Novel Technologies for Food Processing and Shelf Life Extension

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Lecture - 50
Food Fortification

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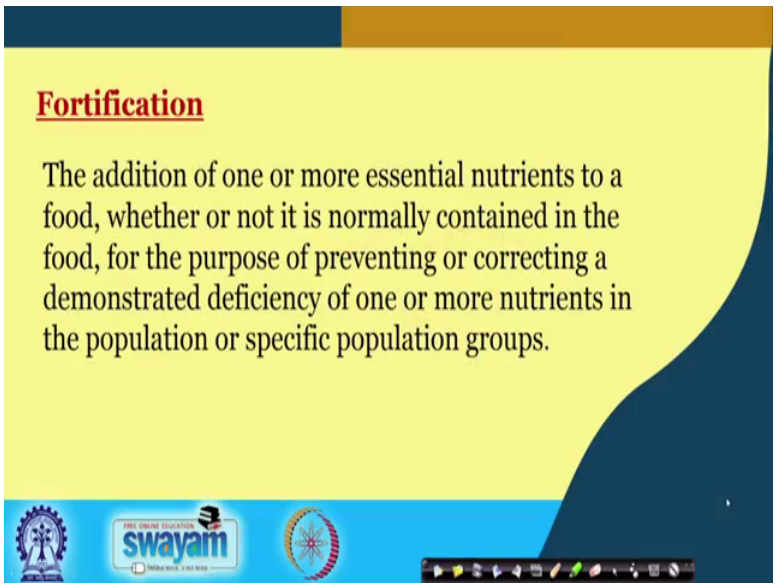

Hello everybody. Today, we will study a very important topic in food processing, particularly from the point of view of nutrition and health, and that is food fortification. Fortification let us see, what do you mean by fortification? Actually, the addition of one or essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or a specific population groups.

So, in general we can say is the fortification is the increase of a level of particular nutrient or group of nutrients, particularly micro nutrients in food material to tackle some nutrition related issues.

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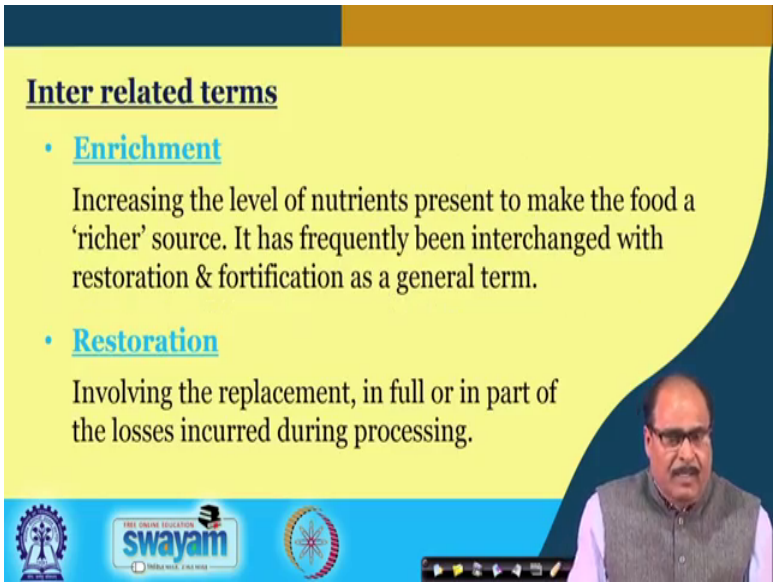

There are some interrelated term in fortification like enrichment, restoration etcetera. Enrichment is the increasing the level of nutrients present to make the food a richer source. It has frequently been interchanged with the restoration and fortification as a general terms. So, in most of these processes, they are interrelated to each other, but there may not be very very clear cut differentiation, but for general understanding. So, enrichment like you see that by vitamin that vanaspati enriched with vitamin A. So, here the level of a particular nutrient is raised to the desired concentration, and normally this enrichment programs are controlled by governmental agencies and regulations.

Restoration involves the replacement, in full are in part of the losses incurred during processing, you can take understand from the term restoration is (Refer Time: 02:46) like when we heat or thermal process or concentrate orange juices or citrus juice is used in thermal processing, some of the nutrients particularly vitamin C etcetera, get lost destroyed. So, after the processing, that is the ascorbic acid or vitamin C from other some other natural sources can be added into it to make up the loss that was done during the processing.

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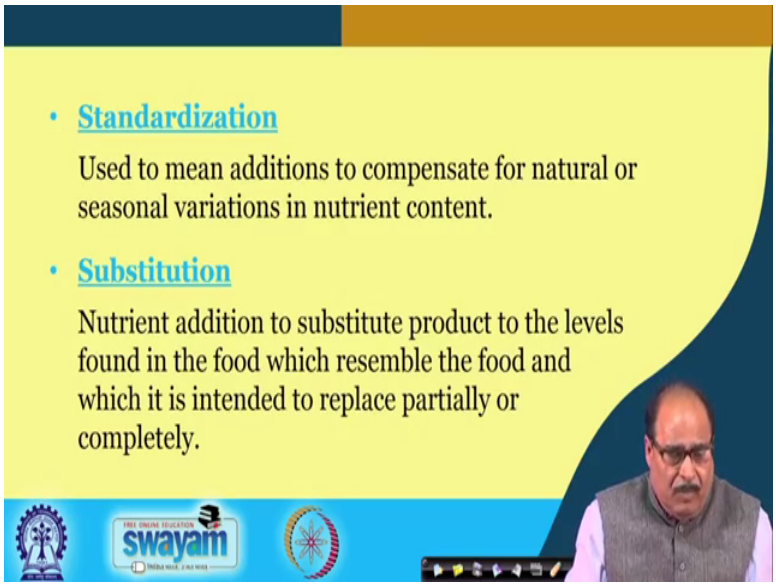

Similarly, standardization; this term is used to mean additions to compensate for natural or seasonal variations in the nutrient composition. Substitution is another term which means nutrient addition to substitute product to the levels found in the food which resembles the food and which it is intended to replace partially or completely. So, these are the some of the term terminologies which you may come across in the literatures, when you read food fortification.

