

1
2
3
4
5
6
7
8

Dairy and Food Process & Products Technology
Prof. Tridib Kumar Goswami
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 45
Milk Pasteurization and Homogenization (Contd.)

9So, we stop in this Dairy and Food Process and Products Technology that milk
10pasteurization and organization continuation class. So, there we have said that what are
11the steps required for pasteurization.

12(Refer Slide Time: 00:30)

Steps of pasteurization

Before you begin pasteurization, chances are high that you will be bulking milk to attain an economically viable volume. Milk being a highly perishable product, it requires extreme care to avoid incurring losses. For this reason, it is necessary to chill the milk to avoid spoilage.

a). Milk chilling

Chilling is not a pasteurization process but it is a necessary step when dealing with large volumes of milk. Milk leaves the cow's udder at temperatures above the ambient, which encourages rapid bacterial multiplication that speeds up spoilage. However, reducing the temperatures to between 2° C to 5° C arrests bacterial growth and metabolism. This provides a head start at keeping the quality before proper pasteurization commences.

Chilling may affect the quality of the product negatively if it is kept for long. Psychrotrophic bacteria will cause proteolysis of protein, which leads to bitter flavor attributed to the released polypeptides.

The slide also features the IIT Kharagpur logo and NPTEL Online Certification Courses branding at the bottom.

13

14Now, will go quickly because our this 45th class, so 15 more classes already left. So, we
15cannot we cannot elaborate, so much though these slides will be with you. So, you can
16also go through, but I will not highlight, so much as we had been doing.

17So, milk chilling that is one chilling is not a pasteurization process, but it is a necessary
18step when dealing with large volumes of milk. Milk leaves the cows under at temperature
19this is why required because this is pre-pasteurization steps, before beginning of the
20pasteurization you need to because what you are doing you are in the bulk. When you are
21getting from different places you are storing them in one place that is why chilling is a
22must, because already heating has not started pasteurization is the first process where
23you are heating is being done, but before that when you are a accumulating all milk from

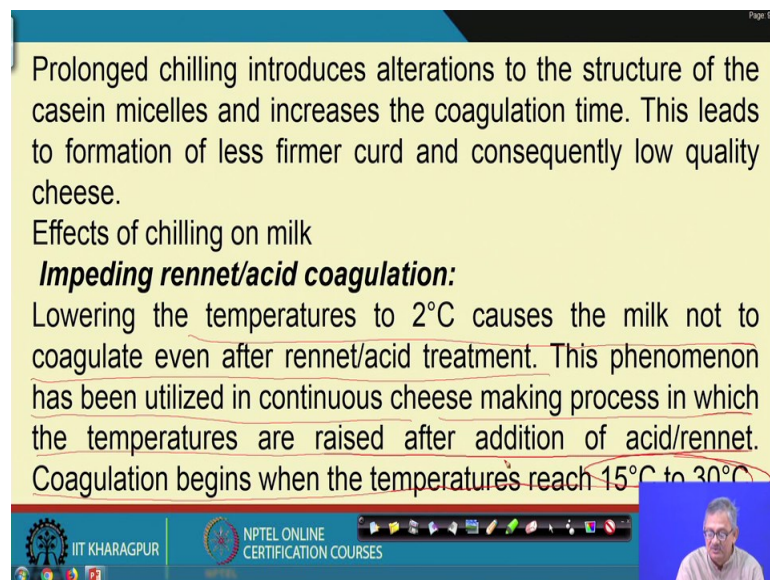
1
2

1different sources. So, that that you have to keep them under chilled condition that is why
2chilling prior to your pasteurization is required right.

3So, that more I will not will not follow them right, so chilling may affect the quality of
4the product negatively if it is kept for a long time, because psychrotrophic bacteria will
5cause proteolysis for protein which leads to bitter flavor attributed to the released
6polypeptides right; that means, that you thought you will bring all milk from different
7places and then after couple of days you will start doing that processing of pasteurization
8not at all encourage able, because I said earlier that there are three types of bacteria that
9is psychrophilic, mesophilic and thermophilic.

