

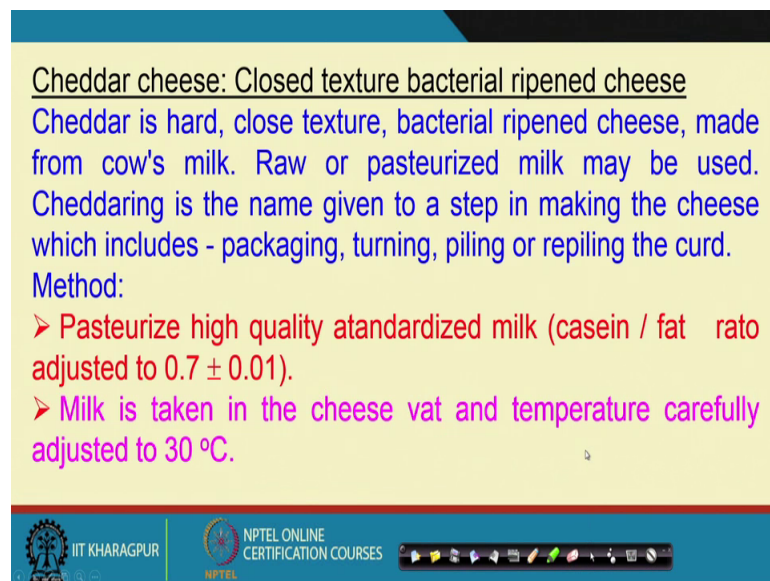
**Dairy and Food Process & Products Technology**  
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**Indian Institute of Technology, Kharagpur**

**Lecture – 52**  
**Cheddar Cheese**

So, we said in the previous class that, we have made cottage cheese, because very easy to prepare it right. You do not have to make, get rennet you do not have to do ripening all these. So, very easy and in many of the houses this cottage cheese nowadays, they are producing right. And it is almost similar to making paneer or things like that. So, it is not very very difficult.

But the other one which we now, will deal with is the cheddar 1 in our 52nd class. We will deal with the cheddar cheese and this is definitely a little more tough than preparing cottage cheese right. And let us look into how cheddar cheese is being made.

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Cheddar cheese: Closed texture bacterial ripened cheese  
Cheddar is hard, close texture, bacterial ripened cheese, made from cow's milk. Raw or pasteurized milk may be used. Cheddaring is the name given to a step in making the cheese which includes - packaging, turning, piling or repiling the curd.  
Method:  
➤ Pasteurize high quality atandardized milk (casein / fat rato adjusted to  $0.7 \pm 0.01$ ).  
➤ Milk is taken in the cheese vat and temperature carefully adjusted to 30 °C.

And cheddar is a typical term where you will see that piling re-piling all these are there right. So, you have a heap of this and they are a made upside down, so made a pile and then again upside down. So, like that this is basically to drain the moisture right. So, that is followed in this cheddar cheese preparation. So, let us look into the cheddar cheese, which is close texture bacterial ripened cheese and in this process, cheddar is hard, close texture, bacterial ripened cheese, made from cow's milk. Raw or pasteurized milk may be

used cheddaring is the name given to step in making cheese which includes- packaging, turning, piling, repiling the curd right. So, the method used let us go quickly, because we will have not veryvery high time, much time.

So, hopefully in this class, we should cover the cheddar cheese and rest of the part of the cheese. So, we will proceed a little quicker than earlier, unless there is a requirement for explicit explanation. We will proceed, because this is manufacturing process right. So, understanding is less, but the procedure is more. So, that will follow very quickly.

So, if we look at that the method is pasteurized high quality standard milk where casein fat ratio, it adjusted to 0.7 plus minus point 0.01 percent right. So, not percent, it is ratio casein to fat ratio is 0.07 plus minus 0.1 or 0.01. Milk is taken in the cheese vat and temperature is carefully adjusted to 30 degree centigrade, then inoculate, I hope inoculation we have said earlier also inoculation means suppose, we have this is a making process right and we have to inoculate say in a pipette, you take it and then add it to that.

This is from the source right from the starter culture, where you have taken is your definite quantity may be 1 ml 10 ml that depends on the quantity you have already measured and then you transfer it to that this is called inoculation right.