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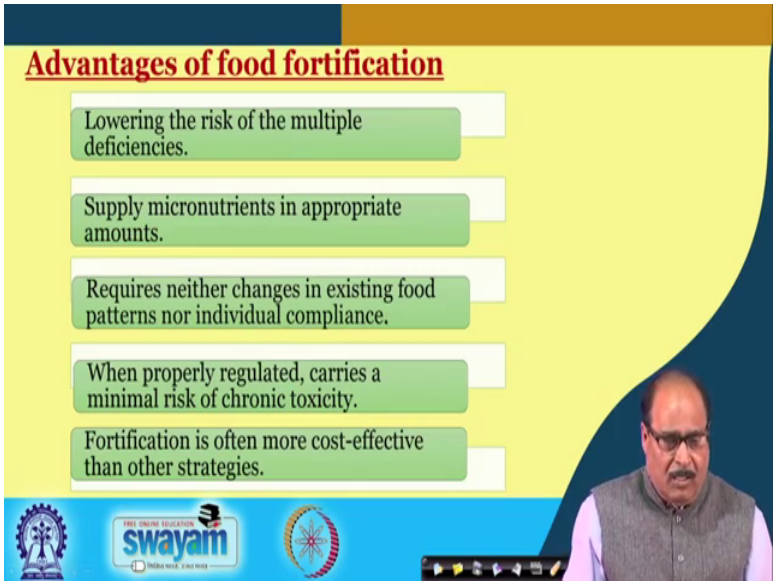

The advantages of the food fortification programs include lowering the risk of the multiple deficiencies. Supply of micronutrients in appropriate amounts that it requires neither change in existing food patterns nor individual compliance. When properly regulated, the fortified food carries a minimal risk of chronic deficiency or chronic toxicity. Fortification is often more cost-effective than other strategies for improving the nutrients content in food.

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The fortified foods are characterized by certain properties that is there should be commonly consumed by the target population and linked to energy intake. Fortified food should have a constant consumption pattern with low risk of excess consumption. They should have a good stability during storage. Be relatively low in cost. They should be carefully processed with minimal stratification of the fortificants. They should have no interaction between the fortificant and the carrier material. And it should be contained in most meals with availability and related to socio-economic status.

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Different fortification programs, which run in the countries various agencies various countries, it may be mass fortification program, targeted fortification program or market driven fortification program.

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The mass fortification program is the addition of one or more micronutrients to staple force consumed by the population that has an unacceptable public health risk of being deficient in certain micronutrient or the micronutrients which are added in that particular fortified foods. Examples of this program are food fortification with iron folic acid or we

have iodised salt. Salt is a fortified with iodine. These mass fortification programs are usually led by governments, but voluntary are mandatory also. It reaches all sections of the population including the most one which are at risk or even the group of the people which are at risk.

However, the mass fortification program has certain disadvantages at time is it now if not conducted properly, like it might result into the population or people taking or possibility of taking excess intake of the nutrients, if the intake is not properly regulated. There may be potential negative health consequences, if the program is not well control or additional cost of the micronutrient premix might be required. So, it will little bit increase the cost of the material.

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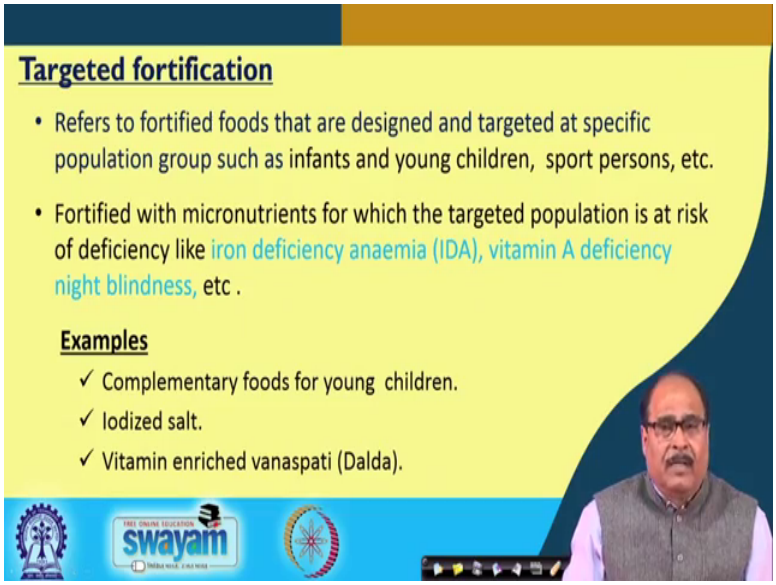

The targeted fortification refers to fortify foods that are designed and targeted at a specific population group such as infants young children, sport persons, etcetera. So, in this type of foods that the micro nutrient which are required by those targeted populations majorly are fortified or they are level is increased by one other that means, the fortified with the micro nutrient for which the targeted population is at risk of deficiency, for example iron deficiency anaemia.

So, for those people which are which suffer from anaemia that is iron, folic acid, etcetera can be added. Similarly, vitamin A deficiency that is a which leads to the night blindness disease so, the food as I told you that Vanaspati, dalda. This is enriched dalda added with

vitamin A to take care of this problem. The examples of targeted fortification include complementary food for young children, iodized salt, vitamin enriched Vanaspati or dalda.

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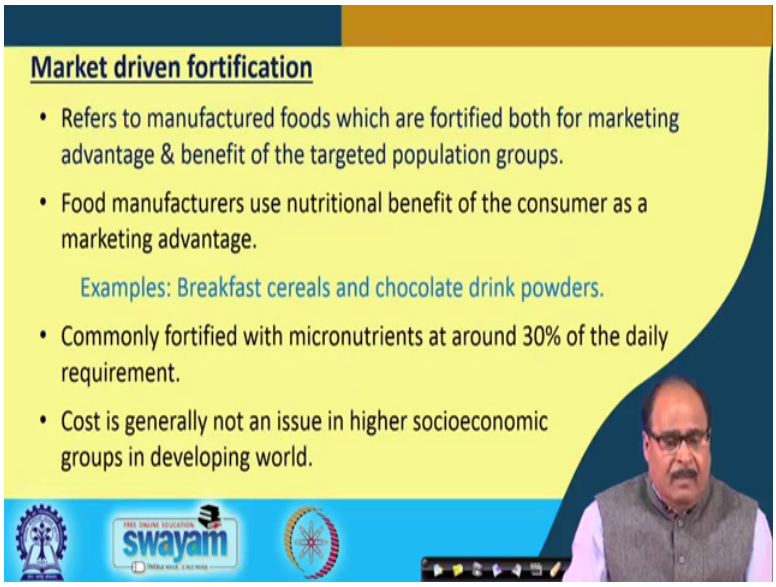

The other type of fortification program is the market driven fortification. And this refers to the manufactured foods, which are fortified both for marketing advantages, and benefits of the targeted population group. Food manufacturers use nutritional benefits of the consumers as a market advantage. For example, breakfast cereal chocolate drink powders and such other products, where there is a for particular taste particular micronutrient, whether the consumer like that.

So, these manufacturers, they try to add those micronutrients. And enrich the food or increase the nutritional value, so that the consumer get attracted with those fortified foods. These foods are commonly fortified with micronutrients at around 30 percent of the daily requirement in this case. And the cost is generally not an issue in higher socio economic groups in developing world.