10So, when you are chilling psychrophiles will be there, so they may act on the proteins
11and rest and may contribute to bad flavor odor color etcetera all negative. So, that is not
12desirable, so chilling you do chill, but not for a long time; so, that that those organisms
13can grow and act on your product right. So, this is one very vital step you have to
14remember or keep in mind right.

15(Refer Slide Time: 03:42)



Prolonged chilling introduces alterations to the structure of the casein micelles and increases the coagulation time. This leads to formation of less firmer curd and consequently low quality cheese.

Effects of chilling on milk

Impeding rennet/acid coagulation:

Lowering the temperatures to 2°C causes the milk not to coagulate even after rennet/acid treatment. This phenomenon has been utilized in continuous cheese making process in which the temperatures are raised after addition of acid/rennet. Coagulation begins when the temperatures reach 15°C to 30°C.

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

16

17Then prolonged chilling introduces alterations to the structure of the casein micelles and
18increases the coagulation time. Now, effect of chilling on milk what are their impeding
19rennet acid coagulation.

1 So, lowering the temperature to 2°C causes the milk not to coagulate even after rennet
2 acid treatment. So, even is too cold then even if you do rennet that is one type of enzyme
3 available in the in the calf your that in the calf belly from there it is coming stomach of
4 the calf it is coming and or rennet or other coagulant like your lactic acid producing
5 organisms even then they are or even if you directly put acid they are not. So, good to
6 separate the fat, protein that is channa. So, very low temperature is also not desirable for
7 different purposes.

8 So, this phenomenon has been utilized continuous cheese making process in which the
9 temperatures are raised after addition of the acid coagulated big and that begins when the
10 temperature reaches around 15 to 30°C that is one application right.

11 (Refer Slide Time: 05:30)

No coagulation of milk at isoelectric point: pH - 4.6
Even after adjusting the pH of casein to isoelectric point (IP), the milk will not coagulate if its temperature ranges between 2°C and 5°C.
Low temperatures encourage the formation of many diffusible inorganic salts that distorts the micellar structure of casein leading to formation of more non-micellar (soluble) casein. Consequently, one you have to lower the pH of the medium further to achieve complete coagulation. However, acid coagulation leads to formation of a less rubbery coagulum.

12

13 Then no coagulation of milk is at isoelectric point, so even after adjusting the pH of
14 casein, casein to isoelectric point the milk will not coagulate if the temperature ranges
15 between 2 to 5°C. So, you have brought down the pH 4.6, that is the isoelectric point, but
16 even then coagulation is not taking place, so that is the bad part of the chilled right.

17 The best example at home you ask your mummy that when you are making channa, if the
18 milk was in the freezer, I do not say that in the deep freezer if the milk was in the freezer
19 which is in good condition and if the temperature is too low. Then if whether she had put
20 any time any acid like maybe generally at home you acid citric acid that is the cite
21 coming from even orange or lemon and coming from the lemon. So, that citric acid is

1

3

2

1 added whether coagulation took place or not to ask and most of the time she will say no
2 she prefers, before adding to heat that milk and bring it to the certain temperature and
3 then add then only coagulation takes place. So, this is a negative part of the too cold.

4 Low temperature can encourage the formation of many diffusible inorganic salts that
5 distorts the micellar structure of the casein leading to formation of more micellar or
6 soluble casein. Consequently, one you have to lower the pH of the medium further to
7 achieve complete coagulation. However, acid coagulation leads to formation of a less
8 rubbery coagulum right.

9 (Refer Slide Time: 08:00)

Chilling increases viscosity of milk:
Viscosity of milk largely depends on its colloidal components, of which proteins forms the bulky part. Chilling changes the structure of milk proteins leading to an increase in their bulk hence the increase in milk viscosity at chilled temperatures.

Chilling decreases in cheese curd firmness:
Milk chilling affects the ratio of calcium:phosphate hence their interaction in the colloid solution. A drop in this ratio leads to an increase in the duration it takes for the milk to coagulate. To counter this problem, add calcium chloride to cheese milk before cold aging starts.