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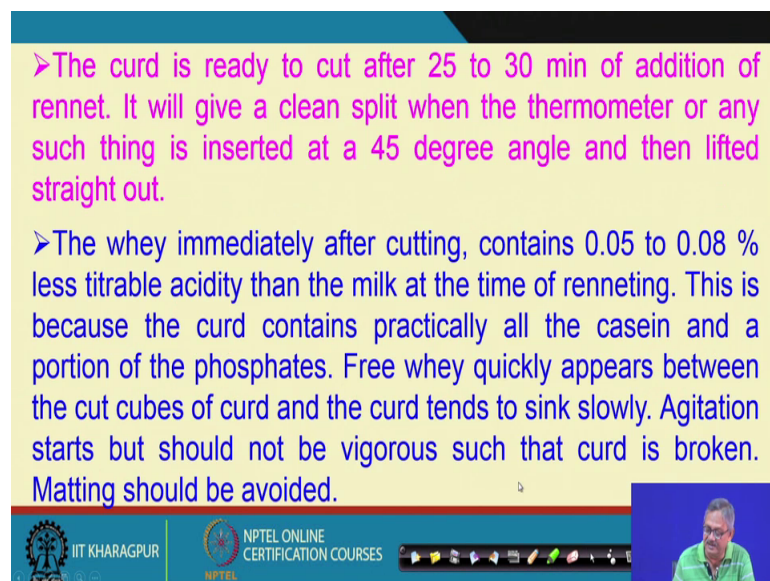
- Inoculate with fine active lactic starter at the rate of 0.5 to 1.0 %, usually 0.7% after straining and stir thoroughly.
- Test for acidity, should not be 0.005 to 0.01% higher than original.
- Generally 0.25 to .4 % rennet is added diluted to 20 time of its volume with cold water. It makes possible to distribute the rennet thoroughly and uniformly. Milk is stirred thoroughly for 3 to 5 min after rennet is added and agitators are taken out leaving a cover on the vat to keep the surface warm and clean. Curd is set.

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So, these inoculate with fine active lactic starter at the rate of 0.5 to 1 percent usually 0.7 percent after straining and stir thoroughly. So, test for acidity and that should not be 0.005 to 0.01 percent more than that right. Originally, 0.25 percent 0.25 to 0.4 percent rennet is added, diluted to 20 times of its volume with cold water and it makes possible to distribute the rennet thoroughly and uniformly, because you are diluting that is why the rennet which you are adding that is uniformly going to all over the milk, so that your localized fermentation is not there right, you are making culture.

So, that should be, that is why stirring is also required that uniformity of the distribution of the organisms are to be there. So, that the acidity is produced are also more or less same all over right. Now, milk is stirred, milk is stirred thoroughly for 3 to 5 minute after rennet is added and agitators are taken out, living a cover on the vat to keep the surface warm and clean curd is set.

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➤ The curd is ready to cut after 25 to 30 min of addition of rennet. It will give a clean split when the thermometer or any such thing is inserted at a 45 degree angle and then lifted straight out.

➤ The whey immediately after cutting, contains 0.05 to 0.08 % less titrable acidity than the milk at the time of renneting. This is because the curd contains practically all the casein and a portion of the phosphates. Free whey quickly appears between the cut cubes of curd and the curd tends to sink slowly. Agitation starts but should not be vigorous such that curd is broken. **Matting should be avoided.**

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Now, after that curd is ready to cut after 25 to 30 minute of addition of the rennet. It will give a clean split when the thermometer or any such thing is inserted at 45 degree angle and then lifted straight out. I do not know whether you have seen at home that your seniors they are making cake and other things right. So, it is a bake product. So, when cake is being made. So, that cake from outside you will not be say this one outside, you will not be able to see whether the interior moisture is also dried or not.


So, for that what do they do they also put a stick and put it inside and see whether moisture is adhering to that or not. In the same similar way here also you are testing that moisture right. So, that 45 degree angle and then lifted straight out right.

Then, when way immediately after cutting contents around 0 to 0.5 to 0.08 whereas, the 0.05 to 0.08 percent less titrable acidity than the milk, at the time of renneting; this is because the curd contains practically all the casein and a portion of the phosphates. Free whey quickly appears between the cut cubes of curd and the curd tends to sink slowly. Agitation starts, but should not be vigorous such that curd is broken. Then matting should also be avoided right.


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Heating or cooking begins within 15 minutes after cutting. Enough free whey should be there in the vat to float the curd. It helps to keep curd away from direct contact with the vat. Cooking should be started slowly so that 38.8 °C will reach in 30 mins as:


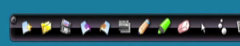
Min after turning on steam	Temp. of curd & whey
0	31 °C
5	31.6 °C
10	32.6 °C
15	33.8 °C
20	35.5 °C
25	37.2 °C
30	38.8 °C



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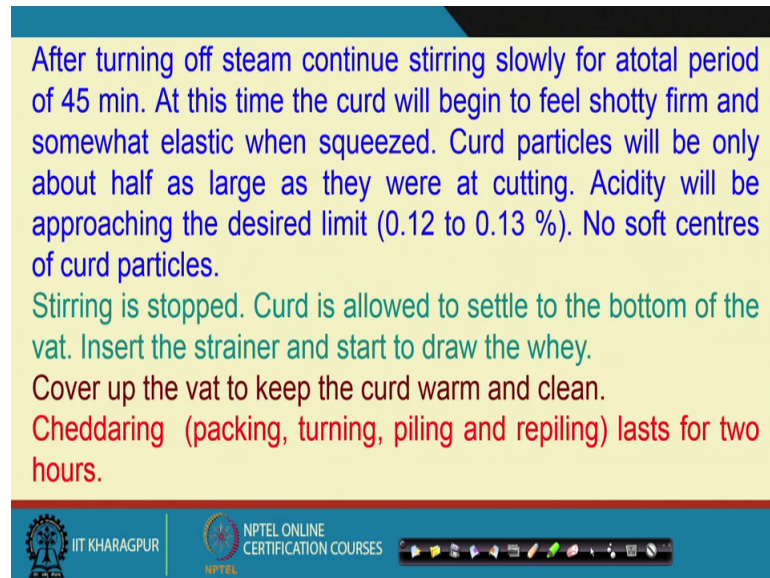


Then we come to that heating or cooking begins within 15 minutes after cutting. Enough free whey should be there in the vat to float the curd. It helps to keep curd away from direct contact with the vat and cooking should be started slowly so that 38.8 degree centigrade will reach within 30 minutes.