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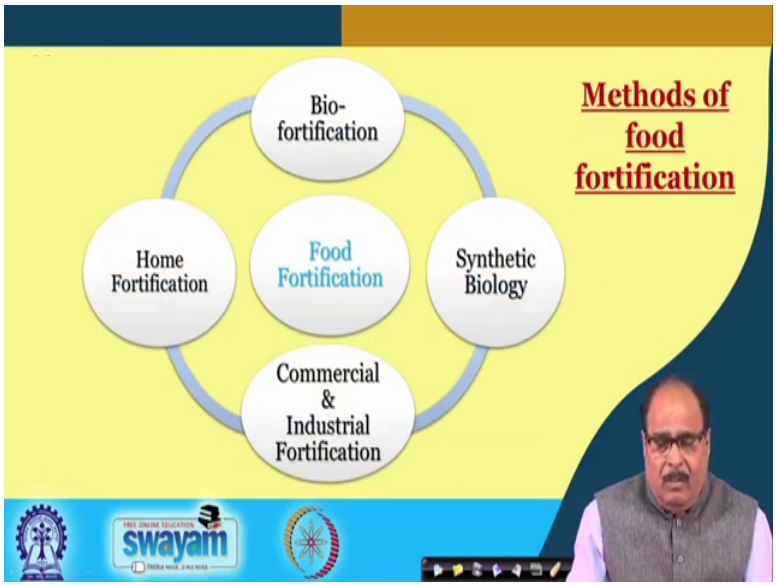

So, now after having that study, there is know that what are the different programs? Let us see, what are the different methods of food fortification, that it will be like bio-fortification, it maybe commercial and industrial fortification, home fortification or even synthetic biology approaches also can be used to fortification a food.

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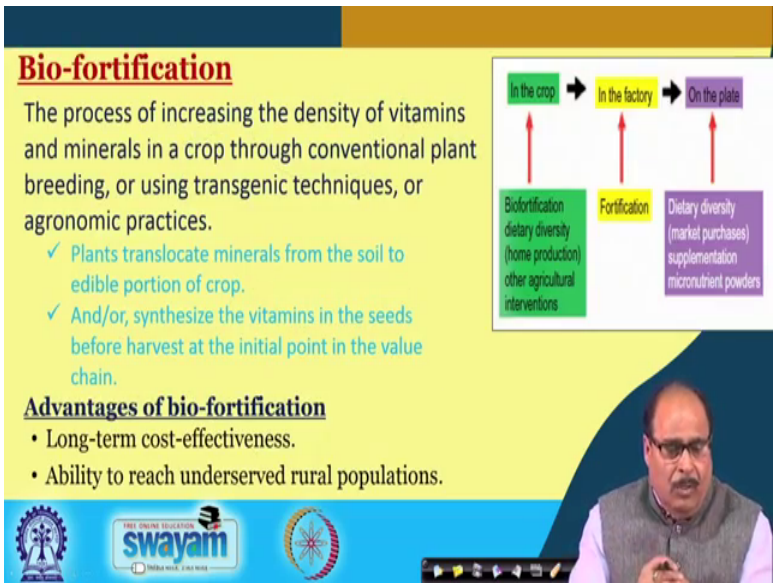

So, the bio-fortification is there is a process of increasing the density of vitamins and minerals or other micronutrients in a crop through conventional plant breeding or using

transgenic techniques or using appropriate economical practises or biotechnological approaches.

In fact, the in this plants translocate minerals from the soil to edible portion of the crop, and therefore the crop has more micronutrients or it can also be added the plant they add or synthesis the vitamins in the seeds, before harvest at the initial point in the value chain. In fact, some in some places in various universities, there is a various efforts has been made researchers are trying to increase like this iron content in the paddy or such other experiments are being conducted to increase the micro nutrient level in one or the other foods by genetic engineering approach.

So, basically this process has certain advantages like, it is a long-term cost-effective process. And it has ability to reach underserved rural population, because the agriculture and by this the raw material which reaches to the underserved rural population etcetera that itself will be fortified or will have the higher nutritional value.

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Food to food fortification that is there, this means that is fortified blended foods are used as food aid are millions of people worldwide, especially malnourished individuals and vulnerable groups. The most common food to food fortification are that the for example that is corn-soy blend CSB or wheat-soy blend.

Like you see the wheat and soya bean; wheat is a deficient in lysine or that is but soya bean is efficient in lysine. Soybean is deficiency soya protein has less amount of sulphur containing amino acid, whereas wheat protein has more sulphur containing amino acid. Soya protein and which proteins are complementary to each other. So, if they both together soya flour and wheat flour is a mixed together, then it become the weakness of the one becomes strength of the other, the blood has required proportion of all essential amino acids like sulphur containing amino acid, lysine, etcetera etcetera, so that is one example of the food fortification.

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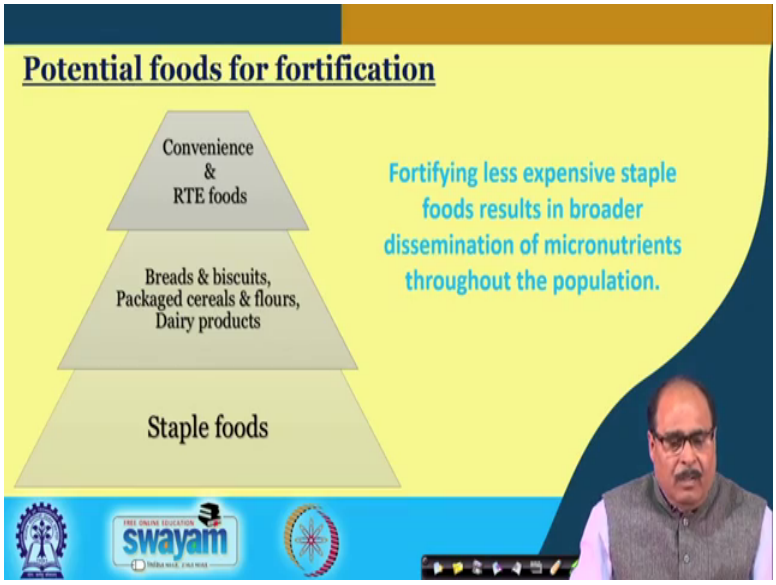

Potential foods for the fortification may be staple food that is one very good approach that is the staple food, which is consumed by large population, they if they should are taken for the food application programs.

Other than that the process foods like bread, biscuit, package serials, and flours are dairy product that is this category of the again the product which has a that is more inroad into the population, particularly the villages etcetera, because the nutrition related issues are little bit more towards the villages, and so by this the products which are more likely to be consumed in bigger or more quantities in those areas, they can be fortified.