10

11 We are moving fast because chilling increases viscosity of milk that is true this is more
12 prominent when you will understand much when your ice cream mix is being chilled
13 after pasteurize homogenized and aged, for couple of hours to increase the viscosity. So,
14 when you go to ice cream hopefully we will deal with better or in a bigger way right.

15 So, viscosity of milk largely depends on its colloidal components of which proteins
16 forms the bulk part chilling, changes the structure of the milk proteins leading to an
17 increase in their bulk, hence the increase in milk viscosity at chilled temperatures
18 chilling decreases the curd firmness, cheese curd firmness. So, that is another
19 disadvantage right, so milk chilling affects the ratio of calcium to phosphate, hence their
20 interaction in the colloid solution a drop in this ratio leads to an increase in the duration it

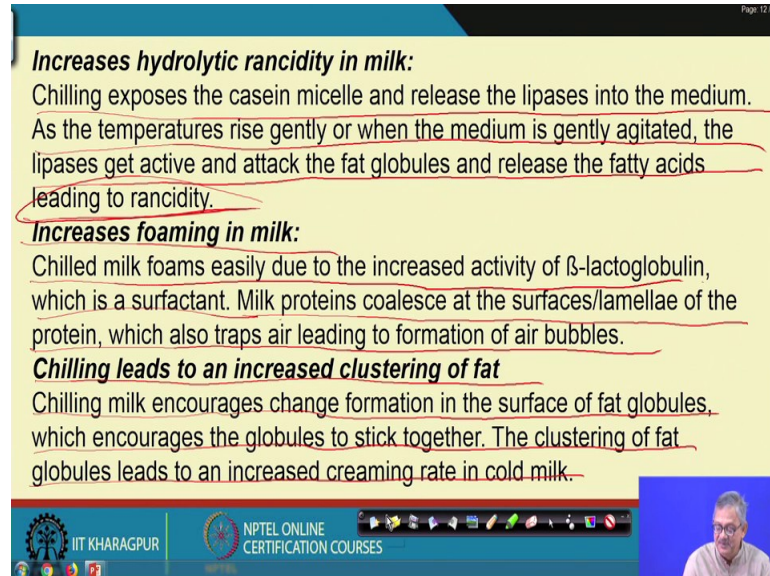
1

4

2

1takes for milk to coagulate to encounter this problem and add calcium chloride to cheese
2milk before cold aging starts right.

3(Refer Slide Time: 09:45)



Increases hydrolytic rancidity in milk:
Chilling exposes the casein micelle and release the lipases into the medium.
As the temperatures rise gently or when the medium is gently agitated, the lipases get active and attack the fat globules and release the fatty acids leading to rancidity.

Increases foaming in milk:
Chilled milk foams easily due to the increased activity of β -lactoglobulin, which is a surfactant. Milk proteins coalesce at the surfaces/lamellae of the protein, which also traps air leading to formation of air bubbles.

Chilling leads to an increased clustering of fat
Chilling milk encourages change formation in the surface of fat globules, which encourages the globules to stick together. The clustering of fat globules leads to an increased creaming rate in cold milk.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES

4

5Then increases hydrolytic rancidity in milk chilling, chilling exposes the casein micelle
6and releases the lipases into the medium as the temperature rise gently or when the
7medium is gently agitated the lipases get active and attack the fat globules and release
8the fatty acids leading to rancidity, so that is also bad.

9Increased foaming in milk chilled milk foams easily due to the increased activity of the
10beta lactoglobulin. Which is a surfactant and milk protein coalesce add the surface or
11lamellae of the protein which also traps air leading to formation of air bubbles. Then
12chilling leads to an increased clustering of a of fat, chilling milk encourages change
13formation in the surface of the fat globules which encourages the globules to stick
14together the clustering of fat globules is leads to an increased creaming rate in cold milk.

1

5

2

1(Refer Slide Time: 11:17)

Pre-heating (regeneration) and standardization stage

After bulking, the chilled milk is heated to about 40°C to facilitate easy separation of butter fat during standardization. The system uses regenerative heating, i.e., it uses the heat of the already pasteurized milk to heat up the incoming chilled milk. The chilled milk, in a counter current flow, cools down the pasteurized milk.

