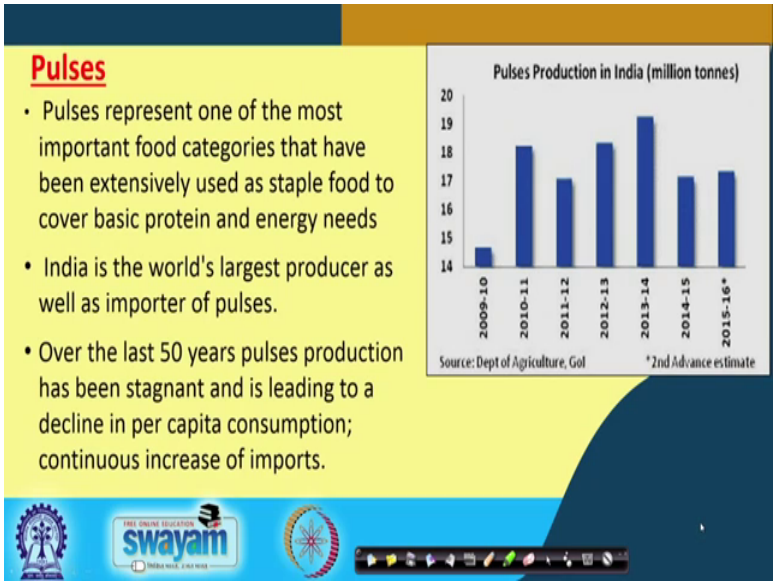
Novel Technologies for Food Processing and Shelf Life Extension

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

Lecture - 52
Nutri Dal & Fortified Noodles

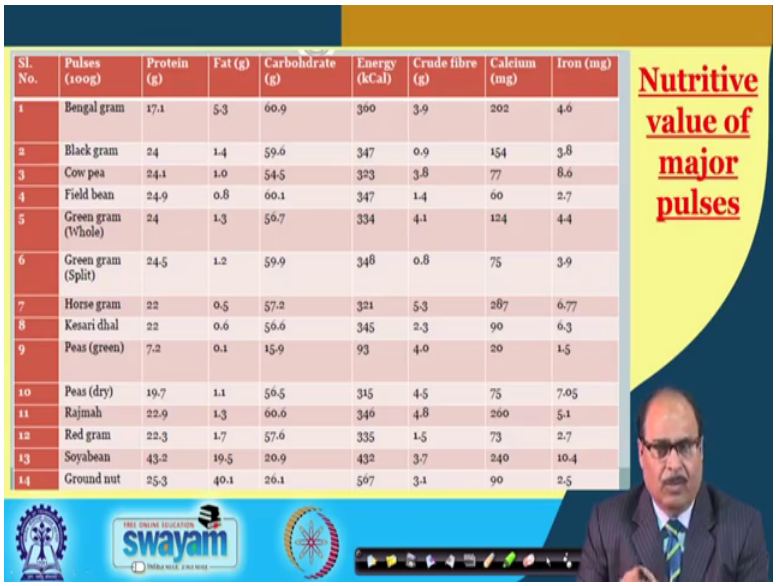
(Refer Slide Time: 00:40)



Hello everybody. In this class, we will study about other two products which are again very very important products from nutrition and health improvement point of view, and those are nutri dal and fortified noodles. First nutri dal, you know the pulses, they constitute one of the most important food crop or food categories that have been extensively used as staple food to cover basic protein and energy needs.

India is the world's largest producer of pulses, but at the same time, also it is world largest importer. Over the last 50 years if you see the products and data which is provided in this, it has almost remains stagnant that is the, but the population is increasing, so this has resulted that per capita decrease regular of the or per capita availability of the pulses has decreased. And that is the reason why the government has to import these pulses.

(Refer Slide Time: 01:35)



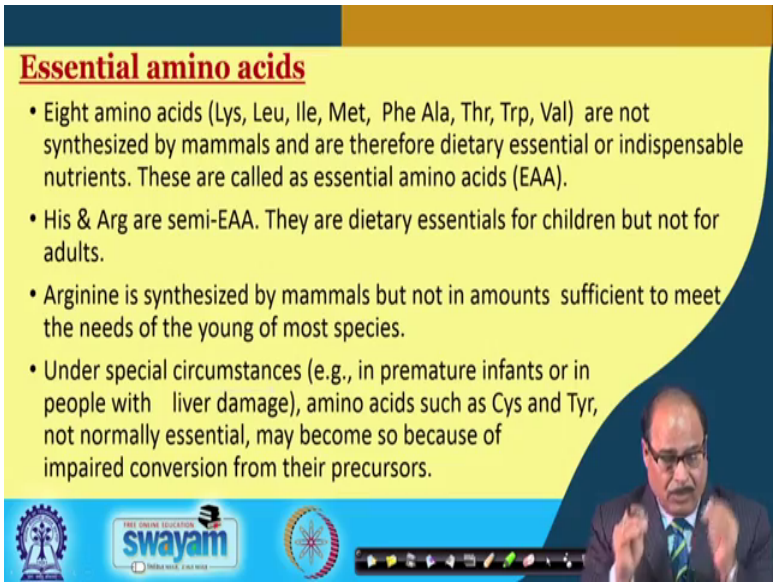
Sl. No.	Pulses (100g)	Protein (g)	Fat (g)	Carbohdrate (g)	Energy (kCal)	Crude fibre (g)	Calcium (mg)	Iron (mg)
1	Bengal gram	17.1	5.3	60.9	360	3.9	202	4.6
2	Black gram	24	1.4	59.6	347	0.9	154	3.8
3	Cow pea	24.1	1.0	54.5	323	3.8	77	8.6
4	Field bean	24.9	0.8	60.1	347	1.4	60	2.7
5	Green gram (Whole)	24	1.3	56.7	334	4.1	124	4.4
6	Green gram (Split)	24.5	1.2	59.9	348	0.8	75	3.9
7	Horse gram	22	0.5	57.2	321	5.3	287	6.77
8	Kesari dhal	22	0.6	56.6	345	2.3	90	6.3
9	Peas (green)	7.2	0.1	15.9	93	4.0	20	1.5
10	Peas (dry)	19.7	1.1	56.5	315	4.5	75	7.05
11	Rajmah	22.9	1.3	60.6	346	4.8	260	5.1
12	Red gram	22.3	1.7	57.6	335	1.5	73	2.7
13	Soyabean	43.2	19.5	20.9	432	3.7	240	10.4
14	Ground nut	25.3	40.1	26.1	567	3.1	90	2.5

So, there is a continuous need to find out that some substitute of these regular pulses to provide protein supply, I will so into this respect that nutri dal has we have worked out. So, in this slide, I have just tried to give you from the literature that and normal nutritional composition of the major pulses, which are grown in the country that is bengal gram, black gram, green gram, etcetera that is they have protein ranging from even 7.2 percent in pea as well as high as 40, 43 percent in soya bean etcetera.

So, they have wide ranging amount of the protein, similarly they also have in some like bengal gram around 5 percent fat, it has soya bean has as high as 20 percent or 19.5 percent fired ground nut that is a which it has around that 40 percent fat, also they have significant amount of carbohydrate ranging from around 15 to 16 percent to 60 percent or 65 percent like that.