Then also the convenience, and ready to eat foods are the other lot for the fortification, and this may be for the targeted fortification or especially fortification. So, depending upon like on mass fortifications may be stable foods might be a good idea, market driven

fortifications may be convenience as and ready to eat food or even breakfast bread, biscuits and all such products. (Refer Time: 14:52). So, fortifying less expensive staple foods results in broader dissemination of micronutrient through the population.

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The selection of fortificant and fortification vehicle depends upon the different factors like prorated intake by the target group that what is the level of micronutrient deficiency, what is the normally consumed foods by those population, and then what is the intake etcetera that is accordingly, the level of the fortificant, type of the fortifications and the vehicles etcetera is decided.

And then the safe dosage that is what is the level of the micronutrient up to which the population can be given cost, bio-availability, sensory acceptability like the micro nutrient which are added, they should not interfere with the routine of the sensory characteristics or other properties of the food. And of course, they should be stable to storage and processing conditions, the micronutrient many a times that it is like fortified Atta is available in the Atta certain micronutrients are added.

So, then the Atta or flour, it is a further processed into bakery product bread, biscuit, chapatti etcetera. So, these micronutrient, they should be stable, they should have adequate stability to these processing conditions or there should be after the process in the food, they should be properly there by availability should we ensured that this will be available.

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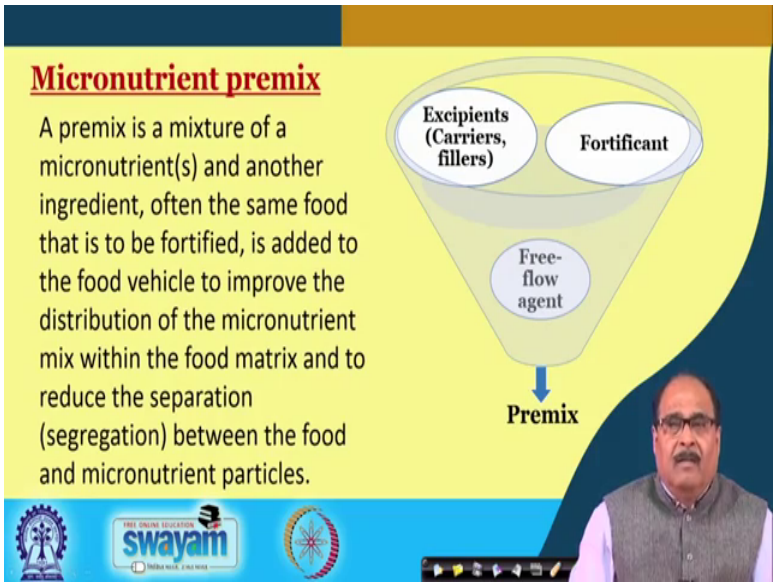

So, these are the some of the factors, which decide the selection of micronutrients and even fortificant are there vehicles. So, one important very very important aspect in the micronutrient premix that is it micronutrient premix that it is a mixture of several micronutrients, and another ingredient of in the same food that is to be fortified is added to the food vehicle to improve the distribution of micronutrient mix within the food matrix and to reduce the separation between the food and micronutrient particles.

So, there is a like vitamin A fulvic acid, iron, B 12, etcetera etcetera. So, obviously so these are the fortificant. So, these fortificant as per the requirement of the fortification programs, their suitable forms need to be selected, and they should be in proper proportion should be properly mixed etcetera.

And of course, that is the they are excipients like carriers materials, fillers etcetera that is so that the different forms of these micronutrient should properly mixed together. They should be grounded in the free flowing powders etcetera some, free flow agents etcetera may be added, so that the free flow (Refer Time: 18:17) of this micronutrient premix is maintained. And also there should be of a proper size in some cases, even they should be micronized to the premix to improve their bio-availability etcetera.

So, it is basically that is the micronutrient in there specific forms, they are mixed together with suitable excipients that is carriers or fillers, they also added with certain free flowing agent like master observing agent etcetera. Of course, all these materials

that the free flow agent or excipients, etcetera should be food grade. And then they are mixed in the desired formulation. Normally, they are it will be (Refer Time: 19:02) these excipients normally are the food in which, they are unlikely to be added or the food similar to that.

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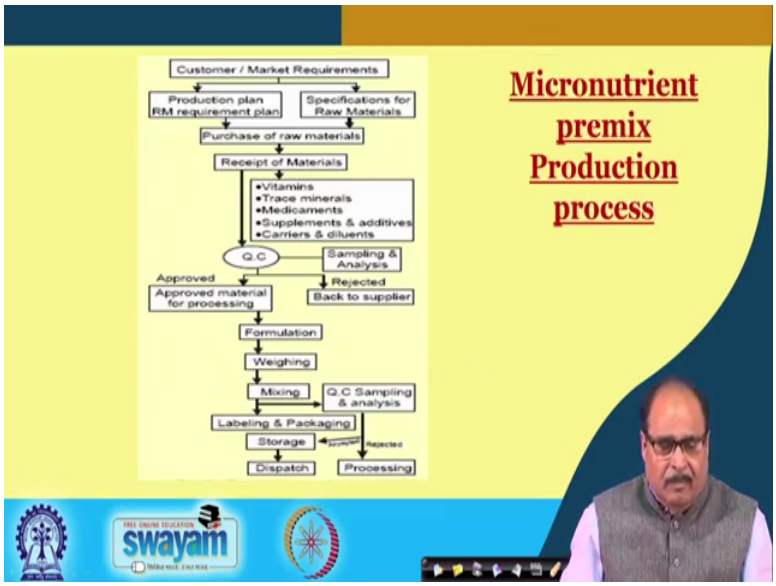

Then obviously, the production process for micronutrient premix as I told you that as for the production plan, as per the fortification plan or as per the need of the market, these are the consumer that is food that is raw material is selected, and then fortification, and their sources are decided right. And then these vitamin stress mineral whatever sources, they are obviously that is tested for the quality. And the all the sources that the even sometimes the chemicals etcetera, synthesis chemicals are all those things which are to be used in this preparation of the fortificant mix, they should of food grade or cross listed chemicals.

So, in their the dependent in the knowledge of their chemical structure or molecular formula that is actual like ferrous sulphate is used or ferrous (Refer Time: 20:13) phosphate is used. So, in that what is the amount of Fe that can be calculated, and accordingly the premix mixture is formulated. And appropriate quantities of each that is the chemicals or there other material added converted into powder all right. And then using appropriate mixing machinery, they are mixed. And after mixing if required, they

may be further ground to micronized and package process, so that is the (Refer Time: 20:51) the processing basically.

It involves that is selection of appropriate source of the fortificant, the deciding its level or quantity of that particular fortificants or group of fortificants, then bringing them to desired particle sizes. And then mixing homogenously or uniformly and parallely packing, and of course in this average where ever possible, and where ever needed quality test should be performed for various characteristics.