The purpose of standardization is to obtain a product with uniform content of butter fat. Different products can be obtained from this process e.g. skimmed milk, standardized milk, low fat milk, high fat milk, etc.

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

2

3Pre-heating or regeneration this is another, but so chilling part we have finished that pre
4chilling if it is too cold if it is for longer period what is the bad effect those we are dealt
5with right. Now, I go to pre heating you remember we have said that in most of the most
6of the pasteurizers commercial. The pasteurizer because pasteurization what do you are
7doing you are heating. So, when you are heating and after eating you are cooling them
8sharply. So, if you are doing that, so you are then heating and cooling simultaneously.

9So, lot of lot of energy you are employing to overcome this if you can utilize that you are
10you just said that you have you have accumulated from different sources milk and this
11milk when you are pasteurizing heating before that you have chilled. So, that temperature
12is low, so before it is going to pasteurizer if this temperature could be used by the heat
13exchange that is called regeneration by regional heating, because already pasteurized
14milk that can act as a pre heater for this chilled milk that is what here we are doing.

15So, pre heating pre heating and standardization stage, after bulking the chilled milk is
16heated to about 40 degree centigrade to faciliated easy separation of butter fat during
17standardization. The system uses regenerative of heating, that is it uses the heat of the
18already pasteurized milk to heat of the inoculum or incoming rather incoming chilled
19milk, the chilled milk in a counter current flow cools down in the pasteurized milk,
20purpose of the standardization is to obtain product with uniform constituent of butter fat

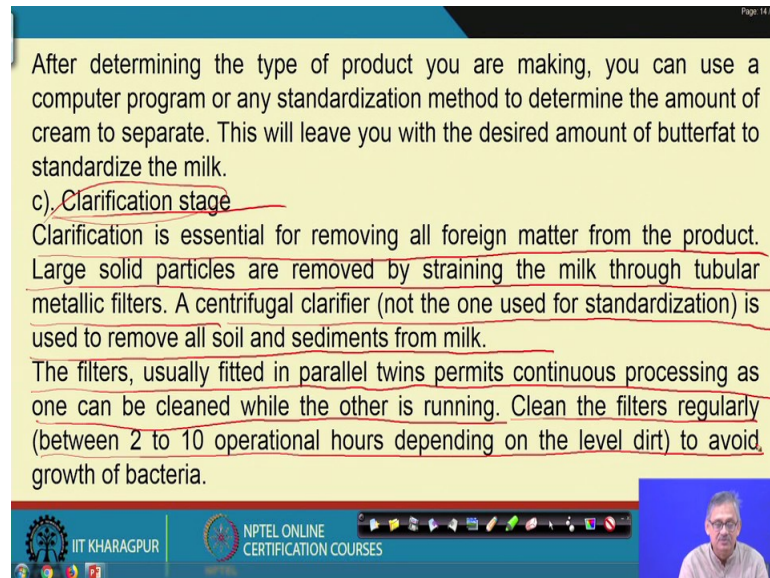
1

6

2

1 different products can be obtained from this process for example, skim milk,
2 standardized milk, low fat milk, high fat milk etcetera right.

3 (Refer Slide Time: 14:00)



The slide contains the following text:

After determining the type of product you are making, you can use a computer program or any standardization method to determine the amount of cream to separate. This will leave you with the desired amount of butterfat to standardize the milk.

c). Clarification stage

Clarification is essential for removing all foreign matter from the product. Large solid particles are removed by straining the milk through tubular metallic filters. A centrifugal clarifier (not the one used for standardization) is used to remove all soil and sediments from milk.

The filters, usually fitted in parallel twins permits continuous processing as one can be cleaned while the other is running. Clean the filters regularly (between 2 to 10 operational hours depending on the level dirt) to avoid growth of bacteria.

The slide footer includes the IIT KHARAGPUR logo, NPTEL ONLINE CERTIFICATION COURSES text, and a small video feed of a speaker.