Also in addition to this protein fat and carbohydrate contents that is which that is the particularly fat and carbohydrate, they result in to the significant energy contribution. So, they also become a good source of energy. So, apart from that energy and protein providing nutrients, these pulses they also have contained the crude fiber, calcium, iron, and other minerals etcetera.

(Refer Slide Time: 03:26)



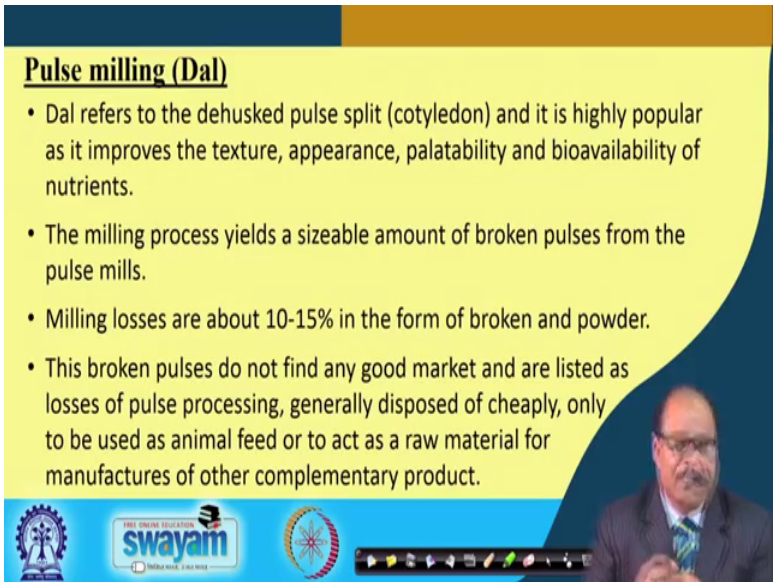
So, this as far as the pulses are concerned that these proteins, they are made up of the various amino acid. And in this amino acid, there are certain amino acids which are essential to human beings like these essential amino acid eight amino acid like glycine, leucine, isoleucine, methionine, phenylalanine, threonine, tryptophan, and valine, they are not synthesized by the mammalian bodies.

And are therefore, they are dietary essentials and they are indispensable in, because these are required for various functions in the body or body growth etcetera. So, these amino acid must have to be provided to the body through dietary sources, and they are called essential amino acid. Similarly, they histidine and arginine are two semi-essential amino acid that they can be synthesized in the adult body, but they cannot be synthesized in the child or infants body. So, for them these include that is the semi-essential amino acids.

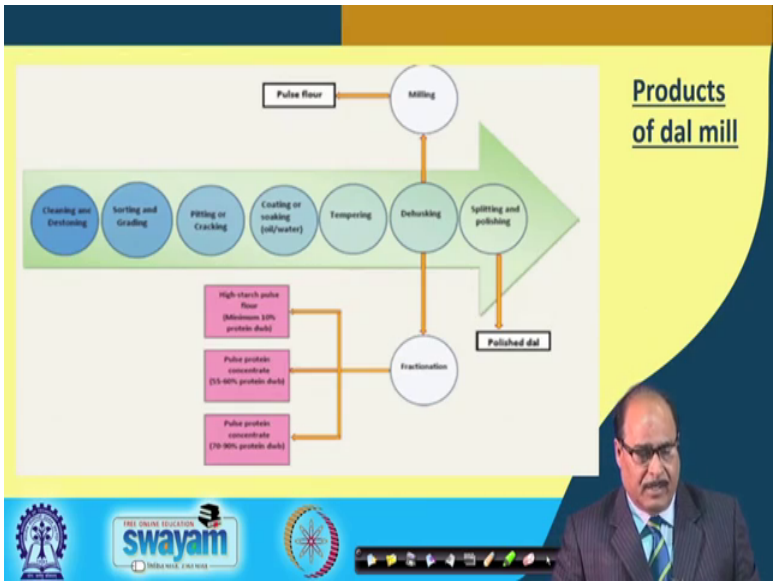
(Refer Slide Time: 04:42)

So, this table gives the essential amino acids semi-essential amino acids content of the important pulses like bengal gram, black gram, I will not read from this table. But, you can say it gives that is yes the, but the important point which there that is not all pulses contain all essential amino acids in required proportion in adequate proportion. And that is why, it is one of the common practice recommended that the pulses, because in the people those particularly, whose are vegetarian people. These pulses provide a major source of protein and energy. So, far the protein for having the balance of amino acid, it is a commonly recommended by dietitians or nutritionists that the vegetarian people should consume mixed pulses instead of consuming one single pulse, so as to balance the essential amino acids.

(Refer Slide Time: 05:46)



(Refer Slide Time: 05:59)

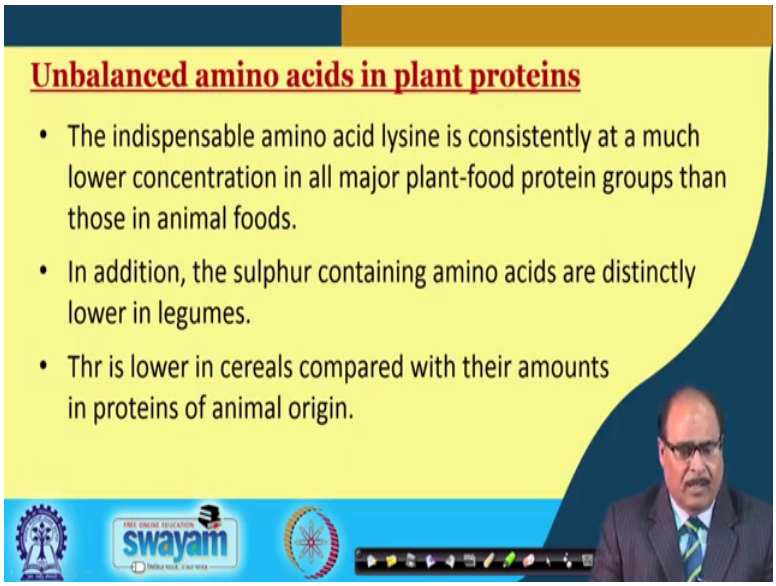


So, the pulses although, they can be consumed in the different products in different form like you can see in this slide that is the pulses, then they are harvested from the field, then after cleaning dehusking sorting, grading etcetera. They are conditioned, and this conditioning and tempering, and then this conditioned and tempered pulses are dehusked that is outer layer husk is removed. And in the process, the removal of this husk. These pulses are broken into two dals two cotyledons, so depending upon the conditioning how much the moisture content, sometimes during the d husking operations some of the pulses, they get broken right.

So, the on and average again here in this case also about 10 to 15 percent broken are produced. So, the for the means that is after de husking, the splits which is obtained that is consumed as a hole splits, it is polished to give surface finish, and this is used as a dal. So, these are the products. So, the brokens which are obtained here, they can be even sent to the fractionation unit or different fractions that is the high starch granule it functions are medium protein functions that are depending upon the size etcetera.