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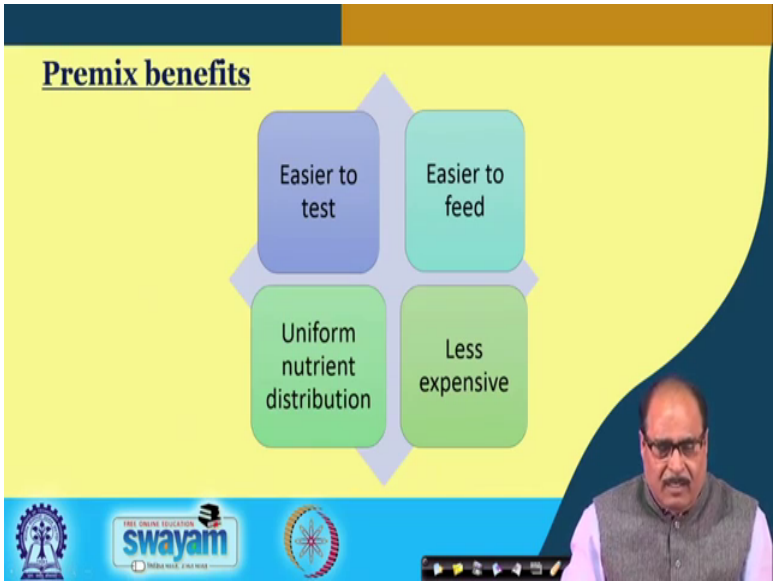

So, obviously the benefits of the premix preparation becomes that is it becomes easier to test that easier to test the bio-availability, easier to test (Refer Time: 21:39), easier to test other characteristics, and the amount quantity it may be easier to feed, uniform nutrient distribution can be obtained. And, of course instead of adding separate nutrients and in a separate process. If a mixture of these micronutrients are prepared and if they are added, so it generally becomes cost-effective or less-expensive.

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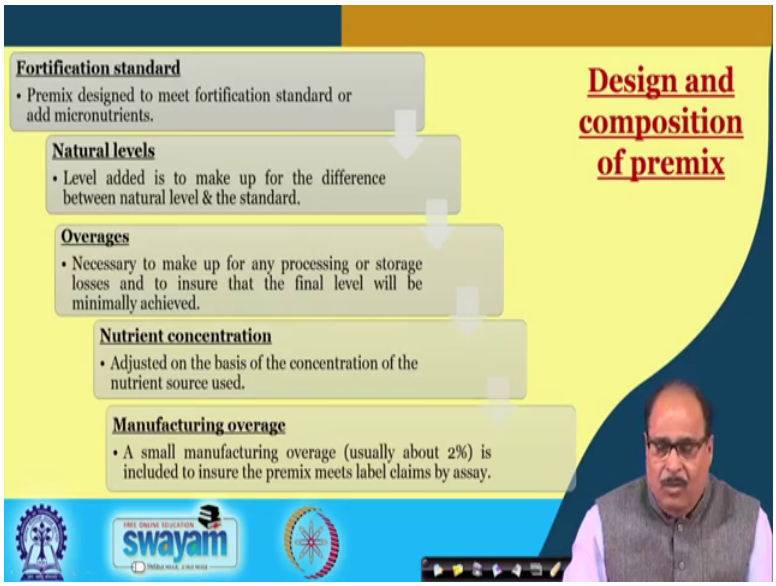

So, or the design and composition of premix, I already gave you (Refer Time: 22:11) the different points need to be kept into the mind, it is one is the fortification standard that the premix are designed to meet the fortification standard or to add the micronutrient, desired micronutrients. Then natural labels label added is to make up further difference between the natural level and the standard prescribed standard.

Then overages necessary to make up for any processing or a storage classes and to ensure that the final level will be minimally achieved that whatever requirement is there in the formulation, so that should be at least maintained. So, in the origin means losses during processing, the trust should be considered. Then nutrient concentration as just around the basis of the concentration of the nutrient sources that are used that is micronutrient sources. And manufacturing overages means, a small manufacturing overage is usually about 2 percent is included to ensure the premix meets the label claimed by the assay.

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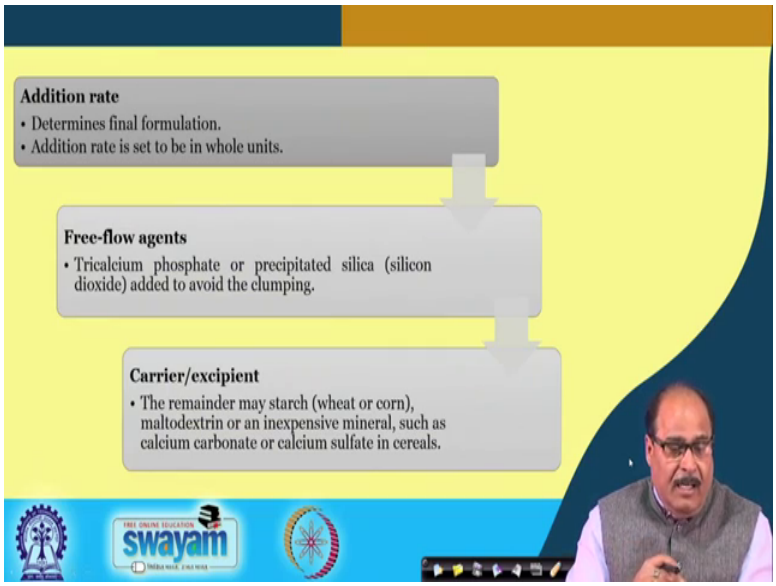

Then the rate of the addition that determines the final formulation, when addition rate is to be set in the whole unit. Then free-floor agents like tricalcium phosphate or precipitated silica etcetera like silicon dioxide etcetera are added to avoid clumping or to maintain the free-flour nature of this micronutrients in the premix.

And then carrier or excipient; the reminder may starch, wheat or corn starch maltodextrin or such other in expensive mineral, source etcetera like calcium carbonate or calcium sulphate in cereals etcetera. So, they can be used or it is better if the material in which this is likely to be added.

If it is should whatever carrier is to be selected is to be match with the food material in which the micro nutrient premix is to be added in characteristics properties. And overall premix should not have any undesirable colour or flavour that is it does not or it should not impart any colour or favour through the fortified food.

