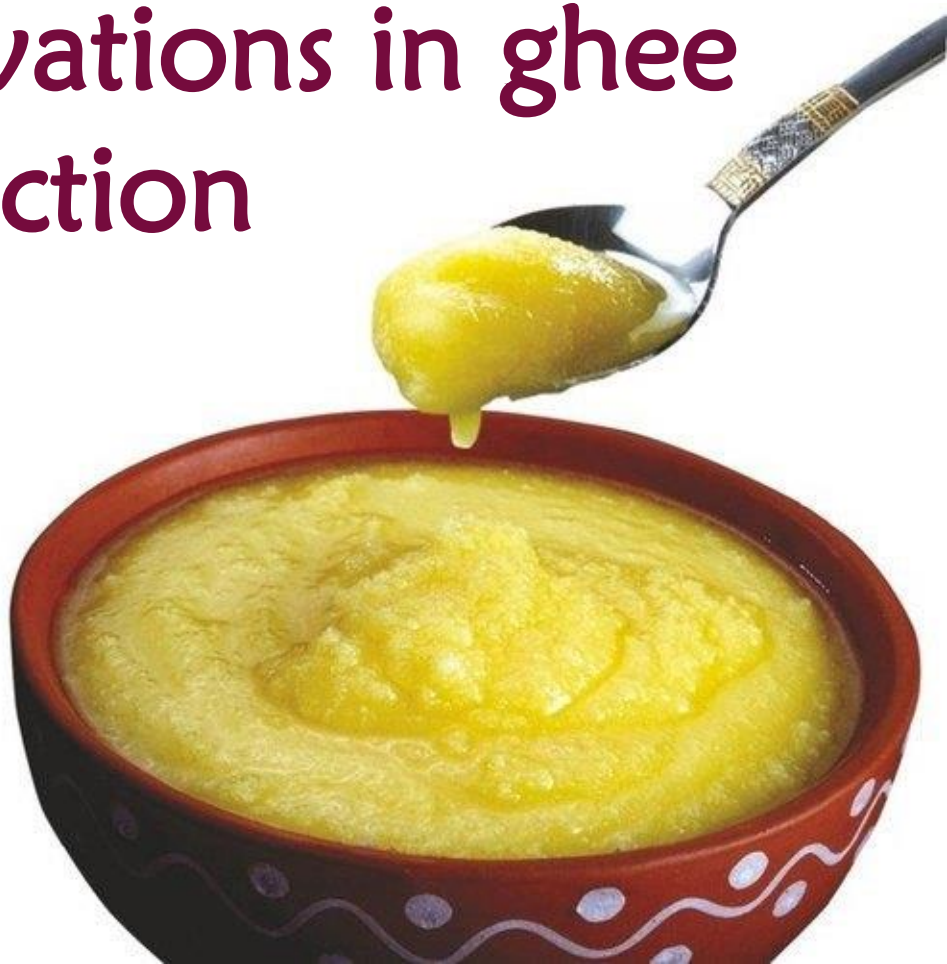
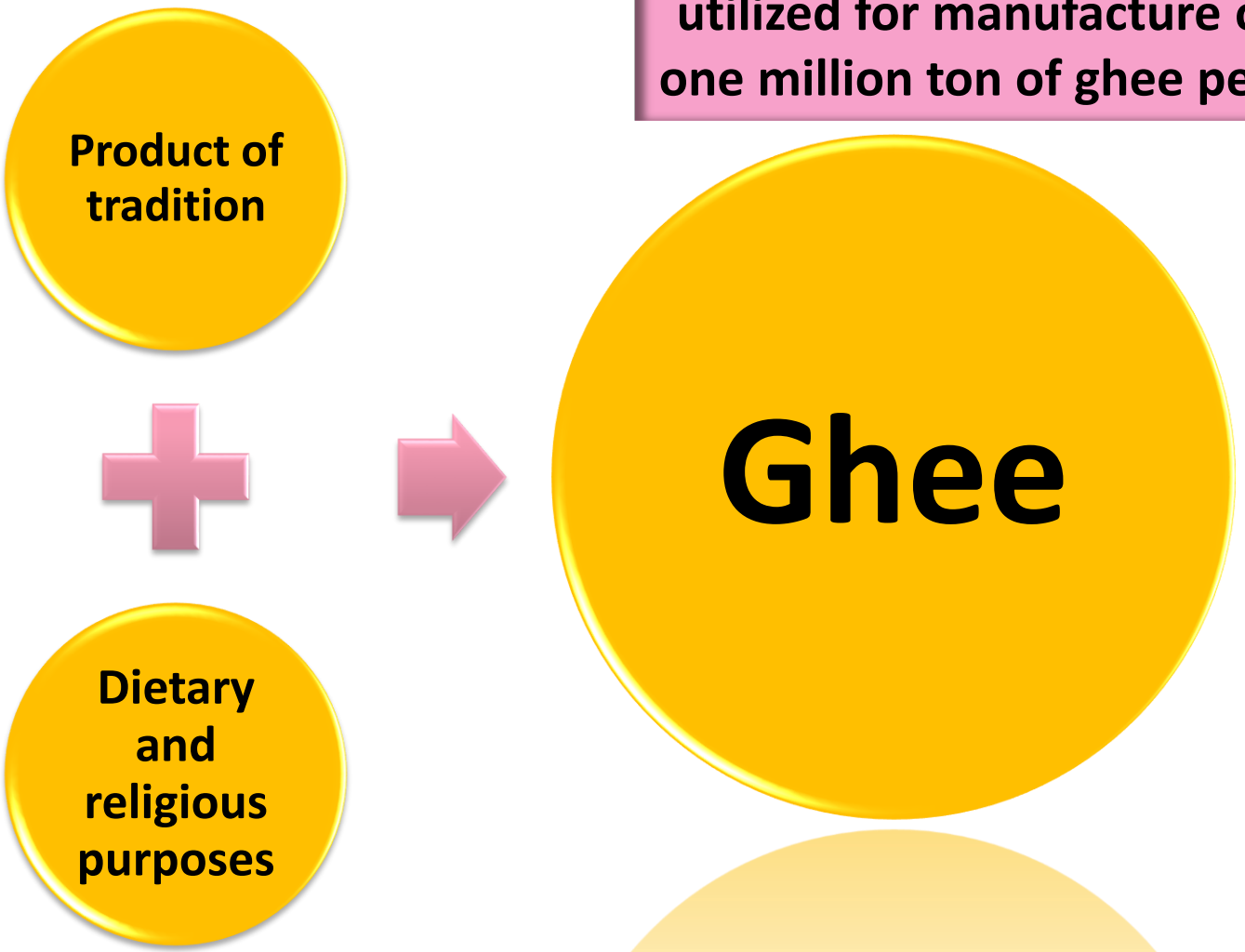