The time temperature combination is like is that 0th time, if the temperature is 31 degree centigrade, after 5 minutes it should be 31.6 degree centigrade, after 10 minutes it should be 32.6 degree centigrade, after 15 minutes it should be 33.8 degree centigrade, 20 minutes 35.5, 25 minutes 37.2 and 30 minutes 38.8. So, this way the temperature is increased very slowly over a period of 30 minutes right.

So, that is why I said in the beginning that making cottage cheese is much easier; so, but cheddar cheese another process where both ripening are also there, that is why I thought, let it also be told to you right.

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After turning off steam continue stirring slowly for a total period of 45 min. At this time the curd will begin to feel shotty firm and somewhat elastic when squeezed. Curd particles will be only about half as large as they were at cutting. Acidity will be approaching the desired limit (0.12 to 0.13 %). No soft centres of curd particles.

Stirring is stopped. Curd is allowed to settle to the bottom of the vat. Insert the strainer and start to draw the whey.

Cover up the vat to keep the curd warm and clean.

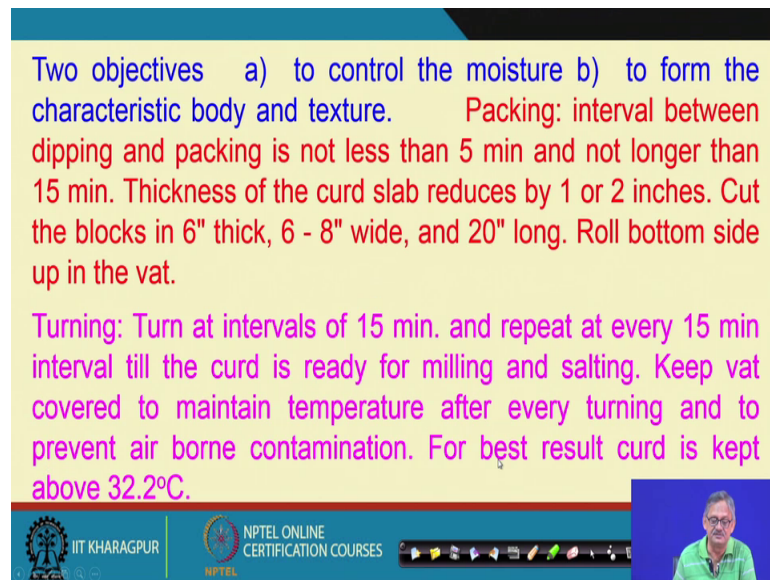
Cheddaring (packing, turning, piling and repiling) lasts for two hours.

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Then after turning off steam continue stirring slowly for a total period of 45 minute at this time the curd will be will begin to fill short will begin to fill shotty firm and somewhat elastic when squeezed. Curd particles will be only about half as large as they were at cutting. Acidity will be approaching the desired limit of 0.12 to 0.13 percent. No soft centers of curd particles are there right.

Stirring is stopped. Curd is allowed to settle to the bottom of the vat. Insert this stir, insert the strainer and start to draw the whey. So, by strainer you have seen that people are using things like some net where the fish ring is being done similar way that, through that the strainer this curd is lifted or separated. Cover the vat to keep the curd warm and clean. And cheddaring that is packing, turning, piling and repiling is there and it lasts for around 2 hours, right.

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Two objectives a) to control the moisture b) to form the characteristic body and texture. Packing: interval between dipping and packing is not less than 5 min and not longer than 15 min. Thickness of the curd slab reduces by 1 or 2 inches. Cut the blocks in 6" thick, 6 - 8" wide, and 20" long. Roll bottom side up in the vat.

Turning: Turn at intervals of 15 min. and repeat at every 15 min interval till the curd is ready for milling and salting. Keep vat covered to maintain temperature after every turning and to prevent air borne contamination. For best result curd is kept above 32.2°C.

