that these antioxidants and other bio two molecules which are present in naturally in the food. So, in the form of food we provide them these bio actives or antioxidants or other such components health promoting factors so that they will not allow these free radicals etcetera. They have to take a true progress or proceed their action further and manifest into diseases. So, that is the concept you can say in the health food etcetera.

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So, in this list I have provided the some of the antioxidants which are present in naturally which are present in the various foods which we eat daily like vitamin A, vitamin C, vitamin E, zinc, selenium. And is it a vitamin A is available in the that is a carotenoids etcetera, they are precursors of vitamin A, they are available in the most of their yellow colour fruits and vegetable vitamin C in all citrus fruits vitamin E tocopherals.

So, they are the point is which I want to make it that is the food which we consume they have all these bio actives and but earlier in our earlier days the focus during processing and other methods it was not that returns are not these bioactive returns are up these. And these antioxidants were not our focus, as I told you in earlier slide that focus was just how to get some guide and balance to meet the requirements of the body.

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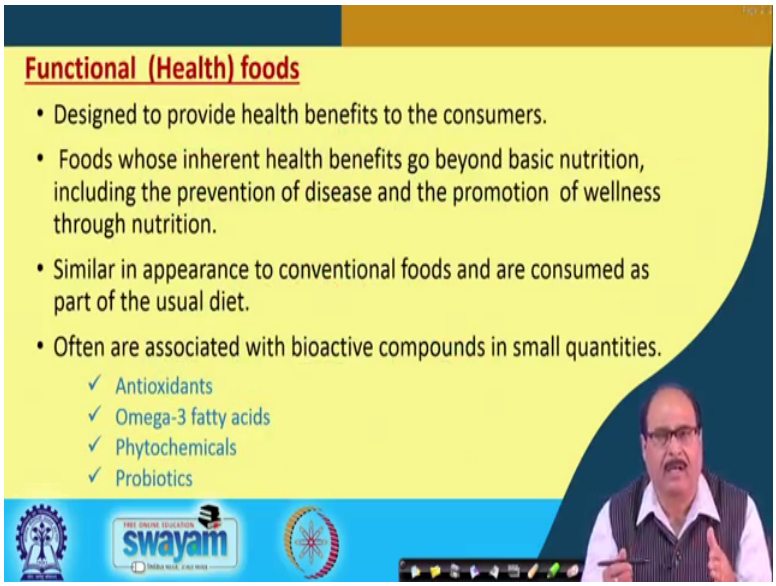

But that focus has now changed by my I will tell you that is the functional food or health food that these antioxidants are that these various other bio actives which are present in the food like omega-3 fatty acid, phytochemicals, probiotics etcetera. So, they are manipulated in such a way that they are managed in the food, it is basically you can say functional food development is the management of these bio actives in the food during processing and other by processing or by such other methodologies and technologies and accordingly the food is designed to provide health benefits to the consumer.

So, these are you can say functional foods which whose inherent health benefits go beyond basic nutrition alright that is including the prevention of diseases and the promotion of wellness through nutrition. So, the foods, functional foods are those foods which provide health benefits of course, they provide the nutrients needed by the body, but their function their effect in the body goes beyond this normal nutrition that is they also provide health benefits ok.

And these functional foods are similar in appearance to conventional foods are and they are consumed as a part of their usual diet. I will tell you in the next slide that is yes how they can be made and what are the different ok.

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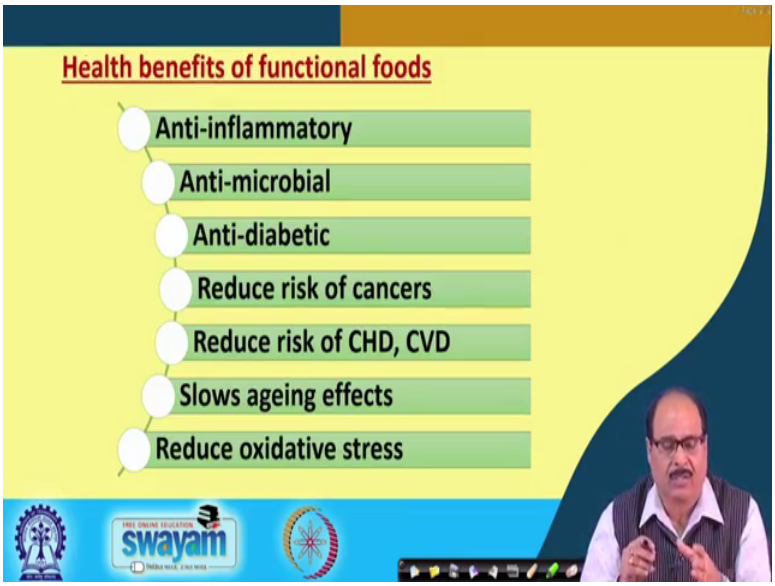

So, the functional foods; in fact, a by manipulating by proper management of those bio actives and antioxidant which I showed you in the earlier slide the food can be developed to have to provide a specific functions to have a specific function. Like it can be anti inflammatory food, anti microbial food, anti diabetic food which can reduce the risk of cancers which can reduce the risk of coronary heart disease, or cardiovascular diseases which slows the ageing effect the food, which slows the ageing effect which reduces oxidative stress. And accordingly even various foods claiming such functional benefits are available now in the markets ok.