4

5 Then after doing this pre heating or regeneration you are going to after determining the
6 type of product you are making, you can use a computer program or any standardization
7 method to determine the amount of cream separation or amount of cream to be separated,
8 or to separate this will leave you with the desired amount of butter fat to standardize
9 milk.

10 Then this step comes in is the clarification right, clarification stage because if you are not
11 clarifying the milk that if it contains some undesirable things which are visible or which
12 you can fill, so that has to be separated. So, that is done under this segment that is
13 clarification stage. So, in this what you are doing clarification is essential for removing
14 all foreign matter from the product large solid particles are removed by straining the milk
15 through tubular metallic filters a centrifugal separator also or clarifier not the one used
16 for standardization is used to remove all an all soil and sediments from the milk.

17 The filters usually fitted in parallel twins permits continuous processing as one can be
18 cleaned while the other running. So, that is the use ease, so one both are in parallel. So,
19 one it is running and another is being cleaned and another is running the former one is
20 being cleaned, so that is when clean one.

1

7

2

1So, clean the filters regularly between 2 to 10 operation hours depending on the level of
2that relevant encountered to avoid growth of the organisms. So, otherwise if you are not
3cleaning then what will happen this milk which was residing inside? So, that will be a
4very good source of the organisms to grow. So, that may contaminate that may
5unnecessarily add the microbial population or microbial load to the milk right that is not
6desirable.

7(Refer Slide Time: 16:43)

Standardization stage
It is important to standardize milk fat to ensure that you end up with a product of consistent quality in the market. Different consumers prefer different products.
There are customers who will consume skim milk only while there are those who will take low fat milk. There are those who will take standardized milk while there are those who prefer high fat milk.
Standardization is necessary to ensure that all the customers are catered for. Again, it is during the process of standardization that you get to separate the butterfat that is used for making cream and other fat based products such as butter and ghee.

8

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

9Then after this perhaps you are going to standardize, now standardization is a process
10which is in most of the cases in commercial food, commercial milk is required because
11unless you standardize because you remember you are got from the different sources
12different milk.

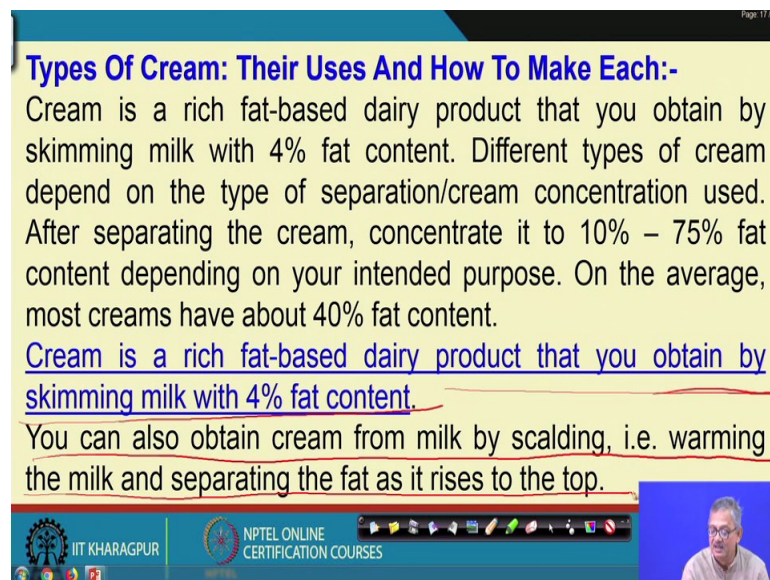
13So, they content different quantities of fat, protein or SNF all these. So, if you are adding
14them then you can never be sure that what is the your final constituent. So, after adding
15you must know what is the composition and then you already have decided, I will sell I
16will sell market with this that is this quantity of fat, this quantity of solid not fat etcetera.
17So, that is standardize, so that is why standardization is a must.

18So, it is important to standardize milk fat to ensure that you end up with a product of
19persistent quality in the market different consumers prefer different products there are
20customers who will consume skim milk only while there are some who will take low fat

1milk, there are those who will take standardized milk while there are those who prefer
2high fat milk.

