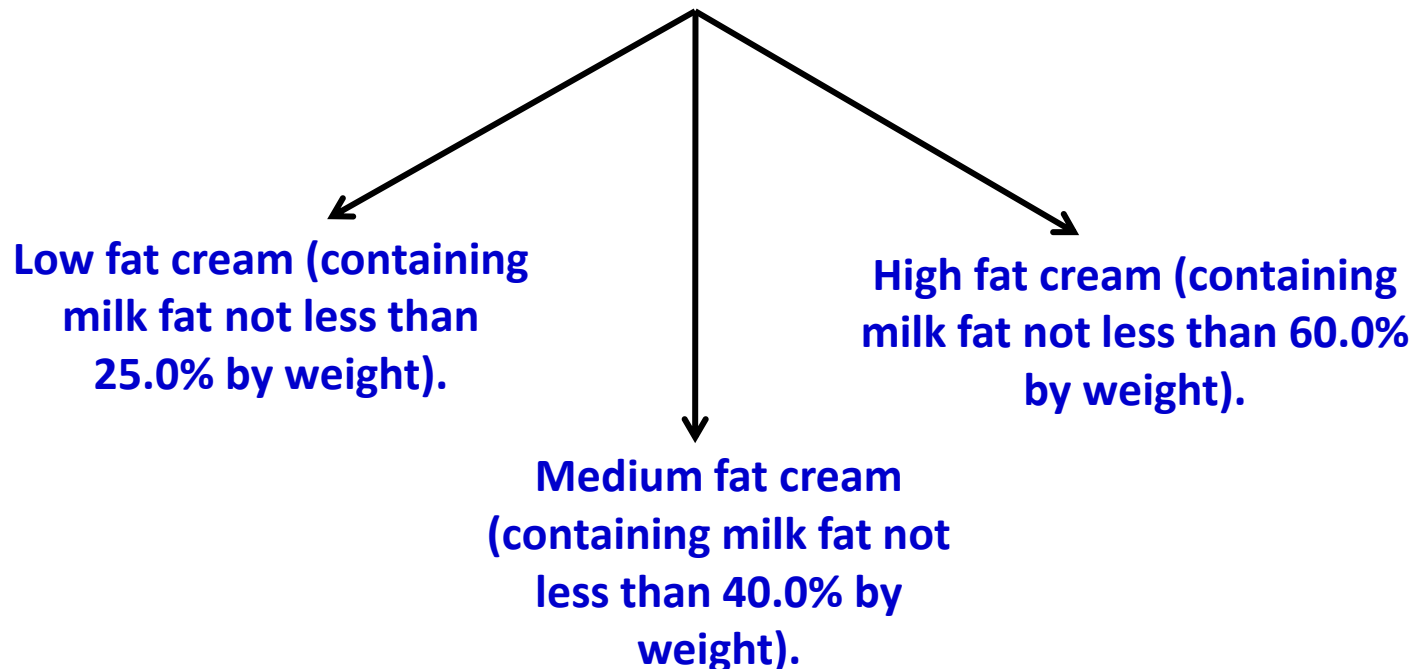


A close-up photograph of a glass bowl filled with a thick, white cream. A silver spoon is lifting a dollop of the cream from the bowl, showing its smooth, slightly peaked texture. The background is a warm, wooden surface. The text is overlaid in the center of the image.

**Definition, Legal Standards,
Efficiency of Cream Separation and
Factors Affecting, Control of Fat
Concentration in Cream**

Cream is the fatty portion of milk which rises to top of milk on storage, rich in fat and produced by separation of un-homogenized whole milk.

According to FSSR 2011, cream including sterilized cream means the product of cow or buffalo milk or a combination thereof, free from starch and other ingredients foreign to milk.



Classification:

- 1. Fat in cream varies from 18-85%. As the fat % in cream increase the components of milk in cream gradually decreases.
- 2. Classified into two groups:
 - Market Cream: Used for direct consumption
 - Manufacturing/Industrial Cream: Used in production of various milk products.