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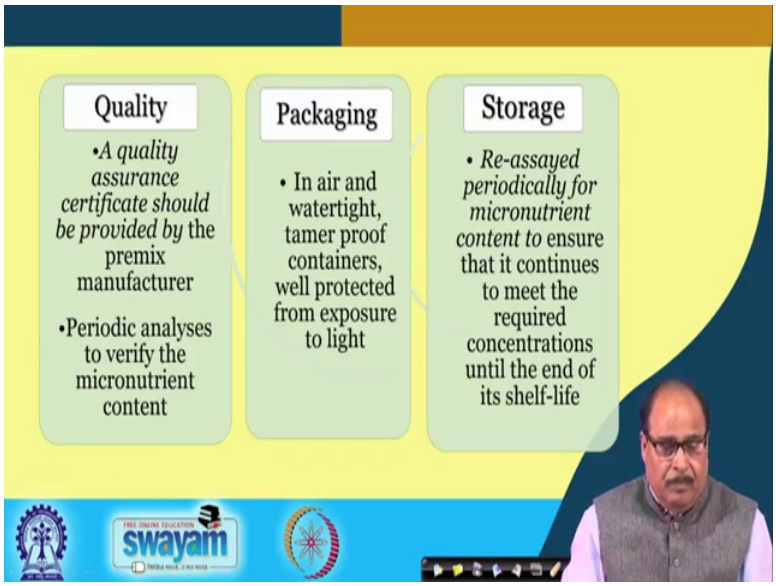

So, of course three aspects are important here like quality, packaging, and storage. Every premix manufacturer the manufacturing company, they are supposed to have proper quality tests, and this should rather provide a quality assurance certificate along with the premix to the (Refer Time: 25:21) company which is using this premix. Then also must make sure that the periodic analysis of the micronutrient is done is performed to make sure that there is no change in the micro nutrient content or its availability or its characteristics etcetera.

Then of course, packaging, then in air and water tight, tamper proof container, it should be packed, so that during its handling transportation storage etcetera. There is no change, no influence, no effect on the quality of the micronutrient premix. It should remain, it is free flow nature, it should not because chemicals etcetera there might be certain chemicals, which might get oxidised, if they are exposed to sunlight. So, all those things should be taken packaging must ensure that such a reactions or such changes are not occurring to the micronutrient premix or its qualities maintained.

And of course, in the storage; re-assayed periodically for the micro nutrient content to ensure that it continues to meet the required concentrations until the end of the its shelf-life fertility used means that is a very very important (Refer Time: 26:44) there is even it is stored, and continuously, intermediately, it should be tested.

The thing is that the from the point of the production of these micronutrients, the quality the desired required quality must be ensured. And all necessary steps, during its handling, during its transportation storage should be taken by appropriate packaging by maintaining appropriate conditions, so that the quality of the micronutrients is maintained at the time of its use, then it is used that type.

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Now, this let us discuss something different of fortification food, fortification programmes in India, the government of India at present is taking a very effective measures, they have taken food fortification programs in a very big way in an organised way. And they have identified certain foods that is staple items which are in fact the items of included, which are included in daily diet at the individual both rural and urban individual (Refer Time: 28:00).

So, these items have been identified by food safety and standards authority of India for fortification. For intrusion into the fortification programs to tackle the health related issues, to make sure or to improve the nutritional status of the people of the country as well as to improve the general nutrients level nutrients intake by the masses. So, the commodities considered in this includes salt, oil, milk, wheat atta, and maida, and raw rice.

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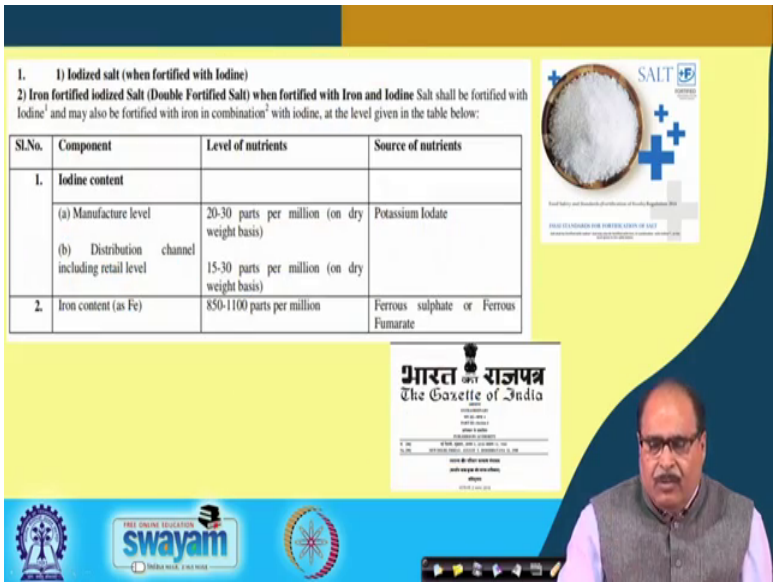

And the FSSAI has also come up they have various inputs, which has been collected by FSSAI from the different sources and scientific agencies and this various such (Refer Time: 28:58), and they have has been notified in the gadget like further iodized salt that is a when it is fortified with iodine.

So, its iodine content, what should be there at the manufacturer level, level of nutrients. And then what should be source of the nutrient like for example, potassium iodate is the. Then iron content as ferrous, it is the in the salt 850 to 1100 parts per million. And the ferrous sulphate or ferrous fumarate is the source of them.

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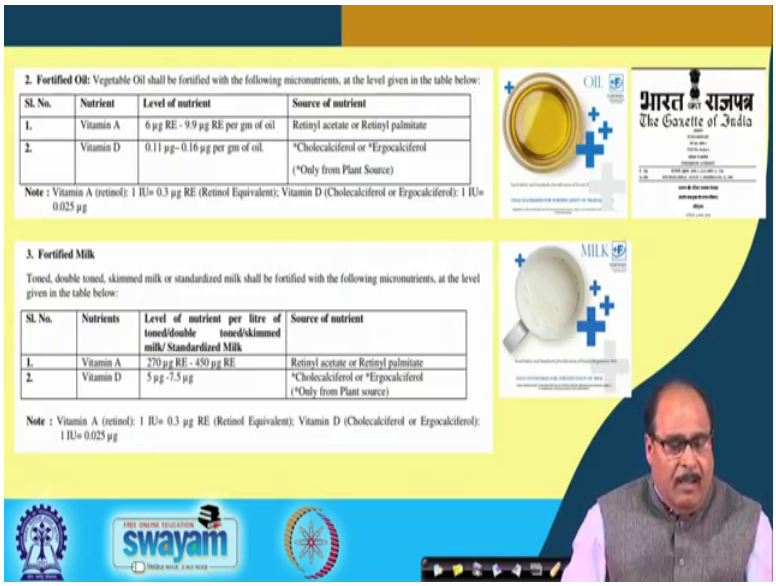

So, similarly in the case of fortified dial, the vitamin A and vitamin D are the micronutrients, their levels have also been specified and the form like vitamin A, its source may be retinal acetate or retinal permitted. And for vitamin D cholecalciferol or ergocalciferol from the plant sources are to be used as a fortificant.