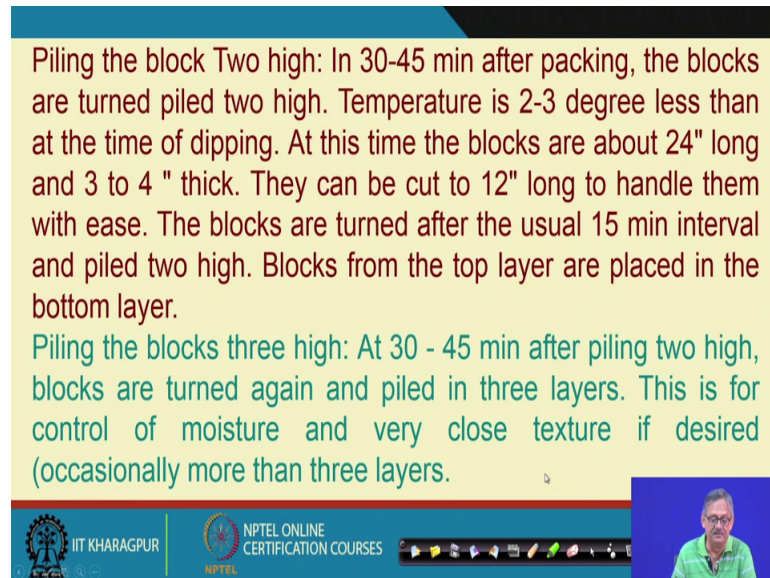
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Then, your cheddaring is done. There are two objectives to do that cheddaring: a one is to control the moisture, and another is to form the characteristics body and texture. Now, these four things which are primary for the cheddaring or cheddar cheese that should be: one is packaging that is interval packaging, interval between dipping and packing is not less than 5 minute and not longer than 15 minute within 5 to 15 minute has to be done. Thickness of the curd slab reduces by a 1 or 2 inches, cut the blocks in 6 inch thick or 6 and 8 inch wide and 20 inch long right.

So, you have a block where it is 6 inch in thickness right, 6 inch in thickness; so this is the 6 inch and 6 to 8 inch wide. So, that is 6 to 8 inch wide, the other one is the; this is 6 to 8 inch wide and long maybe 20 inch. So, we have made a little bigger right. So, roll bottom side up in the vat then turning. So, turn at intervals of 15 minute and repeat at every 15 minute interval, till the curd is ready for milling and salting, keep vat covered to maintain temperature after every turning and to prevent air borne contamination for best result curd is kept above 32.2 degrees centigrade.



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The image shows a slide from an NPTEL presentation. The slide has a yellow background with red and green text. The red text describes piling blocks two high, and the green text describes piling blocks three high. At the bottom of the slide, there is a blue banner with the IIT Kharagpur logo, the NPTEL logo, and the text 'NPTEL ONLINE CERTIFICATION COURSES'. A small video inset of a man in a green shirt is visible in the bottom right corner of the slide.

Piling the block Two high: In 30-45 min after packing, the blocks are turned piled two high. Temperature is 2-3 degree less than at the time of dipping. At this time the blocks are about 24" long and 3 to 4 " thick. They can be cut to 12" long to handle them with ease. The blocks are turned after the usual 15 min interval and piled two high. Blocks from the top layer are placed in the bottom layer.

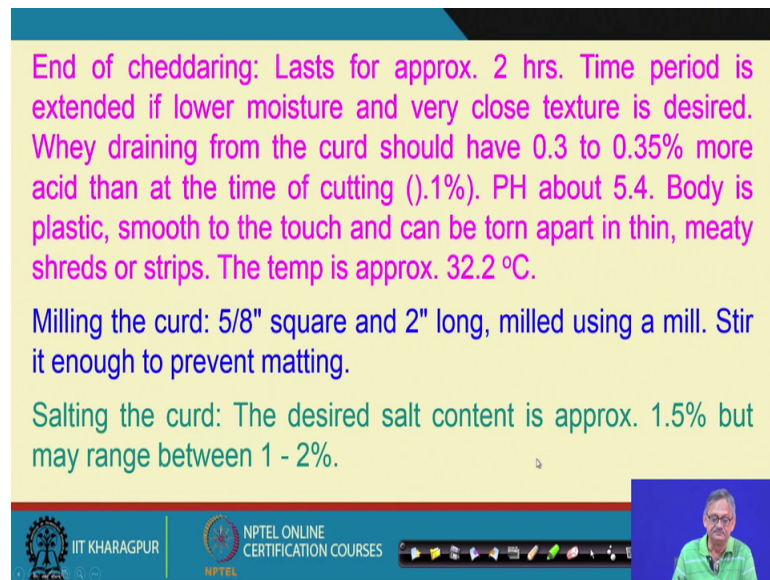
Piling the blocks three high: At 30 - 45 min after piling two high, blocks are turned again and piled in three layers. This is for control of moisture and very close texture if desired (occasionally more than three layers).

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Then your piling and repiling comes. So, piling is done, piling the block two high in 30 to 45 minute, after packing the blocks are turned piled two high temperatures is 2 to 3 degree, less than at the time of dipping. At this time the blocks are about 24 inch long and 3 to 4 inch thick. They can be cut to 12 inch long to handle them with ease, the blocks are turned after the usual 15 minute interval and piled two high blocks from the top layer are placed in the bottom layer.

Piling the blocks three high at 30 to 45 minute, after piling two high blocks are turned again and piled in three layers. This is for control of moisture and very close texture, if desired occasionally more than three layers are also being made right.