They can be are alternatively in other way, these brokers are sent to the milling units, where the basins are pulse flour etcetera are obtained, but these dals they are mainly used, so that is the dehusked pulses is it the a split or cotyledons are there. So, as I showed you in the slide or diagram process flowchart that it result into a sizeable amounts of brokens, and these broken pulses also do not find some good market, they do not fetch good price all right in the market. So, in the millers, they have to ultimately sell it at a lower inferior prices are converted into product or send it to the product manufacturing right, so that is one aspect.

(Refer Slide Time: 08:19)

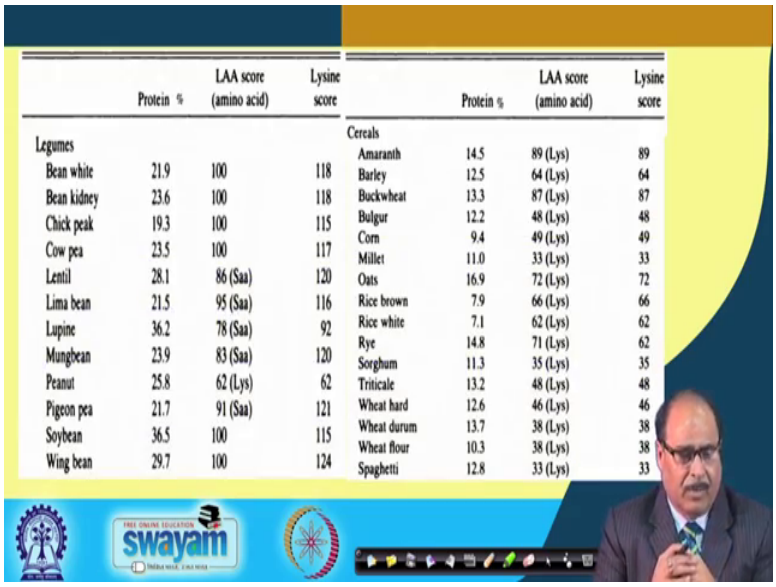


So, other aspect as I told you that these plant proteins and particularly, these pulses that dal which constitute or which provide a major source of energy and protein for the body, but the all the essential amino acids needed by the body, they are not present in this pulse are single pulse right. So, the like for example sulfur containing amino acids are

distinctly lower in legumes, threonine is lower in cereals compared with the amounts in proteins of animal origin.

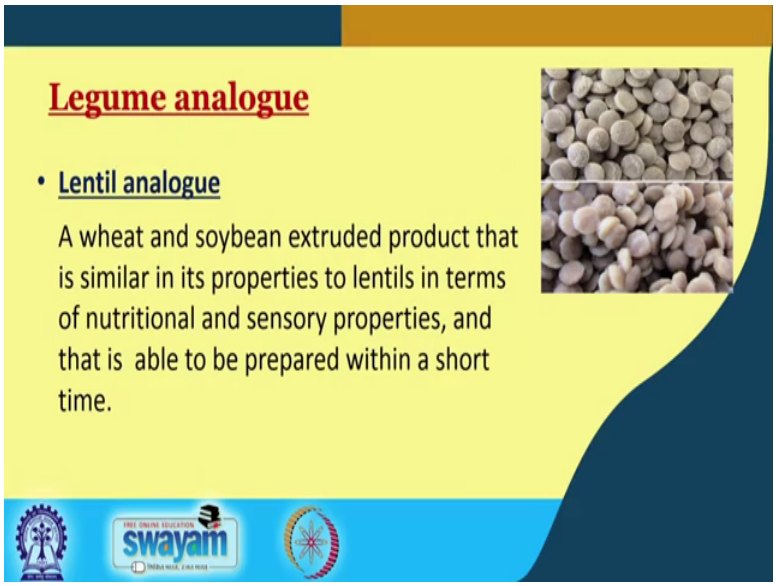
So, they are depending upon their essential amino acid content, they are normally either incomplete or partially complete proteins, but it is the only egg protein is a complete protein which has the essential amino acid content in all the essential amino acids present in it in required proportion or in sufficient quantity in adequate.

(Refer Slide Time: 09:27)



So, in this table the different sources the legume sources, the different cereal sources are and their protein content, and their LLA score, and lysine sources, etcetera are provided, so including the essential amino acid content.

(Refer Slide Time: 09:43)

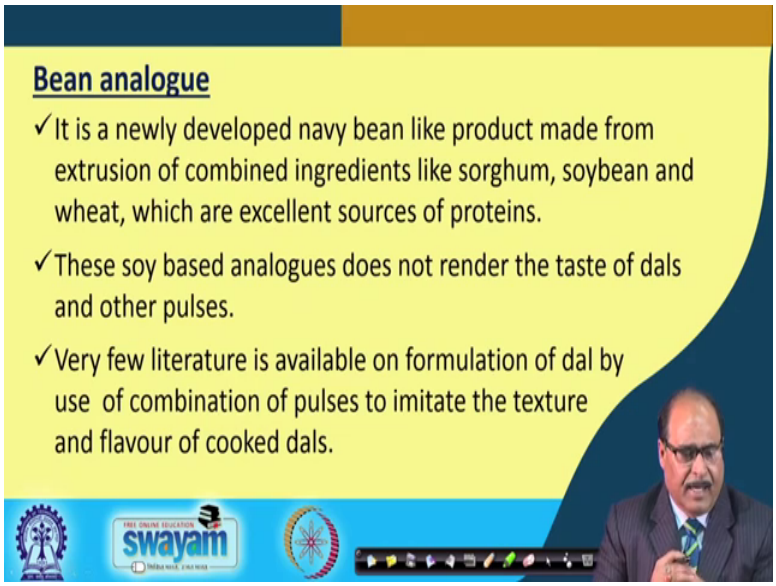


So, in order to meet the requirement of the pulses or protein dietary requirements as in the first introductory slide, I show you shown you that the pulses their per capita availability is decreasing although the production is more. So, government is forced to improve pulses import pulses.

So, to overcome this problem situation, there are certain strategies are to adapted like in this case that is the legume analogue develop that is prepare dal like material dal like materials like the lentil analogue are bean analogue. So, lentil analogue here heat and soya bean, heat flour and soya bean flours are extruded into a products given that they are given the shape of a dal that it is similar to the lentils in terms of nutritional, and sensory properties. And it is able to be prepared within a short period of time.

But, of course it although various manufacturers and such as they claim that, but I have show that whether it is a where this material, they are given the shape of the dal. But, the material it is not exactly the pulse is not, so the it is amino acid content etcetera is a all the amino acids are balanced although soya bean and wheat, they are essential amino acids are complemented to each other.

(Refer Slide Time: 11:30)



But, there are again some problems. The other product is the bean analogue, it is a newly developed navy bean like product made from extrusion of combine ingredients like sorghum, soya bean, wheat, which are excellent sources of proteins. And these soy based analogues does not render the taste of dals and other pulses, but they may provide the amino acids etcetera.

The very few literature is available on the formulation of dal by the use of combination of pulses to imitate the texture and flavor of the cooked dal that is it is important that is whatever this that bean analogue or even dal analogue, they the raw ingredient materials use them for making them, for giving the shape of the dal yeah, they are soya bean or sorghum or wheat or such other material.