In the fortified milk again vitamin A and vitamin D are the micronutrients, which are fortified for addition into the milk the levels again the written, I will acetate or permitted or cholecalciferol, ergocalciferol. So, the same sources are identified, they can be used of course the label vary that is like vitamin D. In the milk, it has been identified that it can be added to from 5 microgram to 7.5 microgram vitamin D. Whereas in the case of iron, it can be added from 0.11 microgram to 0.16 microgram per gram of iron so, FSSAI as specified this.

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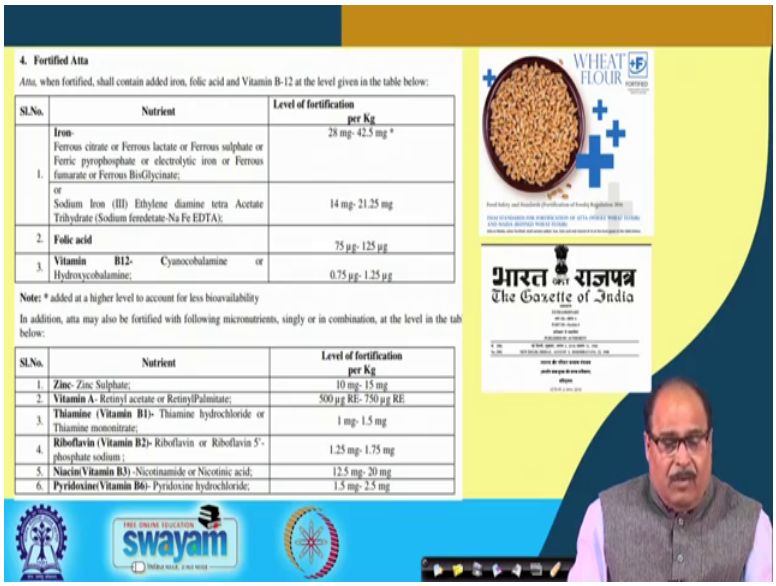

Similarly, in the fortified Atta, the micronutrients have been recommended for use in fortification of the Atta include iron or sodium iron, folic acid, and vitamin B 12, and their form like vitamin B 12 in the form of cyanocobalamin or hydroxy cobalamin, then iron either ferrous nitrate, ferrous elected, ferrous sulphate or ferric pyrophosphate as a or sodium and iron form, and their levels are also recommended to be used. In addition the Atta, they also the manufacturer may also add zinc, vitamin A, thymine, vitamin B1, vitamin B2, vitamin B3, B6 that also as there level is (Refer Time: 31:47) advised.

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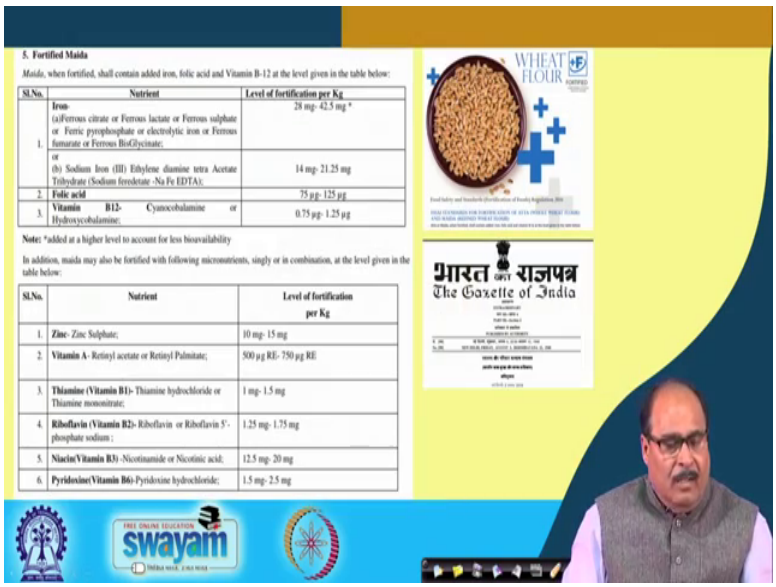

For fortified Maida also, similarly that the same nutrients are recommended for listen, but their label, there are slight variations (Refer Time: 32:01). And these are in fact all (Refer Time: 32:04) information or notified in the (Refer Time: 32:06), and this as you have seen earlier also. This is the plus sign is that for the fortification like so if you have a fortified Atta, they are supposed to contain this plus and this symbol fortified Atta (Refer Time: 32:20).

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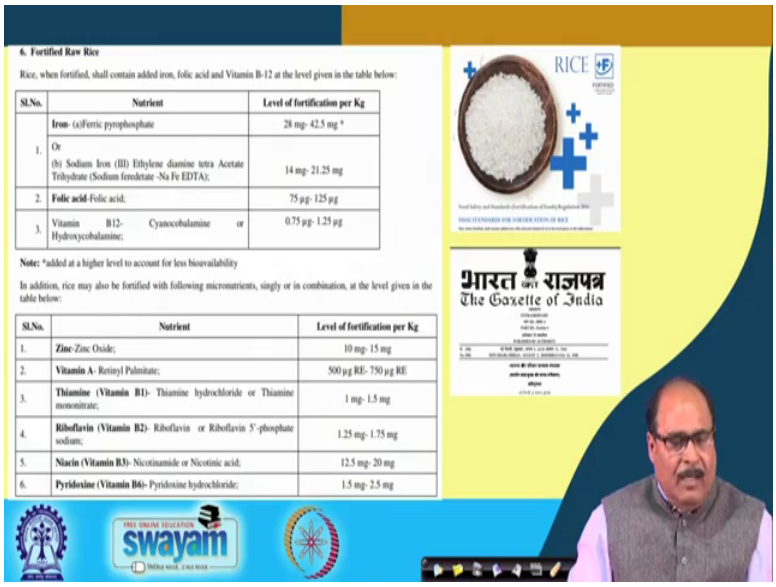

Similarly, and then very important category are the staple food, which is included for the fortification program is the fortified, rice that is fortified raw rice, and the micronutrients which are recommended for fortification in the raw rice include iron that ferric pyrophosphate or sodium iron like EDTA or sodium federate or folic acid, and form of folic acid or vitamin B 12 in the form of cyanocobalamin or hydroxyl cobalamin. The micronutrient level in the rice are recommended 28 milligram to 42.5 milligram per kg of fortification level, but with level of fortification per kg price. Similarly, the folic acid and vitamin B 12 levels are also.

Again like the case of (Refer Time: 33:22), similarly here is the rice also that other micronutrients depending upon the choice of the manufacturer, they may add be added like zinc, vitamin A, B 1, B 2, B 3, and B 6. And the fortified rice like they have to carry (Refer Time: 33:44) this that is the packet of the fortified rice, they should have this step, so that indicates that is it is fortified rice. In fact, iron fortified rice we have also work in

some other lecture may be next lecture, we will discuss something in detail about the iron fortified rice.