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End of cheddaring: Lasts for approx. 2 hrs. Time period is extended if lower moisture and very close texture is desired. Whey draining from the curd should have 0.3 to 0.35% more acid than at the time of cutting (0.1%). PH about 5.4. Body is plastic, smooth to the touch and can be torn apart in thin, meaty shreds or strips. The temp is approx. 32.2 °C.

Milling the curd: 5/8" square and 2" long, milled using a mill. Stir it enough to prevent matting.

Salting the curd: The desired salt content is approx. 1.5% but may range between 1 - 2%.

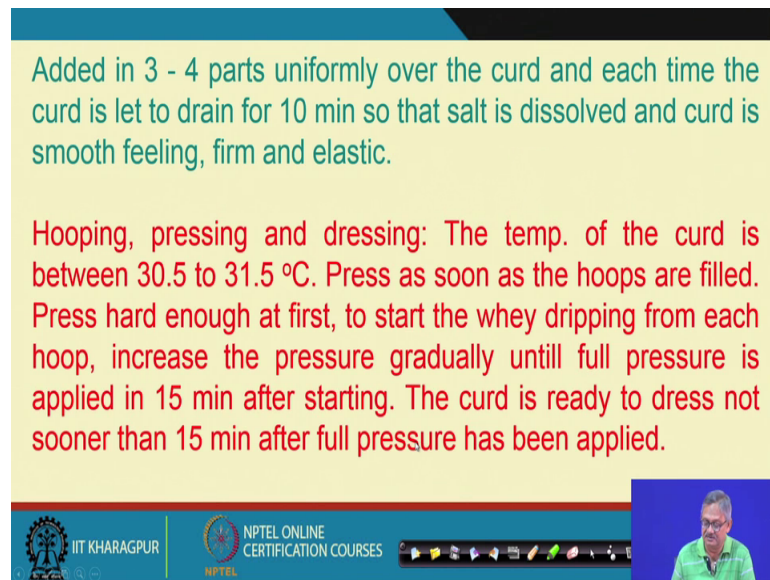
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Then end of the cheddaring, how we will come to know that it lasts for approximately 2 hours time period is extended, if lower moisture and very close texture is desired. So, the lower the moisture, the texture will be very close be the higher the moisture texture will be a little open right. So, more compactness will be there, if the moisture content is low; that is why if you need more then maybe some more time you have to add. Whey draining from the curd should have 0.3 to 0.35 percent more acid then at the time of cutting around 1 percent. PH about 5.4 body is plastic smooth to the touch and can be torn apart in thin meaty shreds or strips the temperature is approximately 32 degree centigrade, then it is milled.

So, milling the curd is around with 5 8 inch square and 2 inch long milled, using a mill. Stir it enough to prevent matting rather stir it enough to prevented matting and then salting the curd, the desired salt content is approximately around 1.5 percent, but may not range between or it should not be more than 2 percent, maybe it is ranging between 1 to 2 percent.



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Added in 3 - 4 parts uniformly over the curd and each time the curd is let to drain for 10 min so that salt is dissolved and curd is smooth feeling, firm and elastic.

Hooping, pressing and dressing: The temp. of the curd is between 30.5 to 31.5 °C. Press as soon as the hoops are filled. Press hard enough at first, to start the whey dripping from each hoop, increase the pressure gradually until full pressure is applied in 15 min after starting. The curd is ready to dress not sooner than 15 min after full pressure has been applied.

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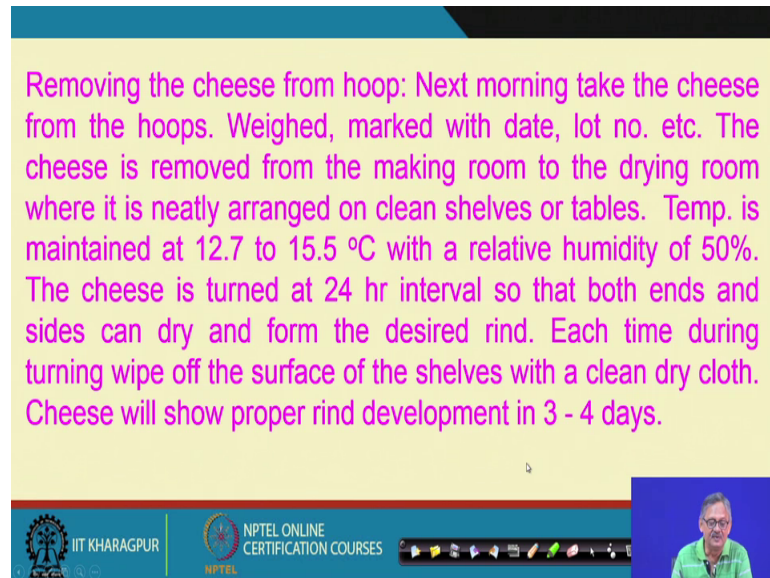
Then add this, added this, salt is added in 3 to 4 parts uniformly over the curd and each time the curd is led to drain for 10 minutes, so that salt is dissolved and curd is smooth feeling firm and elastic.