But, it will be more appropriate that if the pulses itself, they are used to give and in this regard the utilization of that broken of the pulses, we at IIT Kharagpur. They have developed a process technology for making nutri dal, we call it nutri dal, because it is we where we use combination of pulses, I will show you little later in one of the slides, where different combinations of pulses are used in appropriate requirements, and its amino acid content is balanced.

(Refer Slide Time: 13:14)

So, in one single dal in one product all the essential amino acid, and it is purely from the protein or vegetable source that is what is the nutria dal concept, you can see here in the picture. These dals are those obtained from that these are the balance, they have the balance of essential amino acids. So, nutri dal is a essential amino acid balance dal, which resembles the natural dal in physical and sensory characteristics, it has improved nutrient delivery, reduced antinutrients, and requires comparatively less time to cook, because and it has all the ingredient only the pulses are used for its preparation.

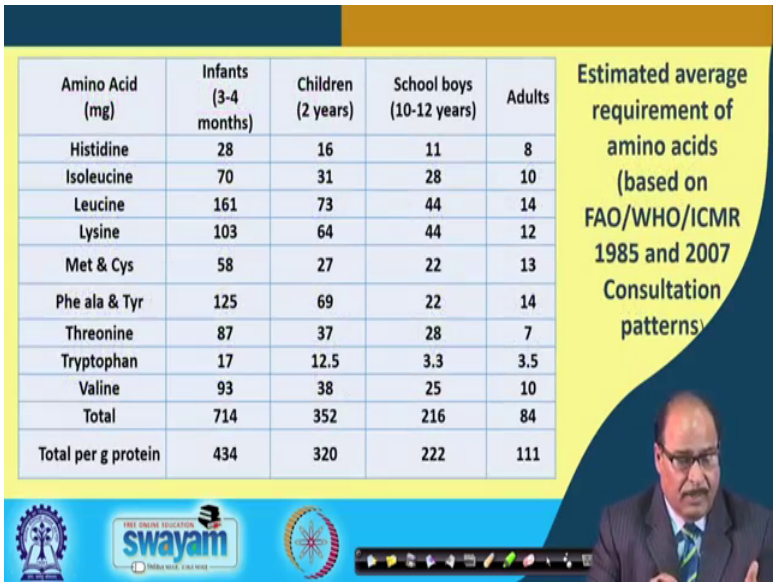
It is a value added product made by utilizing the broken dal. So, again that is it a value addition, and also it provides or economical benefits to the dal millers as well as to the farmers. The broken dal is a byproduct valuable byproduct valuable industry. So, this engineer dal will be prepared by the heart extrusion technology.

We use like in the earlier lectures, we studied the iron fortified rice. In fact, the same facility is you utilized or can be utilized for making this product just by simple changing the dye. In that case, we are having a dye which gives a rice stable material. And in this case, we have a dye which gives a dal symmetry also by design it change. And of course, since the materials are ingredients are change in that case it was a rice flour, here it is pulses flour, mixture of different pulses. So, the process parameter is that is conditions of the extrusion etcetera are also change. So, we have optimized those things.

(Refer Slide Time: 14:57)

So, I will just come to give you a little bit more input about the formulation of a nutri dal or preparation of nutri dal. So, first thing is that balance that is have a proper that is there there are four, five pulses. So, obviously either from the literature or we have collected different pulses, identified the pulses which have a good sources of all those essential amino acids. And that to formulate that a blend that is the formulation of the blood includes deciding the quantity of the individual pulses in which this would be mixed, so that the final blend, we get it has a complete blend or balance of essential amino acids. So, in this case, we use egg protein as a reference protein, our aim is to have a blend of different pulses are different pulse flours, which has essential amino acid similar to that of the egg protein.

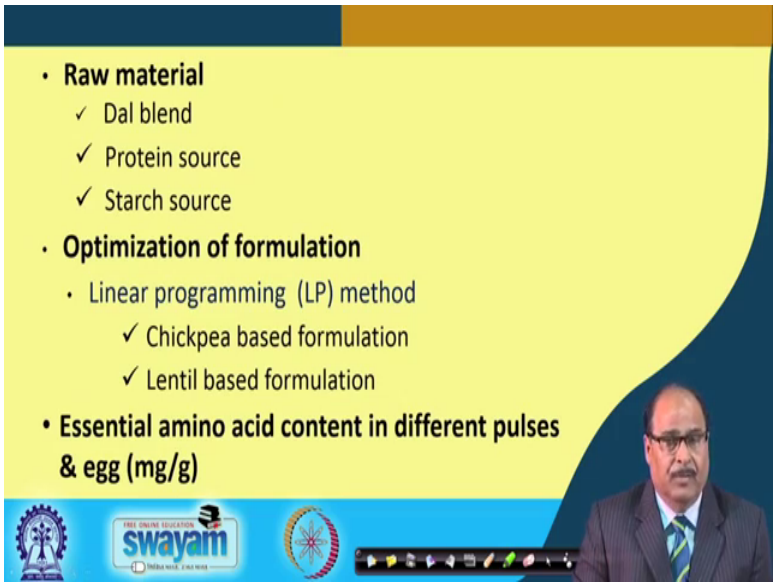
(Refer Slide Time: 16:05)



So, this is the in fact the essence estimated average requirement of amino acid based on WHO, FAO, and ICMR recommendations that is a for infant, for children, for school boys, for adults, these different essential aminos are accordingly, so even this their requirement.

So, this process technology this technology which we have developed, it gives that that chance are you it is flexible enough, one can prepare pulses having the essential amino acid requirement for the infants, we can the product can be developed having the essential amino acid require or fulfilling this essential amino disease requirement of the children is school boy etcetera. So, this provide this technology provides the flexibility to prepare the nutri dal of specifies our designated nutritional value.

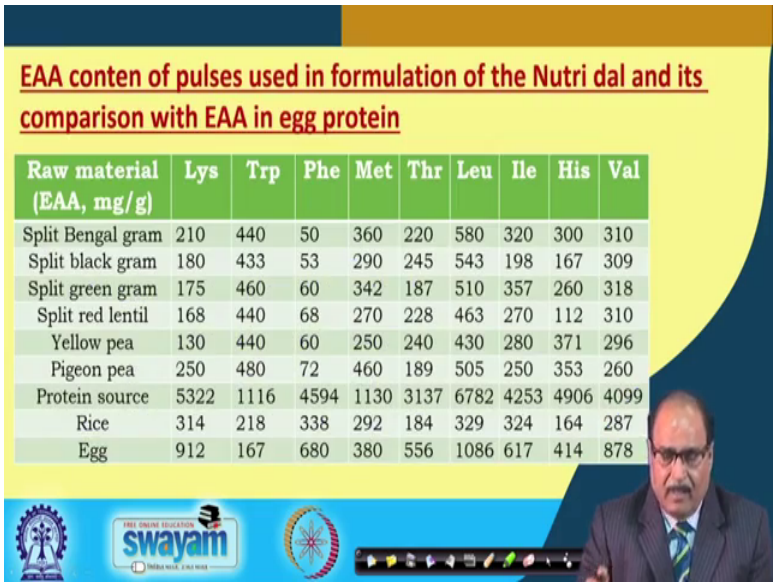
(Refer Slide Time: 17:04)



So, the raw material for this product is the dal blend that is so and might be there depending upon the requirement, which is that it may have said that some other protein source might be required to be supplemented like soya protein, isolate have such other plant protein isolate, to in order to balance the all the essential amino acids. Then of course, starch sources are to be used, because this we take the dal source. So, some starch source (Refer Time: 17:37) providing binding etcetera.