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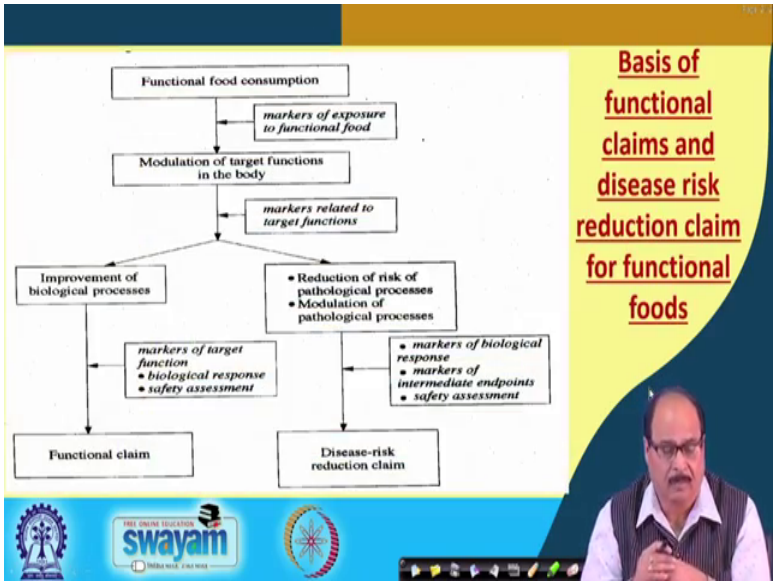

Now this hot basics of functional claim and these risk reduction claim of functional foods that in fact, any the food which we consume that is it has some marker of exposure to functional food. There should be that is that functional that particular food has certain bio active components or has some that is a element in it alright which has some desired a targeted effect.

So, that is the you decide that what is that marker that exposure and then that is a these markers actually result into the modulus and have the target functions in the body alright. So, there are so what is that marker for that have functional and how it modulates the body processes in the body that is to be studied properly understood and then that is the modulation it may result in to the improvement of the biological process or it may result into the reduction of risk of pathological process, or modulation of the pathological process ok.

Categorically there is there may be if for the improvement of the biological process there had to be marker or the target functions like biological response and safety assessment need to be done for the reduction of risk of pathological process or modulation of a pathological process. There one has to identify the markers for biological response, markers for intermediate endpoints or marker for safety assessment etcetera. So, on the basis of this data generated as results one can have a functional claim like improvement of biological process or one can have a disease reduction claim in the food as the case may be.

But any claim which is a as is made on the food it should be on the basis of certain sportive evidences maybe clinical studies or such other study and this should confirm to the regulations prevailing in those lessons.

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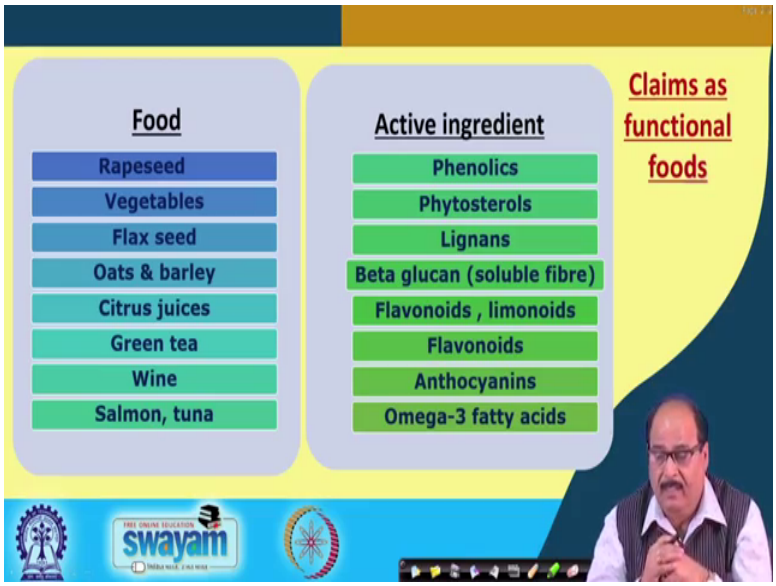

So, that is the as I told you that these most of the food which we eat they have certain active ingredient that can be taken as a basis for a finalizing of or the making the functional claims. For example, in the rapeseed the phenolics; phenolics with there is they have very good antioxidant potential or such other health promoting functions.