3So, lot of variety of customers you have to handle that is why standardization is must
4with respect to their product, standardization is necessary to ensure that all the customers
5are created all the customers are catered for again it is during the process of
6standardization that you get to separate the butter fat that is used for making cream right.
7So, cream making you are using separation of the fat and other fat based products such as
8butter right and ghee for that you separate fat if you are making skim milk. So, this fat
9you can use for butter making for making cream etcetera right.

10(Refer Slide Time: 19:20)



Types Of Cream: Their Uses And How To Make Each:-
Cream is a rich fat-based dairy product that you obtain by skimming milk with 4% fat content. Different types of cream depend on the type of separation/cream concentration used. After separating the cream, concentrate it to 10% – 75% fat content depending on your intended purpose. On the average, most creams have about 40% fat content.
Cream is a rich fat-based dairy product that you obtain by skimming milk with 4% fat content.
You can also obtain cream from milk by scalding, i.e. warming the milk and separating the fat as it rises to the top.

11

The slide includes logos for IIT KHARAGPUR and NPTEL ONLINE CERTIFICATION COURSES, and a small video inset of a speaker in the bottom right corner.

12So, it comes to the level of standardization, types of cream there are different types of
13creams their use and how to make each of them cream is a rich fat based dairy product
14that you obtain by skimming milk with 4% fat content. Different types of cream depend
15on the types of separation or cream concentration used after separating the cream
16concentrate it to 10% to 75% fat content depending on your intended purpose.

17On the average most cream have above 40% fat content. Cream is a rich fat based dairy
18product that you obtained skimming milk with 4% fat content you can also obtain cream
19from milk by scalding that is warming the milk and separating the fat it raises to the top.

1(Refer Slide Time: 20:30)

After separation, cool the cream to below 5°C to avoid spoilage by inherent enzymes such as lipases. Concentrating the cream causes rupturing of the fat globule membrane (FGM), which facilitates an easier access to the fat nucleus. In addition to preventing spoilage, cooling also slows down the microbial growth, which minimizes spoilage considerably. Again, cooling avoids oiling off. The butterfat at the center of the globules are liquid, which oozes out during separation.

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

2

3Then after separation cool the cream to below 5°C to avoid spoilage by inherent such as
4lipases concentrating the cream causes rupturing of the fat globule membrane or FGM
5which facilitates an easy access to the fat nucleus.

6So, lipase enzyme will be there, so you have to protect against that in addition to
7preventing spoilage cooling also slows down the microbial growth, which minimizes
8spoilage considerably again cooling avoids oiling of the butter fat at the center of the
9globules are liquid, which oozes out during separation.

10(Refer Slide Time: 21:41)

Generally, you can use different types of cream for the following purposes:- Consumptions as:
Manufacturing butter and ghee.
Used in the confectionery industry.
Standardizing other products (recombined milk).
Manufacturing butter oil and ice cream.
Categories / types of cream
The fat content of the cream determines the category of the cream. They include:
Half cream, minimum fat content of 12%.
Single cream, minimum fat content of 18%.

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

11

1

10

2

1 Generally, you can use different types of cream for the following purposes, like
 2 consumptions depending on that manufacturing of the butter and ghee you can use the fat
 3. Used in the confectionary industry that fat standardizing other products that is
 4 recombined milk, manufacturing butter oil and ice cream you need fat or cream,
 5 categories or types of cream there are different types which you are said earlier also.

6 Fat content of the cream that determines the category of the cream this includes half
 7 cream minimum fat content of about 12%, single cream minimum fat content of about
 8 18% the then.

9 (Refer Slide Time: 22:42)

Whipped cream, *minimum fat content of 35%*
 Double cream, *minimum fat content of 48%*
 Plastic/clotted cream, *minimum fat content of 55%*

Milk Standardization: How to Use the Pearson's Square Method

Soybean meal, 45% CP
 4.0 parts of SBM (obtained by subtracting diagonally, smallest from largest)
 14%
 Corn, 10% CP
 31.0 parts of corn
 35.0 total parts

To use **Pearson's Square**: 1. Subtract the nutrient requirement (middle of **square**) from the nutrient concentration (on left of **square**) in the feed across the diagonal (top left - middle = bottom right; bottom left - middle = top right). Repeat this for both feeds.