So, the optimization of the formulation for the formulation is prepared using linear programming method. So, we have developed two dal formulation; one is the chickpea based, another is a lentil based formulation. And then these formulations are as I told you they are balanced with those of the essential amino acid present in the egg protein.

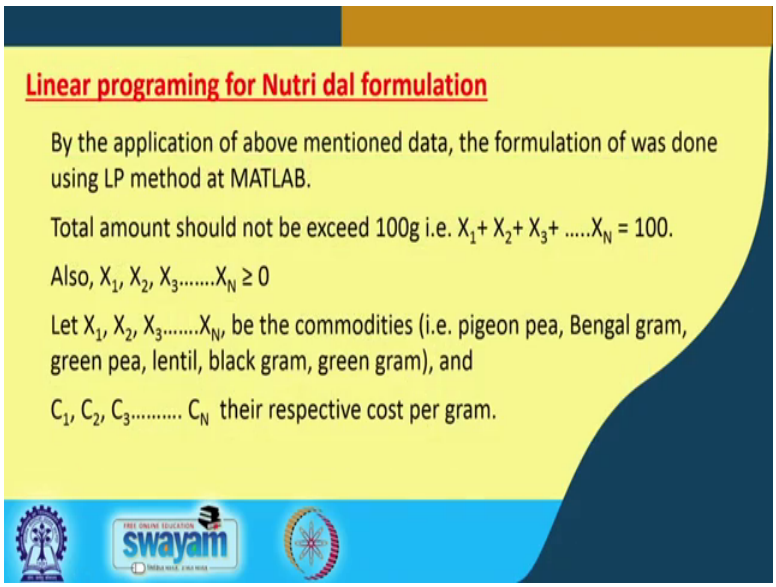
(Refer Slide Time: 18:01)



Raw material (EAA, mg/g)	Lys	Trp	Phe	Met	Thr	Leu	Ile	His	Val
Split Bengal gram	210	440	50	360	220	580	320	300	310
Split black gram	180	433	53	290	245	543	198	167	309
Split green gram	175	460	60	342	187	510	357	260	318
Split red lentil	168	440	68	270	228	463	270	112	310
Yellow pea	130	440	60	250	240	430	280	371	296
Pigeon pea	250	480	72	460	189	505	250	353	260
Protein source	5322	1116	4594	1130	3137	6782	4253	4906	4099
Rice	314	218	338	292	184	329	324	164	287
Egg	912	167	680	380	556	1086	617	414	878

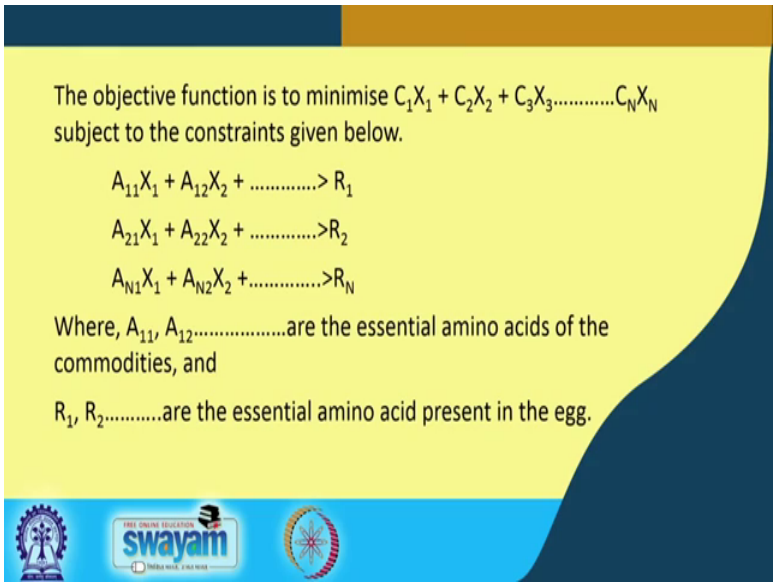
So, this a table gives the different essential amino acid content of different pulses, this is the content of pulses used in formulation of the nutri dal, and its comparison with the essential amino acid is a this all right. So, egg protein that is it has essential amino acid camel accordingly, the pulses which we have usually it is analyzed, and data is generated milligram per gram of the pulse flour.

(Refer Slide Time: 18:38)



And this data is used in the linear programming. So, in the linear programming is actually there are certain constraints, and then some objective function a decision function.

(Refer Slide Time: 18:48)



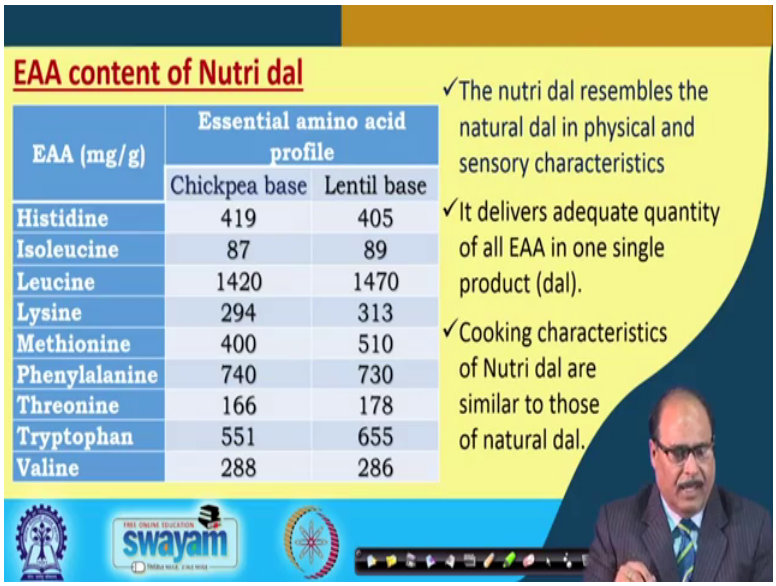
So, the constraint is that is you give the upper limit and lower limit etcetera that is there are whatever raw the different pulses are there. So, we there we give that, this pulse contains X, Y, Z value of the essential amino acids, and it has A, B, C cost etcetera. So, these essential amino acids and this cost, so we want to minimize the cost, we want to maximize or we want to get the desired amount of this essential amino acid.