So, they can be taken as a marker for the claiming the functionality of the foods which has a rapeseed ilr such other ingredient in vegetables phytosterols, lignans in flax seed beta glucan which is soluble fiber in oats and barley flavonoids, limonoids etcetera in citrus juices flavonoids in the green tea anthocyanins in wine or omega-3 fatty acids in salmon trees tuna peas etcetera. So, these active ingredients can be used as a basis for the or to make the their content in the their activity in the food can be used to make the functional claim.

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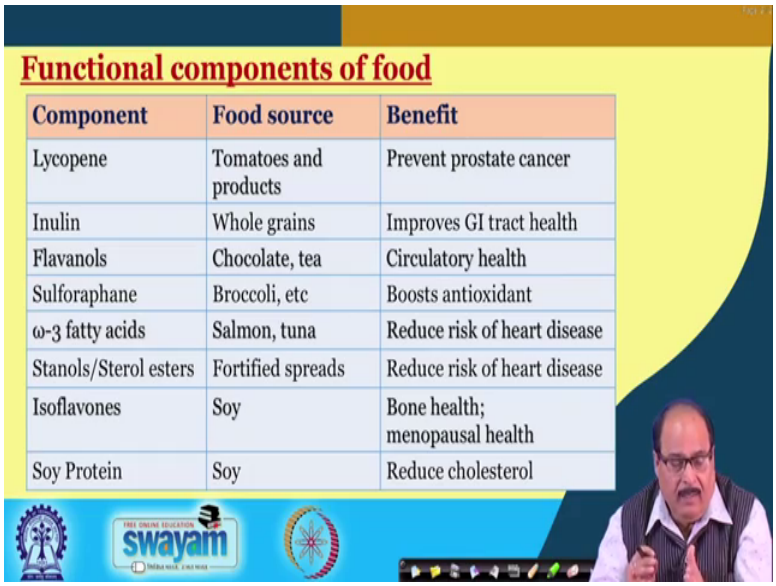

So, further you will see that I take that the certain component which are present in the food sources and the benefits health benefit their out of this if you see the lycopene. So, tomato products we use daily in various culinary preparations in our daily diet we use tomato and tomato products. So, they are good source of lycopene, but a lycopene is now known to prevent prostate cancers, but only thing is that is when this tomatoes that is they should be lukewarm heated so, that the this beneficial effect of lycopene is more pronounced right.

So, similarly in whole grains inulin's are there flavonoids are there in the chocolate or tea and they are important in improving gastro intestinal tract health that whole grain inulin's are chocolate, tea, flavanols they improve or they provide health benefit as far as the circulatory health is concerned. Then similarly omega-3 fatty acids reduce the risk of heart diseases stanols, sterol esters etcetera in the fortified spreads they are found, they reduce the risk of heart diseases.

Isoflavonols or proteins in soya beans they are now known to have benefits against the bone health menopausal health or they reduce the risk of the cholesterol. So, they when the foods containing this tomato, whole grain, chocolate etcetera when they are consumed and when they are processed the processing parameter and other processing technologies should be used in such a manner so that the health promoting functions of the health promoting activities are functionalities of these bioactives in a improved or if

at not improved at least it should not be reduced during processing that care need to be taken. So, it should remain intact.

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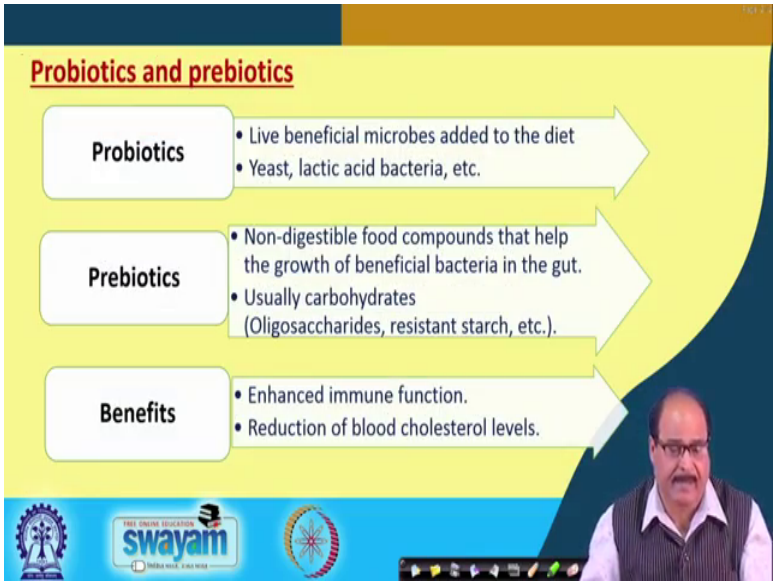