Table cream	}	20-25% milk fat
Light cream		
Coffee cream	}	30-45% milk fat
Whipping cream		
Heavy cream	}	65-85% milk fat
Plastic cream		

Cream As Per Codes Alimentarius Commission

Cream	Description
Reconstituted	Reconstituting milk products with/without the addition of potable water and with same end product characteristics of cream.
Recombined	Recombining milk products with/without the addition of potable water and with same end product characteristics of cream.
Prepared	Subjecting cream, reconstituted/recombined cream to suitable treatments to obtain the characteristic properties.
Pre-packaged liquid	Preparing and packaging cream, reconstituted cream and/or recombined cream for direct use.
Whipping	Fluid, reconstituted /recombined cream that is intended for whipping.
Cream packed under pressure	Fluid, reconstituted /recombined cream packed with a propellant gas in a pressure-propulsion container.
Whipped	Fluid /recombined cream into which air/inert gas has been incorporated without reversing the fat-in-skimmed milk emulsion.
Fermented	Fermentation of cream, reconstituted/recombined cream, by the action of suitable micro-organisms.

Cream relevant to market and industrial purposes

Cream	Description
Table	18-22% fat, consumed directly, food preparations are made from this cream (fruit cream).
Light	20-25% fat, table purpose, manufacturing of cream cottage cheese etc.
Coffee	Light, thin, 18-25% fat, coffee making.
Heavy	30-40% fat, production of butter, ice-cream and paneer.
Plastic	30-40% fat re-separated to obtain the cream of 80%, ghee production, produced directly from milk which is separated in an especially designed plastic cream separator.
Whipped	<ul style="list-style-type: none">✓ Normal cream (30-40% fat) is incorporated with air, the air bubbles are stabilized by protein adsorption. Fat globules assemble around these air bubbles. As whipping continues, these air cells subdivided into smaller one each with adsorbed layer and innumerable fat globules. Favorable temperature for whipping is 10 C.✓ Over whipping may produce a buttery product.✓ Cream pasteurization and sugar addition declines whipping rate in cream.✓ Dairy plants use nitrous oxide gas for cream whipping.

Cream	Description
Sour	Inoculating sweet, pasteurized and homogenized cream with a starter culture (lactic acid and aroma producer) and incubate to proceed fermentation, 0.6% lactic acid, clean flavour and smooth texture.
Clotted	Milk scalded for 15 mins at about 85-90 C in shallow pan and allowed to form a cream layer. After evaporation occurs from the cream layer and on cooling for 24 h, the clotted cream may be removed, decreased ratio of SNF/water, relatively higher proportion of protein.
Frozen	Pasteurize the ordinary cream (40-50% fat) at 77 C for 15 mins and packing in paper, plastic or tin containers after cooling at 4 C. Freeze packaged cream –12 C or below. Used during shortage in preparation of ice-cream etc. During storage, fat globule membrane may ruptured by ice crystals. Tends to “Oil-off” on thawing.
Sterilized/Canned	<p>Homogenize the 20% cream at 80 C (175 kg/cm²) in the first stage and 35 kg/cm² in the second stage and cooled to 16 C. Tri-sodium phosphate is added @ 0.2% as a stabilizer. Packaged in tin cans/bottles and sterilized :</p> <ul style="list-style-type: none"> · Coming up time 15 mins to 114± 1 °C · Holding time 15 mins to 114± 1°C · Cooling time 15 mins to room temperature

Cream	Description
Reconstituted	By vigorous emulsification of unsalted plain butter in milk/separated milk/reconstituted/condensed milk, the fat globules are dispersed and coated with a layer of adsorbed protein.
Synthetic	In the artificial cream, butter fat is substituted with margarine fat and resulted product is known as synthetic cream. The refined oils are carefully blended to have some physical cream, the refined oils are carefully blended to have some physical properties resemble to butter fat.
Whey	Separation is sometimes used to remove fat from cheese whey and resulted cream is known as whey cream.



Composition of cream

	Cream with 30% fat	Cream with 50% fat
Water	64.0%	44.43%
Fat	30.0%	50.00%
Protein	2.4%	1.69%
Lactose	3.5%	2.47%
Minerals	0.4%	0.37%
SNF	6.3%	4.53%

If ratio of water to SNF of milk is 10:1, then the approximate SNF in cream = $(100-F/11)$ where F is fat content of cream.

Physico-chemical Properties Relevant to Cream Processing

Viscosity

- Resistance offered by the liquid to flow.
- Higher the fat % greater is the viscosity.
- Higher the temperature lower is the viscosity.
- Higher temperature of separation lowers the viscosity.
- Homogenization and cooling increases the viscosity of cream.