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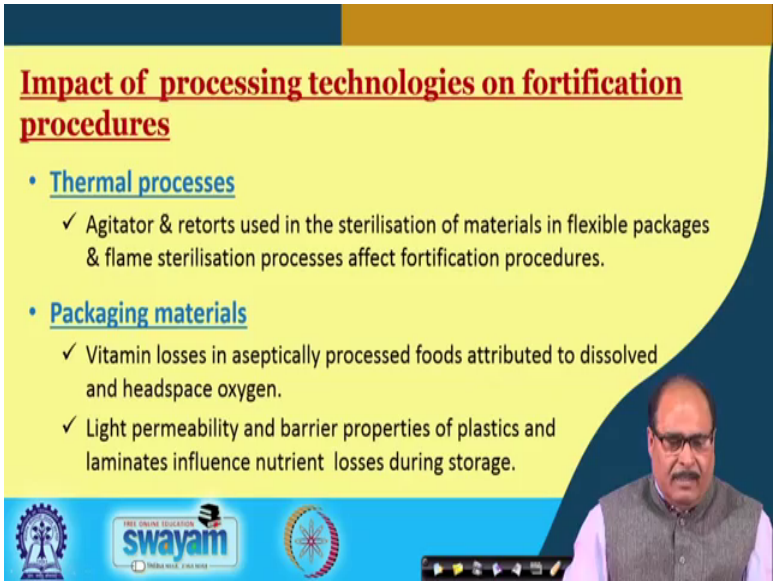

So, one becomes very important to see the impact of processing technologies and fortification procedure that you know many a times as I gave you the example that the in the atta. The fortificant are the added in the (Refer Time: 34:19), these fortificants are milk. So, the (Refer Time: 34:22) is used in frying operations, milk is used heated before consumptions, similarly flour etcetera, rice is cooked before.

So, how I need to be cooked using different technology moist cooking, dry cooking are even the (Refer Time: 34:38) sometime in the (Refer Time: 34:39) very high temperature is so how this thermal processor, thermal treatment or other heat treatment sometime gradients etcetera. So, may also be the foods containing in this may be radiated. So, how this processes or process parameters, the influence the micro nutrient that is stability of micro nutrient, and more importantly bio-availability of the micronutrient. So, these are very important consideration.

And in any food fortification program or any in the preparation of any fortified food or making in the process of making of the premix, these parameters must be given due consideration, the process parameter as well as packaging material that is interaction between the micro nutrients in the food and the micronutrients and packaging materials or polymers, how they interact with that also is very important.

So, the thermal process like agitator and retorts used to sterilize or the sterilisation of the materials in flexible packaging, and the flame sterilisation process affect the fortification procedures. So, accordingly the overage process, overage and etcetera should be taken into consideration, while deciding level of fortification premix to be added. Then vitamin losses aseptically processed food attributed to dissolve and headspace oxygen in the package. Light permeability and barrier properties of the plastics and laminates influence nutrient loss during storage.

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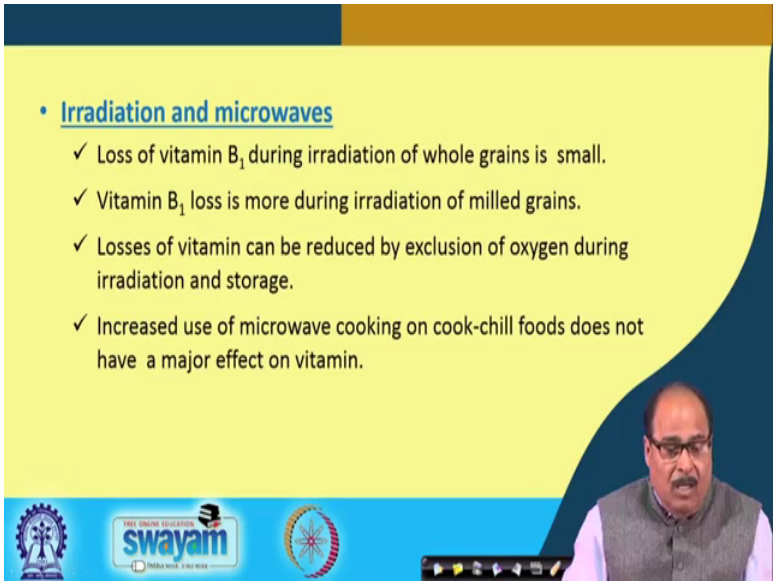

Similarly, irradiation and microwaves: like loss of vitamin B 1 during the irradiation of whole grain is a small. But, if the processed grain or milled grains is irradiated, then the loss of B 1 may increase, so that again becomes important thing that that you are adding that is vitamin B 1 is thymine etcetera, they are the flour etcetera they are in the flour.

So, if they are to be irradiated, so that the grain is irradiated or it is irradiated in the milled form that is important point to be considered. Losses of vitamins that we reduced by exclusion of oxygen during irradiation and the storage are increased use of microwave cooking, and cook chill foods does not have a major effect our on the vitamins.

So, the parted thing, I told you that all this consideration must be ultimately, the micro nutrient which has been added, it should be it should survive the process condition, storage condition, and packers condition. And it should be bio-available, and it should

have the required characteristics for which has it has been added in the food at the time of its consumption.

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So, the general recommendations for food fortifications are that a multi-sectoral approach should be adopted in food fortification programs. National legislation concerning fortified foods should be harmonized with international standards or codex alimentarius. International guidelines on acceptable and safe fortification practices should be adopted.

Relevant nutritional information should be provided through adequate levelling that is in the packet fortified food level, as I told you that the symbol of the fortification is put. Similarly, the level should give that what are the different micronutrient that has been added into the food. And level even their level also should be indicated the levels of the fortification should be indicated, and it should be evaluated and adjusted according to the bio-availability of the nutrients. Particularly, how much it is available after the food is eaten, so to our system that is bio-availability.

Food control systems based on even good manufacturing practices, good hygienic practices or (Refer Time: 39:05) principals should be developed. And analytical method should be developed and they should be adopted to maintain the quality of the premix, and quality of the fortification programs, and to ensure that the hygiene and hygienic conditions are maintained in the preparation of fortified foods.

And this impact of food fortification and nutritional status should be monitored for appropriate corrective action that is very for any fortification program that is the it should be its impact on the, for example if that fortification program is taken for iron deficiency anaemia or what I told that FSSAI, they have recommended levels of nutrients etcetera.

So, of course that is by conducting appropriate feeding program or such other programs, it must be seen, it must be examined or evaluated studied that is how it is actually affecting this program, the there are depending upon the results, accordingly appropriate corrective measures and other measures should be taken.

So, with this, I thank you very much.

Thank you.