Like prebiotics and probiotics are an important agents in this regard like probiotics are live beneficial microbes added to the diet and the yeast the lactic acid bacteria that is in many yogurt etcetera that is a thermophiles group of bacteria, lactobacillus, planetarium etcetera which have beneficial effect. And that is the for like dairy products etcetera or such other products they which have the probiotic and to claim their beneficial effect at least 10 to the power 7 or more than that live bacteria should be present there. And they should go inside that intestine of the stomach and that is necessary for providing this health benefit regulation of the body process and immune improvement in the human functions.

Similarly prebiotics or non-digestible components that help the growth of beneficial bacteria in the gut, they are usually carbohydrate, oligosaccharides, resistant starch etcetera and the benefits as I told you that they private prebiotics have enhanced among functions and reduction in food cholesterol level.

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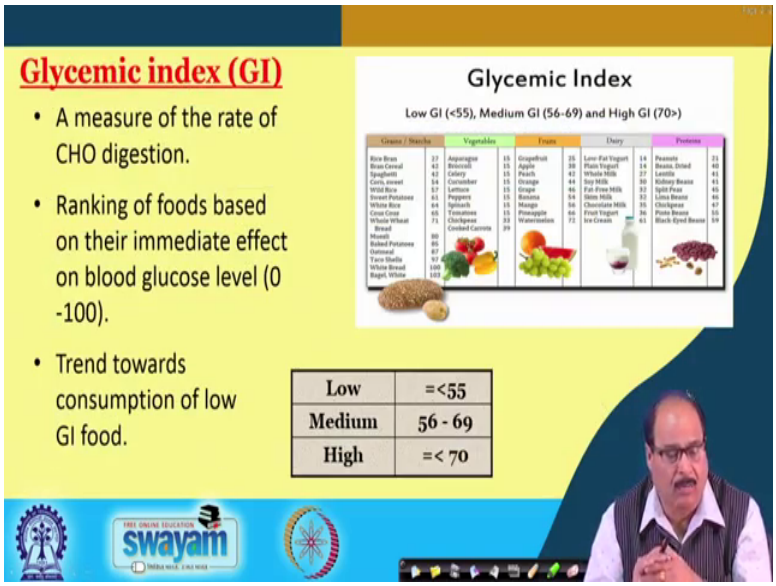

Glycemic Index GI is a measure of the rate of carbohydrate digestion and ranking of food based on their immediate effect on the blood glucose level, there is and there are now trends towards the consumption of low GI food. Low is considered when this GI glycemic index is equal to or less than 55, that is 56 to 69 is considered as medium GI food.

And the food containing GI more than 70 are considered a high GI food and in this slide this table I have taken the data from the literature to show you that is the different foods, various food which we eat daily their GI level.

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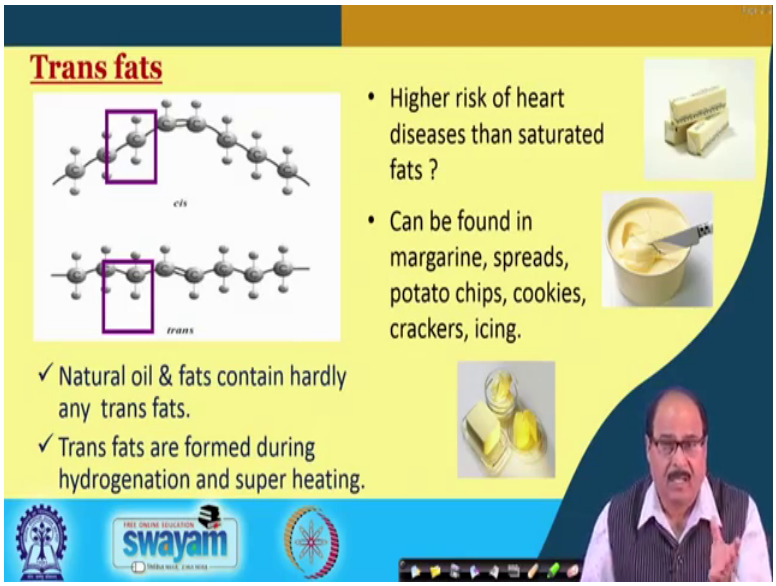

Similarly another very very important component is the trans fats, you can see in the figure here that is most of the vegetable oil they have these unsaturated fatty acids alright. That is the unsaturated fatty acid polyunsaturated fatty acids etcetera and this unsaturation fatty acid it is in fact, beneficial from the health point of view.