Then hooping: the hooping is a another one which I give example: that you might have seen at home your seniors, they are making some something like, like, like embroidery or things like that. So, they are making a frame right and in that frame there are two; maybe if it is circular one, but the (Refer Time:15:15) s may be square or, or, or rectangular depending on what type of things are being done. But there if we say, if it is rectangular, if it is circular then there are two and then at on the top there is some thread and nut things are there to tighten and other things and the cloth is placed between the two right.

So, hooping is such a thing right, you have one such container right and in that another container say like this. So, this is the open space right. And your strainer or the cloth is put in between so that your material that is the curd can be put in that. So, that is what hooping.

So, hooping, pressing, and dressing are done, the temperature of the curd is between 30.5 to 31.5 degree centigrade. Press as soon as the hoops are filled, press hard enough at first to start the way dripping from each hoop, increase the pressure gradually until full pressure is applied in 15 minute after starting. The curd is ready to dress, not sooner than 15 minute after full pressure has been applied.

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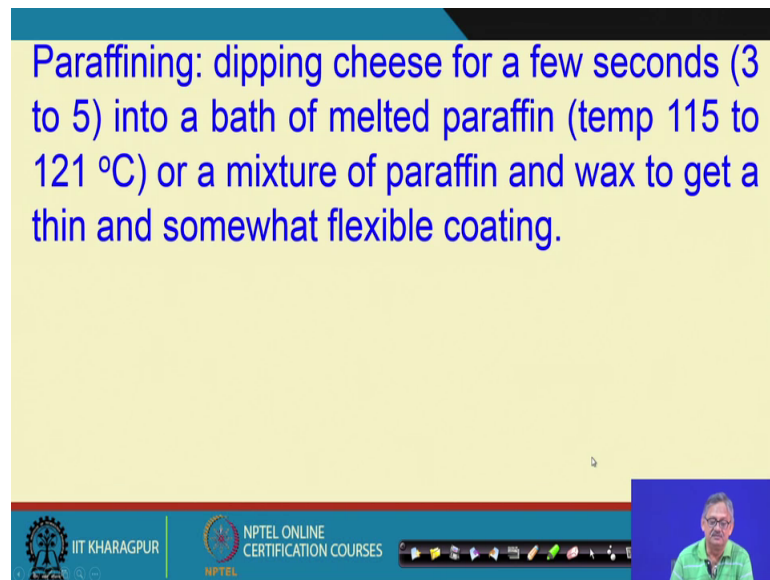
Removing the cheese from hoop: Next morning take the cheese from the hoops. Weighed, marked with date, lot no. etc. The cheese is removed from the making room to the drying room where it is neatly arranged on clean shelves or tables. Temp. is maintained at 12.7 to 15.5 °C with a relative humidity of 50%. The cheese is turned at 24 hr interval so that both ends and sides can dry and form the desired rind. Each time during turning wipe off the surface of the shelves with a clean dry cloth. Cheese will show proper rind development in 3 - 4 days.

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Then, removing the cheese from the hoop is like that; removing the cheese from the hoop is that next morning, take the cheese from the hoops weighed marked with date, lot number etcetera. The cheese is removed from the making room to the drying room, where it is neatly arranged on clean shelves or tables. Temperature is maintained around 12.7 to 15.5 degree centigrade with relative humidity of around 50 percent. That means, you see that in relative humidity is made low, such that moisture from outside cannot come in right.

So, moisture from outside cannot come in and that is the primary for this river from the hooping, when you are packing it, so that moisture is adhere to or if it is observed, then the closeness of the cheese will be hampered right. So, moist is the humidity is around 50 percent, the cheese is turned at 24 hour interval so that both ends and sides can dry to form rather desired rind. Each time during turning wipe off the surface of the shelves with a clean dry cloth, cheese will show proper rind development in 3 to 4 days.

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Paraffining: dipping cheese for a few seconds (3 to 5) into a bath of melted paraffin (temp 115 to 121 °C) or a mixture of paraffin and wax to get a thin and somewhat flexible coating.

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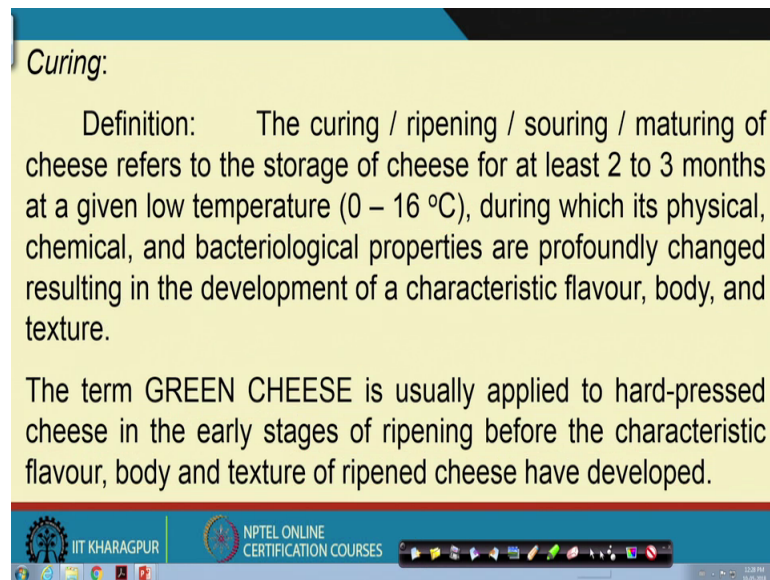
Then paraffining: again this is of course, nowadays in many cases paraffins are not used, but I do not know, you can ask your parents, if they are sufficiently old. Then in a earlier days, when this jam jelly marmalade, they were also available in the market, then the people used to put one layer of paraffin on the top right.