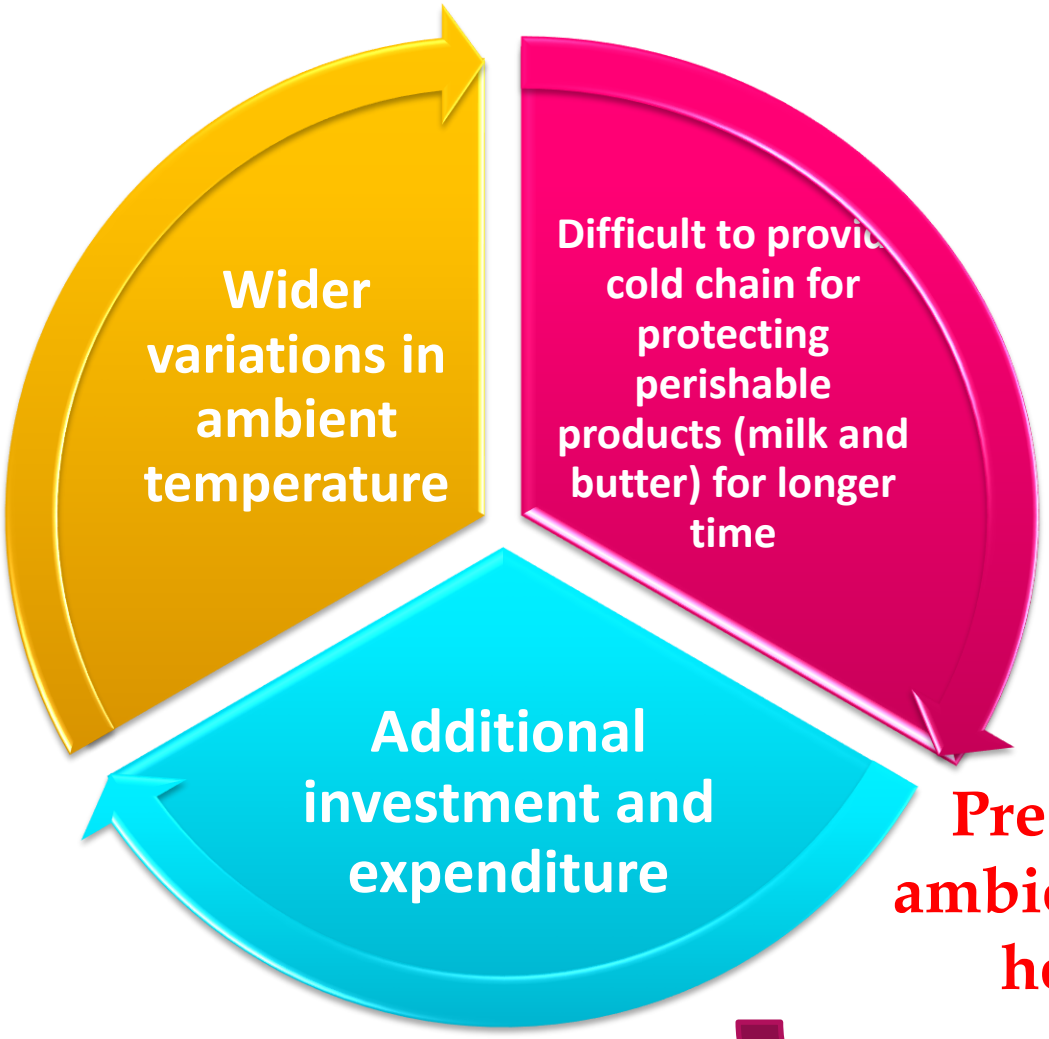
Ghee making batch and industrial processes, innovations in ghee production