So, natural fats and oil there the these polyunsaturated fatty acid you can see the there are they are on the in the cis position alright, that is in the cis position you can see on the level 1 h is on the same side. But when these vegetables oils either during the refining their refining, or during hydrogenation or such other any process even during processing frying up resonance etcetera when these oils are given heat treatment then this cis form is converted into trans form.

You can see that that they come to the opposite directions that is and this trans form is rather more harmful than the cis form. Because they are not removed from the body, they get accumulated and their deposition in the body select or un creates CSD CBD and such other problems. So, they told you they are higher risk of heart diseases are posed by from this transfer it rather than those from the saturated fat saturated fat also have problem, but transfers pose more problem.

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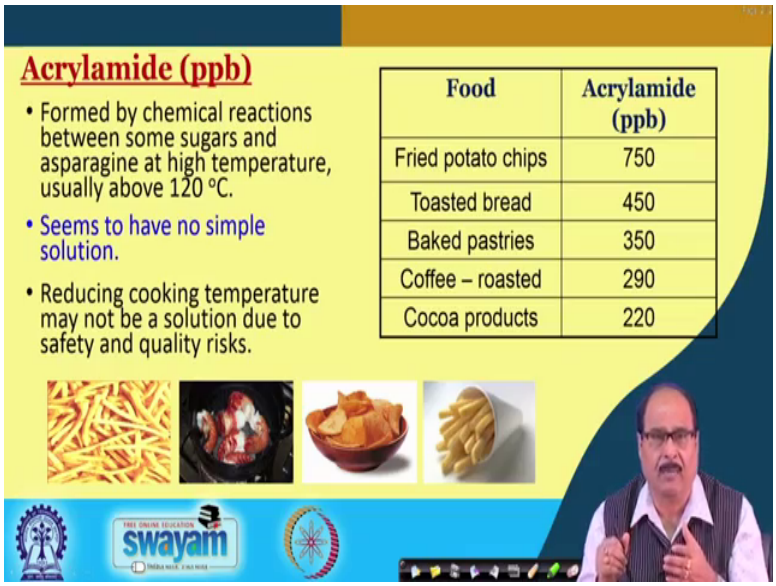

And the foods like margarine, spreads, potato chips, cookies, crackers etcetera they contain substantial amount of that is the trans fat. Acrylamide is another chemical which is formed by chemical reactions between some sugar like asparagine at high temperature which is usually above 120 degrees Celsius.

So, when the food containing this reducing sugar and I mean they are processed, heated then this acrylamide etcetera is formed. And it is a, that is a in fact, it is a you know problem does not have easy solutions of course, by having novel non thermal technology I brought by processing at a lower temperature, but ensuring the safety of the process would.

Because, if you reduce process at a lower temperature the food safety may be an issue, quality risk might be there. So, that has to be taken care of I have given you that is in this table that is a fried potato chips some time contains as high as 750 ppb acrylamide right, the toasted bread, baked pastries, coffee, roasted coffee, cocoa products they all have significant amount of acrylamide.

So, that we will so such products when they are processed the processing parameters should be taken care into such a manner so that there this acrylamide etcetera is that.

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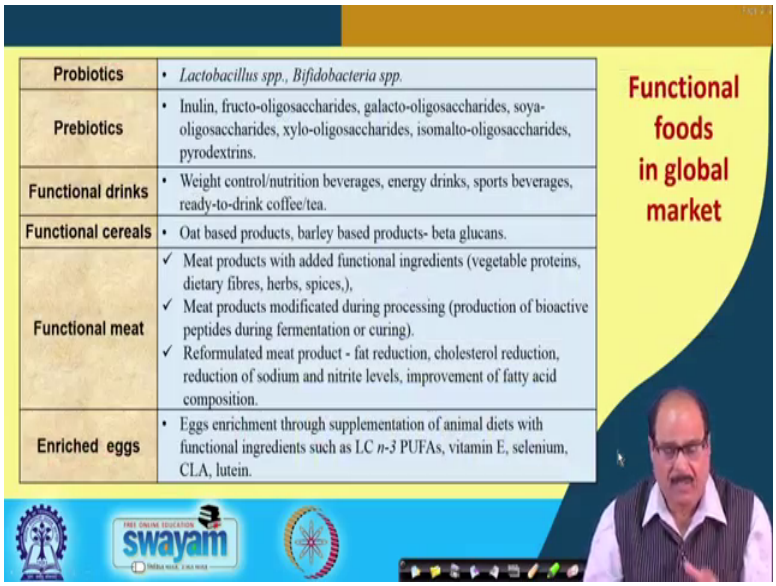

So, the in this list that is it provides some of the functional foods which are available in the global market like a probiotics, prebiotics, functional drinks that is the whole weight control drink, nutrition beverages, energy drinks etcetera. Functional cereals which are made from oat based products barley based products functional meat, that is the meat products with added functional ingredients like vegetable proteins, dietary fibers, herbs, spices etcetera. Or the meat product modificated during processing like products on a bio actives peptides during fermentation or curing are reformulated meat products like the fat reduction low fat meat products low cholesterol meat products are even reduction of sodium or nitrite levels etcetera.