Particular essential amino acid in the pilot blend accordingly that and we give that s in 100 gram that is a equation linear programming X 1 plus X 2 plus X 3 plus upto X n is equal to 100. So, also there is X 1, X 2, X 3, X n should (Refer Time: 19:41) equal to 0 or X 1, X 2, X 3 and we be the commodities like essential, it should be equal to or less than or it can be given a so you are we in this linear programming, we give our requirement that is what is the so this solvers in the linear program this solver MATLAB another comes, it solved the problem and gives s X kg of the one R 1 component of Y kg of R 2 component Z kg of R 3 component etcetera. If it is taken, it gives the desired components. So, this solve these are some of the equations, which are solved by this linear programming, and finally formulations is decided.

(Refer Slide Time: 20:25)

And then this formulation is now here in this figure, you can see you are taking that is these different dals are the taken broken dal at a take an proper proportion all right. As an these dal flours, they are blended in proper proportion and conditioned right. Like the similar manner like that in the case of iron fortified rice preparation, their rice flour was being blended with micronutrient. Here different pulse flours, different dal flours are being blended is required, then it is passed through the extruder yeah the nutri dal die, we have designed die dal. And then it gives the finally the product, this is the dal obtained from the pictures of the photographs of the nutri dal, which is obtained from the extruder, and after cooking it looks like. So, consider that in this process we prepare nutri dal.

(Refer Slide Time: 21:24)



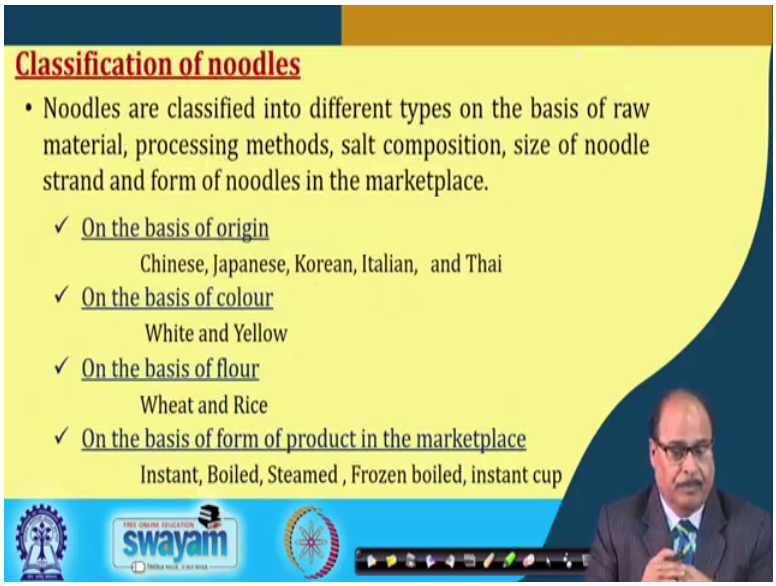
And these are the essential amino acid like histidine, isoleucine, leucine, lysine, etcetera that is in the two formulations check previous formulation, and lenten based formulations that is the essential amino acids this essential amino acids. What is their I (Refer Time: 21:45) the formulation, they contain these amount of essential nutrient. So, nutri dal, it resembles the natural dal in a physical and sensory characteristics. It delivers adequate quantity of all essential amino acids in one single product that is dal. And cooking characteristics of nutri dal are organ electric characteristics are the nutri dal etcetera are similar to those of the natural dal. So, this is all about the nutri dal.

(Refer Slide Time: 22:22)

I will come to the other product that is the fortified noodles. You know the noodles are safe and nutritious product that conform to the set food standards of various countries. With the increase in Asia pacific economy, the demand for quality noodle products among consumers increasing day-by-day.

Since, ancient times, noodles in various formulations and shapes have been used as a staple food in many parts of the Asia many Asian countries. Even now it will become popular in other countries European countries or other countries as well. Noodles may either be served by frying and mixing with the vegetables and meats or they can be served as a soup noodle by boiling in a broth.

(Refer Slide Time: 23:19)



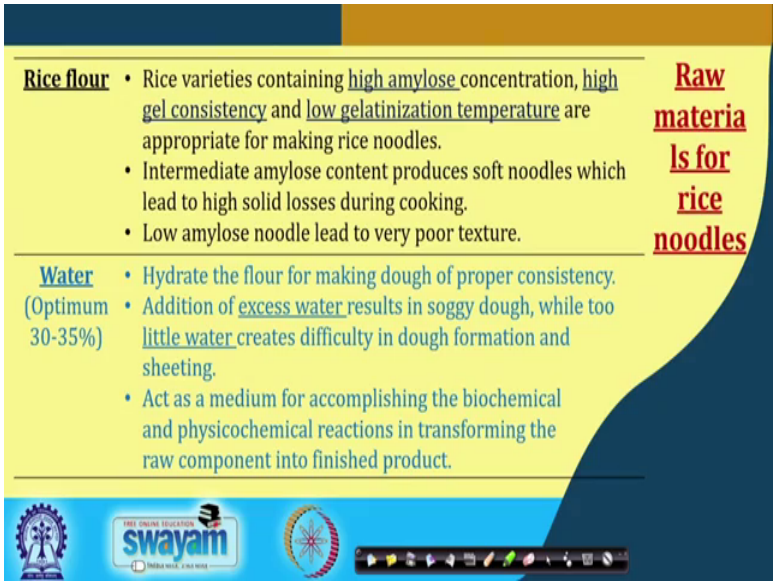
The noodles are classified into different types on the basis of the raw material, processing methods, salt composition, size of the noodle strand and form of the noodles in the market place etcetera. So, under barriers like for example on the basis of their origin, the noodles are classified like Chinese noodle, Japanese noodle, Korean, and Italian, Thai noodle etcetera.

On the basis of their colour, they are classified as white or yellow noodles. On the basis of flour that they are wheat flour is used for their manufacture or rice flour accordingly rice noodles or wheat noodles or on the basis of the form of the product in the market place like instant noodle, boiled noodles, esteemed, frozen boiled instant cup and so on.

(Refer Slide Time: 24:14)

Rice noodle is very important product, commercially important and nutritionally important product. It is the most consumed form of rice product next to cook the rice grain in Asia that is after the if you see the survey, so rice noodle is the next important product which is consumed by the people, after the rice natural normal rice. So, rice noodles are commonly prepared by two methods. One is the seating up dough to develop flat noodles or extruding to develop vermicelli like product or vermicelli.

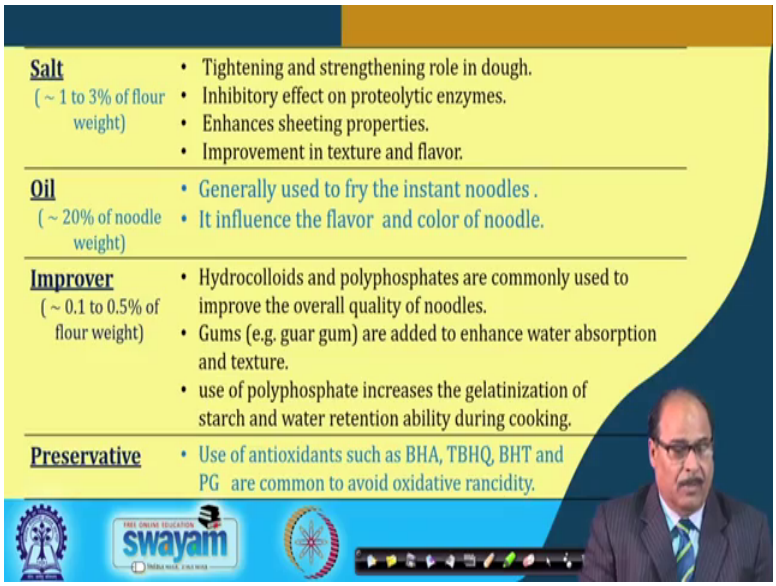
(Refer Slide Time: 24:55)



So, the ingredients for the preparation of the rice noodle raw materials for rice noodles include rice flour that is the rice varieties contained in high amylose concentration, high gel consistency, and low gelatinization temperature are appropriate for making rice noodles.