2-5

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES

10

11 Whipped cream minimum fat content around 35%, then double cream minimum fat
 12 content of around 48%, plastic or clotted cream where minimum fat content is around
 13 55%, already earlier also you had given.

14 Now, when you come to standardization there is there was a unique system developed by
 15 the by scientist called Pearson. And this method was used before calculate another thing
 16 schema this was very much useful in the in the in the dairy industry, because they did not
 17 have calculators like today you just go back to 3 decades 4 decades or 2, and half 2 4
 18 decades, during that period or earlier to that calculators were not there. So, that time
 19 people use to use it very effectively this is this you also should know that is how this
 20 standardized, so this call Pearson square method right.

1

11

2

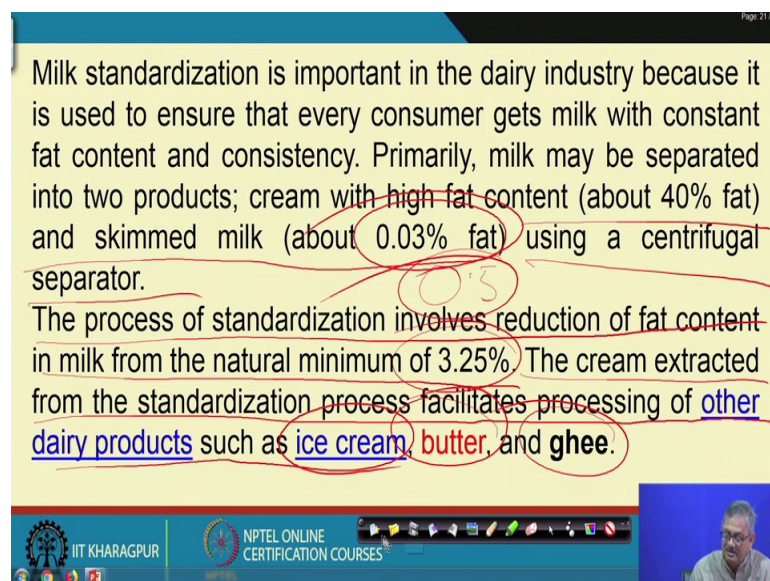
1 So, if you have say soybean milk having 45% right, and your corn around 10%%, cream
2 in both the cases. So, 45% soybean meal with 45%, cream and 10% corn cream. If you
3 are adding then how much you need to add you know that your finished product should
4 have 14% right.

5 So, 45 minus 14 is 31 and 14 minus 10 is 4, this is the product which you need the parts
6 of that soybean milk and that is obtained by subtracting diagonally smallest from the
7 largest this is simply just called mod right. So, the difference between the larger one
8 minus the smaller one right value, value wise.

9 So, and here also 35 minus 14 that is 31, So 31% of corn right your adding, you are
10 adding getting 35 percent by 35 plus total you are getting right 35 percent total you are
11 getting and you can say that four parts of 45 percent soya bean cream and 31 parts of 10
12 percent corn cream, if you are adding then you get 35 parts of 14% cream of the from the
13 two right.

14 So, to use Pearson's square 1 is subtract the nutrient requirement middle of the square
15 from the nutrient concentration on the left of the square in the feed across the diagonal
16 top left minus milk that is the bottom right and bottom left minus middle that is the top
17 right. So, repeat this for both feeds right this is the unique one which was developed by
18 Pearson right.

19 (Refer Slide Time: 26:43)



Milk standardization is important in the dairy industry because it is used to ensure that every consumer gets milk with constant fat content and consistency. Primarily, milk may be separated into two products; cream with high fat content (about 40% fat) and skimmed milk (about 0.03% fat) using a centrifugal separator.

The process of standardization involves reduction of fat content in milk from the natural minimum of 3.25%. The cream extracted from the standardization process facilitates processing of other dairy products such as ice cream, butter, and ghee.