So, different types of we are even in this egg are also available in the market which has a functional benefit like egg enrichment through supplementation of animal diets with functional ingredients such as LC n-3, PUFAs or vitamin E, selenium etcetera.

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So, the as far as the technology of the formulation and processing of the functional food is concerned that is the approach is that, they are processed by modification that is a particular food maybe made more functional by increasing or adding a potential health promoting entity.

Alternatively the concentration of adverse components maybe reduced or there will be a partial interchange between the toxic and beneficial ingredients and using this concept many foods functional foods are formulated, new functional foods are developed or the foods their functionality like you can see the gluten free products local stall products or healthy heart etcetera.

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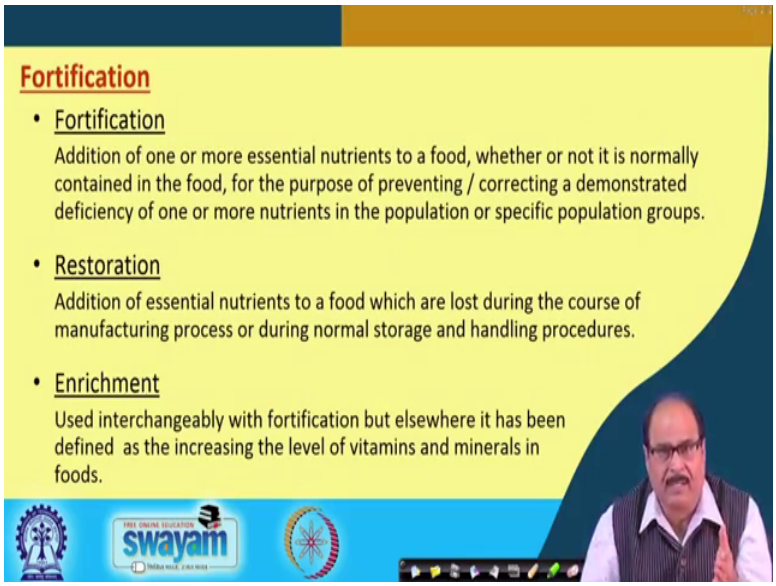

So, there are many the fortification in the food fortification we studied there is a fortification, restoration, enrichment technology etcetera processes they can be used for preparation of the functional food.

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Microencapsulation and also we have studied it in detail the about the technology of microencapsulation where you can do so in this there is the one very very interesting application of this micro encapsulation technology for is for making functional milk, that is health heart plus that is in general the milk contains mostly saturated fatty acids.

They do not contain omega-3 or omega-6 fatty acids, these omega-3 or omega-6 fatty acids they are present in fish like a fish, like cod liver oil or tuna fish etcetera. So, if these oils are these omega-3 fatty acid extracted from these fish sources are such as the like even vegetable source of (Refer Time: 23:31) etcetera. So, they have a strong flavor. So, if they are added as such into the milk in order to make the milk more heart friendly right.

So, it the flavor of the omega-3 fatty acids interfered with the flavour of the natural flavour of the milk the milk becomes may have fishy flavour or there is a seed flavour like that. So, this is the encapsulation technology like these omega-3 fatty acids are they can be taken and is a suitable liquefied encapsulant is taken and the material it is encapsulated and right. So, you have that encapsulated micro encapsulated see microcapsules that is containing omega-3 fatty acids and it can be put without any in the milk it will not dissolve in the milk, but when you consume that milk it will get dissolved in the material that is in capsulant and can be selected in such a way.

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So, that is the micro encapsulation technology can be used. Similarly that is probiotic vegetable beverage with anti-diabetic potential it is a functional probiotic beverages. Beverage this is the experiment and the basis of our laboratory; in our laboratory we have developed a work bottle gourd and then carrot and bitter gourd juices mixed in proper proportion. And they were inoculated with a probiotic bacteria like lactobacillus

planetarium and other bacteria also we have used we have a standardized process and our study indicated that these probiotic bacteria they can grow well in the vegetable juices.