Intermediate amylose content produces soft noodles which lead to the high solid losses during cooking. Low amylose noodles lead to a very poor texture. Water content its optimum water content for preparation of rice noodle is generally the range of 30 to 35 percent. So, this water, and it is used in the prepare the dough, it hydrates the flour for making do a proper consistency. But, this water content should be optimized, it should not be more, it should not be less, because more water content or excess water results in a soggy dough, while too little water creates difficulty in dough formation and seating. So, water acts a medium for accomplishing the biochemical and physicochemical reactions in transforming the raw component present in the rice into a finished noodle farm or compacted farm.

(Refer Slide Time: 26:23)

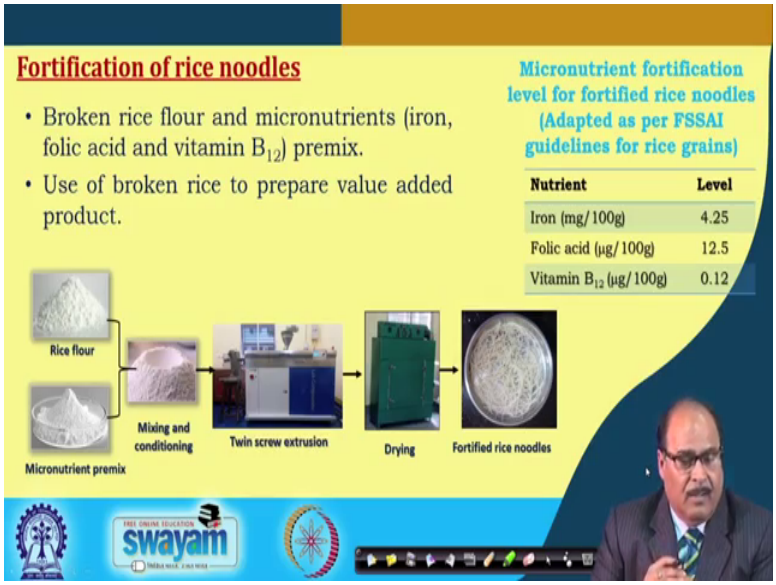


The other component ingredient include salt, oil, and some improvers, and preservatives. Salt may be to the tune of 1 to 3 percent on the flour weight basis. It is used for tightening and strengthening the dough, it has inhibitory effect on proteolytic enzymes, it enhances seating properties of the dough, and improves the texture and flavor.

Oil, it is normally 20 percent of the noodle weight is added. Generally, used to fry the instant noodle, it influences the flavor and color of the noodle. The improvers may be 0.1 to 0.05 percent on the flour weight, and they include hydrocolloids and polyphosphates etcetera, which are used to improve the overall quality of the noodle like gums, like guar gum are so they are added to enhance water absorption properties and texture. In fact, use a poly phosphate increases the gelatinization of starch and water retention ability during cooking.

Preservatives sometimes antioxidants such as BHA, TBHQ, BHT and Propyl Gallate etcetera are added to avoid, because this oil has been added to avoid the rancidity of the oil oxidative rancidity, these antioxidants are other such other preservatives are added.

(Refer Slide Time: 27:54)

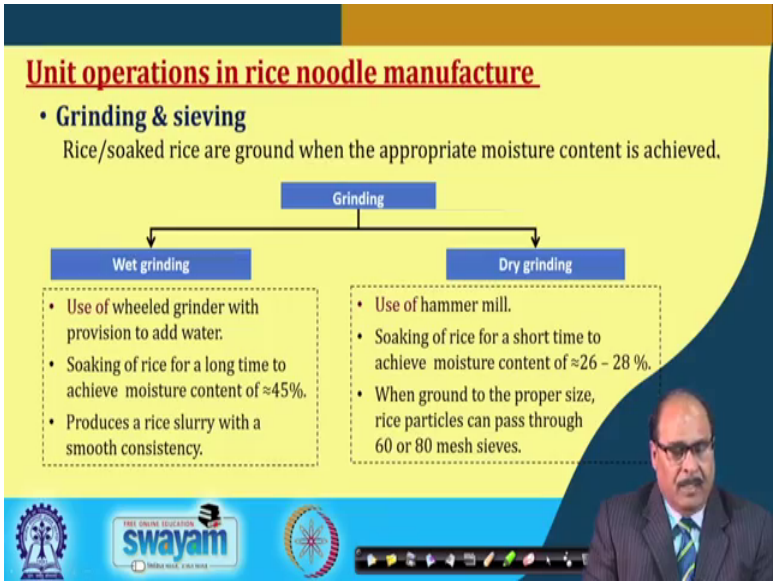


Then this is the method of rice preparation, and fortification of the rice noodle. So, here also we have the like iron fortified rice, the same concept is used here also. We are taking broken rice this broken rice is converted into flour, and it is added with; so the same step like up to conditioning step that is the rice flour, and then this a micronutrient premix, they are mixed conditioned with appropriate quantity of moistures are added conditions. And then this conditioned this wheat flour or conditioned flour, after mixing conditioning that is it is put to the extruder.

So, in the extruder, we have specific design die that is which gives the material in the strep farmer in the third farm, so the noodles are obtained, then the added moisture is

dried, and you get fortified rice noodle. You can see in the here in the photograph between the noodle that has been prepared in our laboratory. So, regarding fortification label, we have used the same fortification level which is recommended by FSSAI for rice the micronutrient iron, folic acid, and vitamin B 12 same micronutrient and same label, we are so it is in fact iron, folic acid, and vitamin B 12, fortified rice noodle, and which may be a very good product as far as the prevention or eradication of the iron deficiency anemia is concerned.