Whipping quality

- Whipping means emulsion of gas or foam production by beating of cream.
- Satisfactory fat content for production of whipping cream is 30-35%.
- The optimum aging period is 24 hours at 4°C.
- Homogenization, acidity and stabilizers in cream reduces the whip-ability of cream.

TA

- There is an inverse relationship between the percent fat and percent titratable acidity.
- Fresh cream has lower acidity percentage than milk.

Specific gravity

- Specific gravity of cream is inversely proportional to the fat percentage

Purpose of Cream Separation

1. To obtain a fat-reduced or fat-free milk
2. To concentrate milk fat for the production of high-fat products
3. To standardize the fat content of milk
4. To recover fat from milk
5. At 16 C, average density of milk fat is 0.93 and skim milk is 1.0404
6. **Key objective:** Manufacture skim milk with the lowest possible fat content, which corresponds to good separation efficiency. Fat exists in poly-disperse system in an emulsified state and specific density difference between milk fat ($\rho = 0.93 \text{ g/cm}^3$) and skim milk ($\rho = 1.035 \text{ g/cm}^3$) is fairly large.

Cream Separation by Gravity Method:

The velocity or rate at which the fat globules rise is given by the following equation (Stoke's Law)

$$V = (2/9) * Gr^2 * (d_s - d_f) / N$$

Where, V = rate of rise of fat globule in centimeter per seconds

r = radius of fat globule

G = Force of gravity (981 dynes)

η = Viscosity of skim milk

d_s = density of skim milk

d_f = density of fat globule

Size of fat globules: As the size of fat globules increases, the rate at which fat rises also increases. Larger fat globules rise faster than smaller ones. Thus, in buffalo milk gravity creaming occurs faster due to the larger fat globules than those in cow milk.

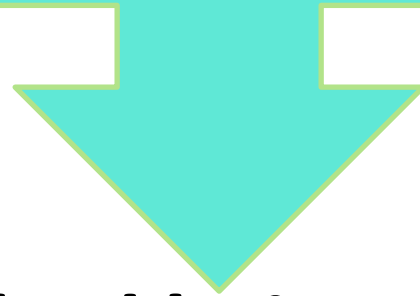
Temperature: As temperature increases, viscosity decreases.

From, Stoke's Law it is observed that theoretically velocity increases with

- a. Increasing radius of fat globule ,
- b. Increasing difference in densities of skim milk and fat
- c. Decreasing viscosity of skim milk

Separating the cream using gravity method:

1. Shallow Pan Method
2. Deep Pan Method
3. Water Dilution Method
4. Scalding Method
5. Jersey Creamery Method



Gravity method being very slow, it is no longer used commercially for cream separation.

Cream Separation by Centrifugal Method:

- 1. Milk is fed to machine through flow regulator which comes to regulating chamber from milk basin by milk faucet.**
- 2. Milk enters the revolving bowl through milk regulator of machine, it is subjected to a gravity and centrifugal force (3000-6000 times more than gravitational force).**
- 3. Fat (0.9) and skim milk (1.037) vary in specific gravity.**
- 4. When fat and skim milk are subjected to centrifugal force, heavier portion affected more intensely than the fat (lighter portion). Skim milk is forced to the periphery and fat portion moves towards the centre.**
- 5. Cream and skim milk forms separated vertical walls within the bowl and goes out through separate outlets near the axis of rotation. The cream outlet is at higher level than skim milk outlet.**
- 6. Rate or movement of a fat globule in machine is estimated by following Stoke's equation:**

Characteristics of Gravity and Centrifugal Methods

$$V = r^2 * ((a_s - d_f) / \eta) * N^2 * R * K$$

V = rate of movement of a single fat globule

r = radius of fat globule

d_s = density of skim milk

d_f = density of fat

N = Revolution per minute of bowl

R = Distance of fat globule from axis of rotation.