So, these are the probiotic vegetable juices that is using prepared using fermentation technology that is after inoculating the juice mixture of the juice with these micro organism in a controlled fermentation chamber they are provided with all the needed. So, this growth these so, these vegetable juice they have the light bacteria probiotic bacteria in it and they can be consumed they have very good colour and flavor as you can see here.

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So, regarding the study design to assess the functional foods that you say that yes this functional food for which group that is what is that target function on the first one need to decide that is like whether it is food for diabetic person, food for CSD person, food for weight gain or food for any such other purpose.

So, we decide that what is the function of functional claim then what is the consumption and intake of these foods regular or by the masses etcetera that data should also be taken. Then you take that normal material what are the biomarkers that is which you can I already told you earlier. So, this would be process and finally, their effect actual effect by clinically studied one should a study, that yes how really it is a performing the function.

So, the food or food components would be characterized minimal doses should be defined, mechanism of action of this bio active or bio marker is useful, but it is not very very essential to understand. But you have its effect should properly be studied alright, the it should comply with the existing regulations, safety, stability of the functional foods that is a should also be taken into consideration. So, while designing the functional food development and more importantly the interactions for instance say food with added minerals might be eaten with high fiber or phytate foods where lowering its by availability etcetera.

How will the cooking affect is that is these various bio actives their functionalities etcetera how they sustained, how different processing conditions influence that also we study. How will the storage affects and more importantly the organoleptic properties that is the it should be allied by the consumer it should not from the natural food it should not deviate too much that is the consumer do not like. So, you have a functional food, but if you did not like they are going to have the qualities are not good. So, it will not within the market.

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Regarding the functional food research there is there are 3 types that is one type of group of food where there is are where there is a strong evidence and there may be moderate evidence and low evidence. So, under (Refer Time: 28:31) for example, is strong evidence there is a substantial scientific agreement of a diet disease relationship. And

obviously, this has to be supported by clinical trials examples of this category include fortified margarines where sterols and stenols are have been proven several studies have been conducted in this regard and they are now alone to provide this benefits.

Similarly, while I am in soluble fiber, soya beans, whole oat products, fatty fish omega-3 fatty acids etcetera. The moderate evidence include that is there is a scientific evidence supporting the diet disease relationship, but it may not be conclusive. Example in this case catechins in the green tea it is known, but it is not very very clearly understood this its effect we say that yes it reduces the risk of certain types of concepts like lycopene in tomato it reduces the prostate cancer probiotics and dairy product support gastrointestinal tract.

But there are many more to understand to study in these affects in these cases no evidence of some scientific evidence suggests a relationship, but it is a limited or not conclusive like garlic, reduction of total cholesterol or LDL cholesterol level that is it is a people know that it is a drug that if you take garlic that is total cholesterol or LDL cholesterol level is reduced not much evidence is there. So, this needs to be asserted.

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So, there is one very very important aspects in functional foods alright and the regulations of the functional food with many developed country European countries and many other countries they have clearly defined the various regulations related to like a

regulation EU number 1169 of 2011 it is under provision of food information to consumers.

Similarly, another regulation by EC, there are an addition of essential nutrients to food, foods harmonizes the provisions let down in member states which relate to the addition of vitamins and minerals and of certain other substances to food. EC number 1924 up to 2006 is on the nutritional and health claims made on foods, EU regulation number 432 up to 012 establishes a list of permitted health claims made on food. Other than those referring to the reduction of disease risk and to children development and health.

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Similarly, directive 2009 of 39 of EC European commission and general rules of food for particular nutritional uses. Regulation number 609 up to 3, 2013 on food intended for infants and young children, foods for a special medical purposes and total diet replacement for weight control etcetera.

So, in this regard the European union European commission in such other many other countries they have clear cut guidelines and clear cut regulations and as far as the formulation, processing and sale of the functional food is concerned and also the claim for the functional food that is any manufacturer if they write that level and claim that their health of benefits etcetera.

So, they so there should be some evidence like a for a dairy beverage I told you to claim that they are probiotic at least this should have 10 to the power saving life probiotic bacteria in it at the time of consumption. So, this like type there are several regulations in India also, there is this a lot of work is being done in this regard by FSSAI that is the it is still on the development stage alright.

But in some cases it has in progressed and some guidelines have been formulated and made alright. And in fact, the FSSAI that is the definitions of the what is the food functional food in the Indian context right, is been decided or defined by the food safety and standards 30 of India and it is listed under content.