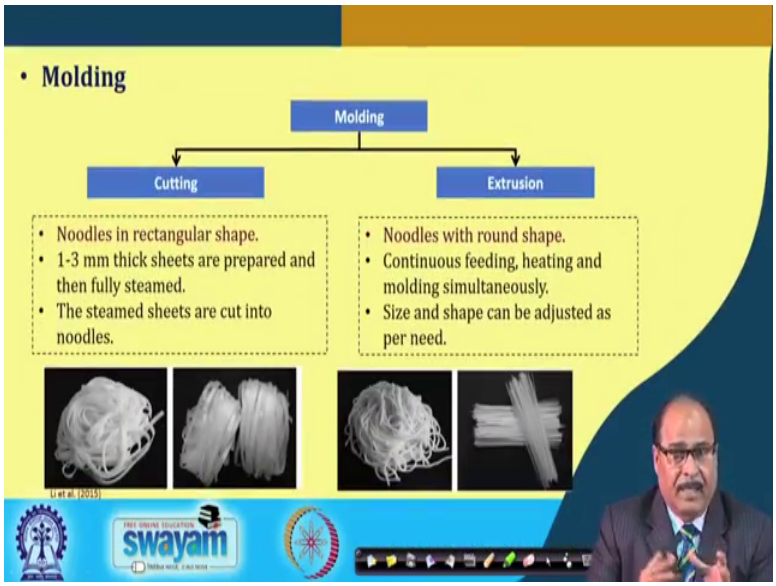
(Refer Slide Time: 29:37)



Then the unit operations, I have already that is before, it is converted into flour. There are some unit operation that is the rice noodle manufacturer may be grinding and sieving, because the proper form proper size of this is very important. And it can be raw as well as flour or it can be wheat do, so both rice raw rice or dry rice or soaked rice, they can be ground, when the appropriate moisture content is achieved.

So, the grinding may be wet grinding and dry grinding. Wet grinding use a wheeler grinder with provision to add water. Here they say produces a rice slurry with a smooth consistency, whereas the dry grinding produces that is the flour rice flour of a proper particle size may be 60 or 80 mesh sieves, then after this grinding either in the celery form or in the flour form.

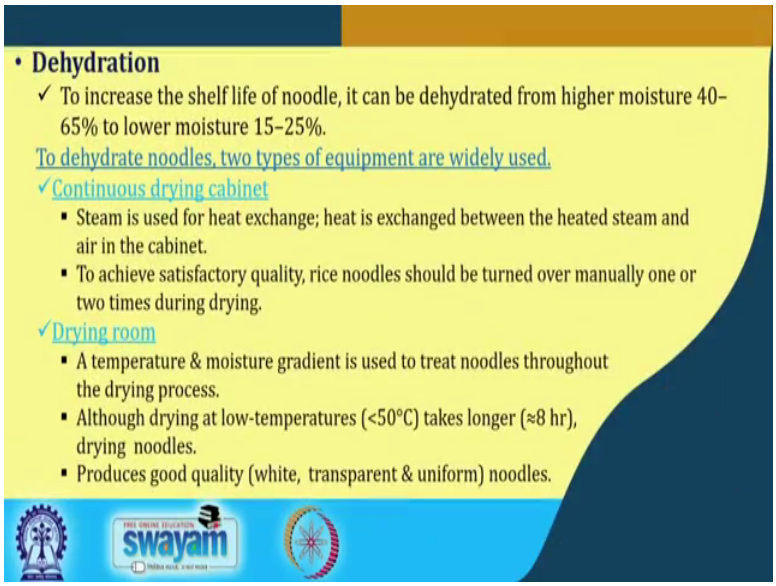
(Refer Slide Time: 30:37)



The next step is molding. The molding in cutting and then extrusion, it can be very appropriate seating and cutting or it can be passed through the extruder, and you can obtain (Refer Time: 30:55). So, the cutting the noodles in rectangular shape, 1 to 3 mm thick seeds are prepared, and then they are fully esteemed. And this steam seeds are then cut into noodles.

Whereas, using extrusion. The noodles varying shapes etcetera, where round shape noodles can be obtained, it is the continuous process, continuous feeding, heating, and molding instant simultaneously in through the extruder inside the extruder barrel. And size and shape can be adjusted as per the need. Then after the material comes out of either this molding, and drying cutting.

(Refer Slide Time: 31:31)



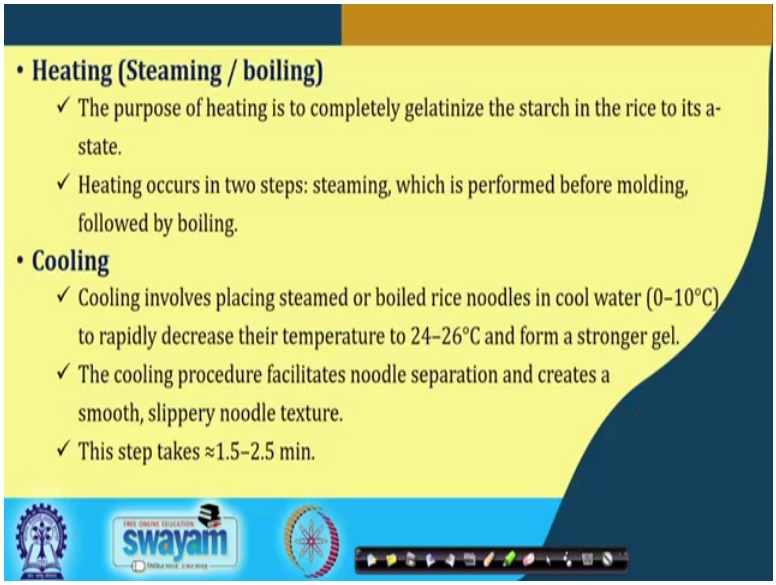
The next step is dehydration. And dehydration obviously to it is to make the product a room temperature stable, because earlier you have seen that is about 30, 35 percent moisture had been added. So, this moisture should be reduced right as I like is about 15 to 25 percent of the moisture, it is a lower than 15 to 25 percent, but this trying again it is little that technical that it should be done with care, because to faster drying may result into curling and development of cracks etcetera. To a drying may result that is some mold infection or some sovereign etcetera of the product, so the Trans would be done with care.

So, dehydration of noodles is may be done in two types right. Like one in the using a continuous drying cabinets, where steam is used for heat exchange. And heat is exchanged between the heated steam and air in the cabinet. To achieve satisfactory quality, rice noodles should be turned over manually one or two times during the drying process or the other method or facility can be used that is a room, where the proper conditions required for the time can be maintained inside the room that is a temperature and moisture gradient is used to treat noodles throughout the drying process.

And although drying at the low temperature less than 50 degree Celsius takes a longer time, but as I told you it produces a good quality right, because at normally the high temperature dry results it has some problems. So, at the low temperature drying is

recommended for noodles etcetera, it results a good white, color, good travel having the noodle having good transparency or of uniform size noodles are often doing this.

(Refer Slide Time: 33:42)



So, the other steps are heating and steaming or boiling. The purpose of this is to completely gelatinize the starch in the rice to it's a-state. Heating occurs in two steps; steaming, which is performed before molding, followed by boiling. And cooling involves placing steamed or boiled rice noodle in cold water may be 0 to 10 degree Celsius water to rapidly decrease their temperature to 24 to 26 degree Celsius and form a stronger gel. The cooling procedure facilitates need noodle suppression and creates a smooth, slippery noodle texture. And it this step takes about 1.5 to 2.5 minutes.

So, with this I have given you I hope you have got a good idea of these two products in this lecture nutria dal and fortified noodles. In earlier lecture, we talked about iron fortified rice. So, these are the if these products are prepared a later this technologies are commercially exploited, this have a vast potential of improving the nutrition status or health are providing nutrition and health security to the masses in the (Refer Time: 35:17).

Thank you very much.