K = Constant

η = Viscosity of skim milk

Particulars	Gravity Method	Centrifugal Method
Nature of force causing Separation	Gravitational force	Centrifugal force
Speed of separation	Extremely slow	Practically instantaneous
Direction of movement of fat and skim milk particles	Vertical	Horizontal
Bacteriological quality of cream or skim milk	Low	High
Fat % of cream	10-25% only	18-85 %
Skim milk	0.2 % above	0.1 or below
Scale of operation	Small	Large
Fat % recovered in cream	not more than 90	99-99.5

Factors influencing the fat percentage of cream by centrifugal separation

1. Position of the cream screw

- ✓ Cream screw/outlet consists of a small, threaded, hollow screw pierced by a circular orifice through which the cream emerges.
- ✓ This screw can be driven IN or OUT, bringing it nearer to or away from the centre of rotation.
- ✓ Skim milk screw/outlet is for the removal of skim milk.
- ✓ By altering the position of the cream screw, the ratio of skim milk to cream changes. Cream screw is moved IN towards the axis of rotation, higher fat percentage in cream obtained and vice versa.

2. Fat percentage in milk

- ✓ Higher the fat % in milk, higher % fat in cream and vice versa.
- ✓ High-fat milk has a higher fat content than low-fat milk.

3. Speed of the bowl

- ✓ **Velocity of fat globule is proportional to square of the rotational speed so an increase in bowl speed has major effect on separation efficiency.**
- ✓ **Higher the speed of bowl, greater will be the centrifugal force and more rapidly the skim milk leaves the bowl with higher fat % in cream.**

4. Rate of the milk flow

- ✓ **Higher the rate of milk in-flow, lower the fat in cream and vice versa.**
- ✓ **When the rate of inflow increases, the discharge from the cream outlet increases.**
- ✓ **As the skim milk discharge remains constant, more cream containing the same amount of fat results in a lower fat test and vice versa.**

5. Temperature of milk

- ✓ Increase in temperature of milk leads to both an increase in density difference between milk fat and skim milk leading to lower separation efficiency.
- ✓ Higher temperature leads to disruption of fat globule which will result in heavy fat losses in skim milk. Fat losses are higher at 70°C.

6. Amount of water or skim milk added to flush the bowl

- ✓ Greater the quantity of water or skim milk added to flush the bowl, lower the fat % in cream.
- ✓ Addition of more water/skim milk will cause an increase in the amount of cream produced which with the same fat content, will show a lower fat test.

Factors affecting the fat losses in skim milk during separation

- 1. Skimming efficiency:** Refers to the % of total fat from milk recovered in the cream. Higher the fat % in milk, greater the fat losses in the skim milk, lower the skimming efficiency (SE).
✓ SE calculated using the following equation:

$$SE = ((C \cdot (F / 100) / M \cdot (F_1 / 100))) \times 100$$

Where,

C - Amount to cream (Kg)

F - Fat percentage in cream

F₁ - Fat percentage in milk

M - Amount of milk (Kg)

high fat-test milk shows a higher SE than low-fat-test milk

Examples:

- 1. Given:** 100 kg milk testing 7.5% fat; cream produced 14.1 kg cream testing 52.5% fat.
Calculating skimming efficiency (SE).

$$SE = \frac{14.1 \times (52.5/100)}{100 \times (7.5/100)} = 98.7$$

2. Factors affecting fat losses in skim milk

Temperature of milk

Speed of the separator bowl

Rate of milk in-flow

Position of cream screw

Mechanical condition of the machine

Amount of separator slime in the bowl

Size of the fat globules

Degree and temperature of separation

Presence of air in milk

Acidity of Milk

3. Yield of cream and skim milk

Yield of cream

$$C = M * (f_m - f_s) / (f_c - f_s)$$

Where,

C = weight of cream (kg);

M = weight of milk (kg);

f_m = fat percentage of milk;

f_s = fat percentage of skim milk;

f_c = fat percentage of cream.

Fat recovery in cream: This can be calculated by the formula:

$$\text{Per cent fat recovered in cream} = \frac{\text{Kg fat in cream}}{\text{Kg fat in milk}} \times 100$$

Yield of skim milk

$$S = M * (f_c - f_m) / (f_c - f_s)$$

Where,

S = weight of skim milk (kg);

M = weight of milk (kg);

f_m = fat percentage of milk;

f_s = fat percentage of skim milk;

f_c = fat percentage of cream

$$\text{Per cent fat lost in skim milk} = \frac{\text{Kg fat in skim milk}}{\text{Kg fat in milk}} \times 100 \dots \text{I}$$

$$= \frac{f_c - f_m}{f_c - f_s} \times \frac{f_s}{f_m} \times 100 \dots \text{II}$$

Where f_c , f_m and f_s are as above.