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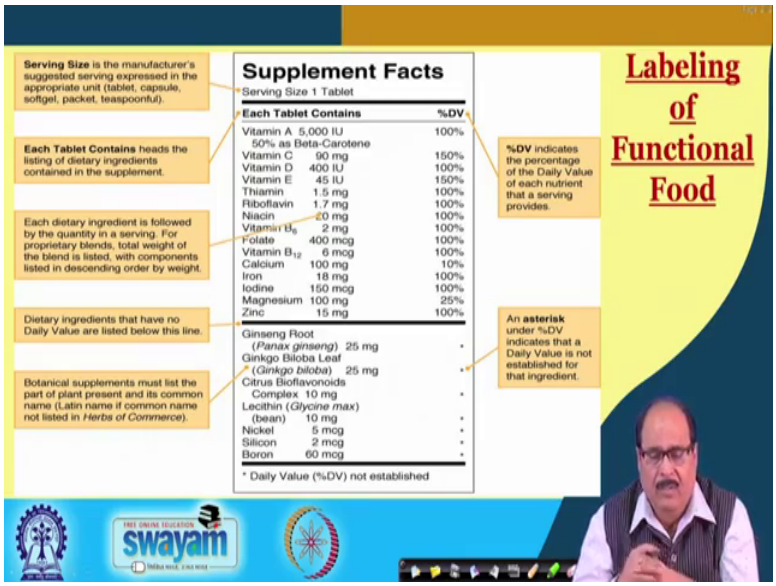

So, another very very important aspect is the leveling of the functional food that is again this is governed by the different nations in different nations regulations are may be provided that is these food or their functional claim, that is their components that is like the product or what does it contain each tablet the functional food tablet or each capsule of the functional food or per 100 gram of the functional food.

It contains these are the various components alright and what is the that is the also what is it serving size it should also be labeled that is this food functional food should be consumed 100 gram per day or 200 gram per day or 1 tablet of 50 gram per day like that depending upon the type of the food or functional claim.

So, that should be clearly provided on the level and also that is as far as it should be provided what is the percent DV that is the if percentage of the daily value of the each of the nutrient which is provided by this per serving of the functional foods. So, all these things are so there might be some ingredient which do not have a dB so that also can be indicated. So, of course, the leveling so they conform to the prevailing regulations of that particular country.

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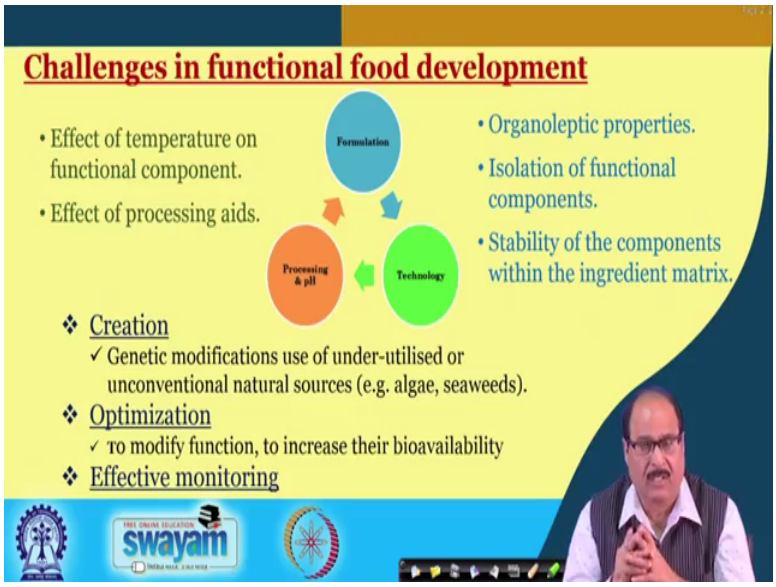

So, this I think we have you have got, but there are certain in the functional food development there are certain challenges that people make any claim, but really whether that claim is established or not that has to be seen. So, both by appropriate formulation, proper technology and proper processing and packaging etcetera manipulation of the ingredient that the claim per claim functional claim to be a certain.

And also there is a what is the effect of process parameter as I told you earlier many a time certain several processing is like enzymes etcetera are added. So, how these processing parameters temperature or ultra violet radiations or such as are the processing aids, how they interact this influence the functionalities of these components etcetera and that is a it should be taken into consideration and properly well-defined alright.

So, genetic modification that is the creation will be genetic modification and modifications you job underutilized or unconventional natural sources like algae, seaweeds etcetera they may be used for the preparation of or for development of

functional foods. And of course, the all the processes that is the optimized processes should be properly optimized and this optimization may be at laboratory scale and pilot scale and finally, commercially scale.

And the optimization should be done on the basis of that is the parameters should be such that the functionality alright and also the bio availability of those bio active components it should be increased alright or if not at least it should not decrease. So, during processing this and for all this proper monitoring must be taken.

So, and the another important in this I already directed that organoleptic properties, isolation of functional components, stability of the component within the ingredient matrix during the storage etcetera all this becomes important aspects to this functional food development. So, with this I thank you very much for your patience.

Thank you.