Handwritten annotations on the slide include a red circle around '0.03% fat', a red circle around '3.25%', and a red circle around 'ice cream, butter, and ghee'. There is also a handwritten '0.5' in the middle of the slide.

Page 21/21

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

20

1

12

2

1 Then milk standardization is important in the dairy industry because it is used to ensure
 2 that every consumer gets milk with constant fat content and consistency primarily and
 3 consistency primarily milk may be separated into two products, that is cream with high
 4 fat content about 40% fat.

5 And about 40% fat and skimmed milk about 0.03% fat, this can be 0.32-0.5, even 0.5%
 6 fat we also call to be skimmed milk using a centrifugal separator. This will come the
 7 process of standardization involves reduction of fat content of milk from the natural
 8 minimum of 3.25%, the cream extracted from the standardization process facilitates
 9 processing of other dairy products such as ice cream, butter and ghee right.

10 (Refer Slide Time: 28:00)

Milk standardization can take two forms i.e. either partial separation or mixing of skimmed and whole milk. Mass balancing plays a key role in successful standardization of milk.

Example 1
 2000 kg of milk (with 87.6% water, 3.8% fat, 3.2% protein, 4.6% lactose, and 0.7% ash content) has to be reduced in fat content from 3.8% to 2.5% by removal of cream with 40% fat content from the milk. How much milk will have to be removed?

Solution.
 TM Balance: $2000 = C + M$ [C – Cream; M – Milk]
 MF Balance: $2000 \times 0.038 = 0.4 \times C + 0.025 \times M$

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

11

12 So, milk standardization can take two form that is either partial separation or mixing of
 13 skimmed and whole milk mass balance plays a key role in successful standardization of
 14 milk right. So, we can we can do a small example that that if you take 2000 kg of milk
 15 with 87%, 87.6% water, 3.8% fat, 3.2%, 4.6% lactose and 0.7% ash content this is one
 16 has to be reduced in fat content from 3.8%, which was there to 2.5% by removal of
 17 cream with 40% fat content from the milk, how much milk will have to be removed
 18 right.

19 So, this can be done simply by the by mass balance that TM balance: $2000 = C + M$ Where
 20 C stands for cream and M stands for milk, MF balance: $2000 \times 0.038 = 0.4 \times C + 0.025 \times M$.

1(Refer Slide Time: 29:53)

2000 X 0.025 = 0.025 X C + 0.025 X M; C – cream & M - Milk
Solving the equations will give the values of C = 69.3 kg and the remaining milk M = 1930.7 kg.
Example 2
If 3000 kg of the same milk used in the previous example is separated into cream with 45% fat and skimmed milk with 0.05% fat, how much cream and skimmed milk are expected assuming no losses?
Solution
TMB: 3000 = C + M
FMB: 3000 X 0.038 = 0.45 X C + 0.0005 X S
Solving the equations will give C = 250.3 kg and S = 2749.7 kg

IIT KHARAGPUR NPTEL ONLINE CERTIFICATION COURSES

2

3So, if we add if we you solve this then we get $2000 \times 0.025 = 0.025 \times C + 0.025 \times M$ right of
4course, C for cream name for milk which you have already said. Solving this equation
5will get $C = 69.3$ kg and remaining $M = 1930.7$ kg right. This is one example and another
6example let us do very quickly, so that our time is utilized.

7If 3000 kg of same milk is used in the previous example is separated into cream with 45
8percent fats and skimmed milk without with 0.05 percent fat, how much cream and
9skimmed milk are expected assuming no losses? Again total milk balance, if you do 3000
10was C plus M that is cream plus milk FMB, that is if we do that fat balance right milk fat
11balance that is 3000 into 0.038 is equals to $0.45 C$ plus $0.0005 S$ right. Now, solving the
12equation will give C is equals to 250.3 kg and S equals to 2 point 2749.7 kg right. So,
13like that we can do by simple mass balance this also can be done with the Pearson square
14method, right to do with Pearson square method you will get the same right.

15So, let us stop today here because time is over we will then come to the next class thank
16you.

17Thank you.

1

14

2