The primary reason is that it should not allow the moisture to go out number 1 and that cap, which you are putting when if some moisture is evaporated and put some droplets over there, should not fall into that. So, that contamination can take place. So, here also this paraffining is primarily done to allow, rather to ,keep the moisture inside the cheese intact right.

So, paraffining is done, cheese for a few seconds, there is 3 to 5 minute into a batch of melted paraffin right. Temperature is around 115 to 121 degree centigrade or a mixture of paraffin and wax to get a thin and somewhat flexible coating.

So, these coating helps the moisture to remain inside. That is the primary objective that moisture should not go out right.

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**Curing:**

**Definition:** The curing / ripening / souring / maturing of cheese refers to the storage of cheese for at least 2 to 3 months at a given low temperature (0 – 16 °C), during which its physical, chemical, and bacteriological properties are profoundly changed resulting in the development of a characteristic flavour, body, and texture.

The term GREEN CHEESE is usually applied to hard-pressed cheese in the early stages of ripening before the characteristic flavour, body and texture of ripened cheese have developed.

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Then curing: these are some associated things, which we are now covering right. Because this is not only in the case of cheddar cheese, but also in all other cheese, these words or these for typical operations are also done curing, then your green cheese, what is that The name green appears, that it is green in colored makes not so like that. So, these are associated which we said that we shall, we should cover in this and I do not know how many still we have around 5 minutes time. Within this we should finish cheese otherwise we will be in trouble with time, right.

So, curing definition is like this that the curing or ripening or souring or maturing of cheese refers to the storage of cheese for at least 2 to 3 months at a given low temperature of 0 to 16 degree centigrade. During which physical chemical bacteriological properties are profoundly changed, resulting in the development of characteristic flavor body and texture, right. The term green cheese that which we call is usually applied to hard pressed cheese in the early stage of ripening before the characteristic flavor body and texture of ripen cheese are developed.

So, it is before the cheese is ripened, whatever you have received now, you will put it for ripening that is called green cheese right. So, green cheese is unripened, before it is putting into ripening that is the green cheese right.

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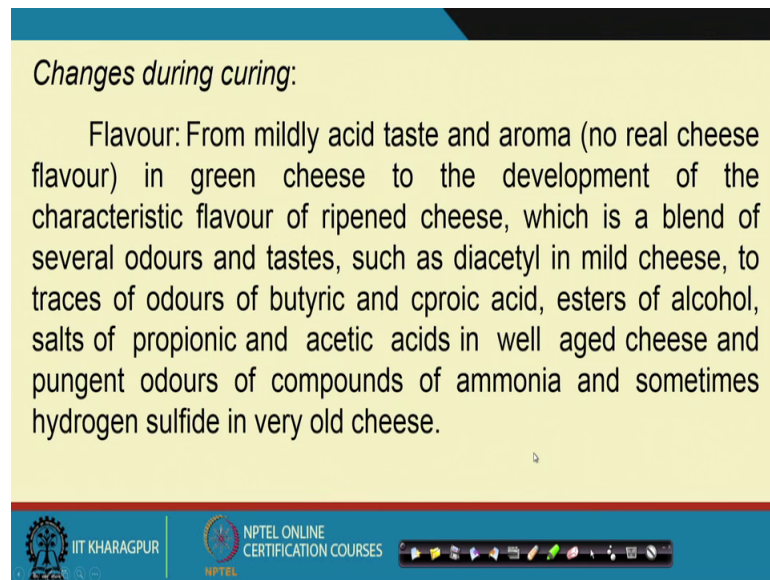
Ripening agents: mainly bacteria and moulds and enzymes including pepsin. System of curing

Particulars	Cold curing	Warm curing
Temperature	0 – 4 °C Avg. 1.5 °C	10 – 16 °C Average 12.5 °C
Humidity	75 %	85 %
Duration	3 to 12 mths	½ to 2 mths
Quality of cheese obtained	Mild flavour, bacterial defects minimized	Sharp flavour, bacterial defects exaggerated.

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Then ripening agents are many, so mainly bacteria and moulds and enzymes including pepsin. They are used and the system of curing is like that say some examples, we have given that temperature between 0 to 4 degree centigrade that is called cold curing and if it is one curing between 10 to 16 degree centigrade, average temperature is 1.5 and average temperature is 12.5. Humidity, generally high, humidity 75 percent 85 percent, duration here, it is for cold curing 3 to 12 months, for one curing it is up to 2 months. And quality of cheese obtained is normally mild flavour bacterial defects minimized and it could be sharp flavour bacterial defects could be exaggerated, because temperature is increased right.

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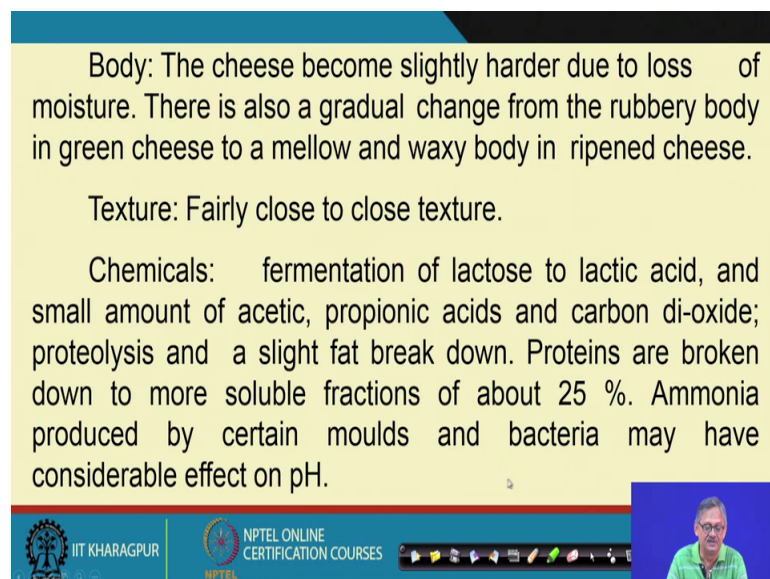
*Changes during curing:*

Flavour: From mildly acid taste and aroma (no real cheese flavour) in green cheese to the development of the characteristic flavour of ripened cheese, which is a blend of several odours and tastes, such as diacetyl in mild cheese, to traces of odours of butyric and cproic acid, esters of alcohol, salts of propionic and acetic acids in well aged cheese and pungent odours of compounds of ammonia and sometimes hydrogen sulfide in very old cheese.

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Then, changes during curing, what it makes: first is flavor lot many flavors are developed from mildly acid taste and aroma, no real cheese flavor in green cheese to the development of the characteristic flavour of ripened cheese, which is a blend of several odours and tastes, such as in diacetyl in mild cheese to traces of odours of butyric and cproic. This is a cproic acid, esters of alcohol, salts of propionic acid and acetic acids in well aged cheese and pungent odours of compounds of ammonia and sometimes hydrogen sulfide in very old cheese. That is during curing, it is developed in flavor right.

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Body: The cheese become slightly harder due to loss of moisture. There is also a gradual change from the rubbery body in green cheese to a mellow and waxy body in ripened cheese.

Texture: Fairly close to close texture.

Chemicals: fermentation of lactose to lactic acid, and small amount of acetic, propionic acids and carbon di-oxide; proteolysis and a slight fat break down. Proteins are broken down to more soluble fractions of about 25 %. Ammonia produced by certain moulds and bacteria may have considerable effect on pH.

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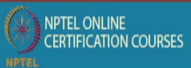



Somebody are also developed texture fairly close to close texture chemicals, which are used are fermentation of lactose to lactic acid and small amount of acetic, propionic acid and carbon dioxide. They are also formed proteolysis and a slight fat break down proteins are broken down to more soluble fractions of about 25 percent ammonia produced by certain moulds and bacteria may have considerable effect on pH.

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*pH of cheese (cheddar) in relation to age*

Age of cheese	PH
3 days	5.05
7 days	5.06
49 days	5.13
9 months	5.32
24 months	5.58



Then, pH is generally like this in the cheddar cheese typically, it appears like that in relation to the age 3 days old your pH is 5.05, 7 days old 5.06, 49 days old 5.13, 9 months old 5.32 and 25, 24 months, 2 year old 5.58. So, you see from 5 to 0.58 that is increased pH right. So, the acidity of course, is getting decreased right. The value of pH mould means the acidity is becoming less.


Then I hope this is perhaps the, a microbial changes ok.

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Microbiological changes

All cheese should contain predominantly lactic streptococci during manufacture and early stage of curing. Cheddar cheese are low in moisture and close in texture sustain a steady change over from streptococci to lactobacilli, some of which contribute to the flavour. Other types are of course present and the higher the proportion of miscellaneous types, the quicker is the curing and greater the possibility of off-flavours.


Ripening index = ( % soluble nitrogen / % total nitrogen ) X 100



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All cheese should contain predominantly lactic streptococci during manufacture and early stage of curing cheddar cheese are low in moisture and close in textures that sustain a steady change over from streptococci to lactobacilli, some of which contribute to the flavor. Other types of are of course, present and the higher the proportion of miscellaneous types, the quicker is the curing and greater the possibility of off flavor right. So, ripening index is percent soluble nitrogen over percent total nitrogen times 100.

So, I hope we have cross the time, and let us say that we have said as much as we can in cheese, right.

Thank you.