28% of total milk production is utilized for manufacture of about one million ton of ghee per annum



Necessity for production of ghee



Preserve milk fat at ambient temperature at household level

1. In festival and ceremonial functions, use of ghee in food is a delicacy due to its pleasing flavour and aroma.

2. Returned market milk at commercial dairy level is utilized for separation of fat and convert this fat to ghee.

3. Huge market demand and involvement of simple technology attracts milk processor to have ghee making plant of variable capacity

Definition and Description of Ghee

According to FSSR-2011, ghee is pure heat clarified fat derived solely from milk/curd or from desi (cooking) butter/cream to which no colouring matter/preservative has been added.

Usually prepared from cow milk, buffalo milk or mixed milk.

Ghee made from buffalo milk is whitish with greenish tinge and from cow milk is golden yellow colour

Liquid, semisolid and some time in solid state based on the storage temperature

Composition

- Complex lipid of glycerides (triglycerides), free fatty acids, phospholipids, sterols, sterol esters, fat soluble vitamins, carbonyls, hydrocarbons, carotenoids (ghee derived from cow milk).
- Milk fat contains at least 500 fatty acids and fatty acid derivatives with 4-20 or more carbon atoms in their chain. Fatty acid may saturated or unsaturated and usually contains an even number of carbon atoms.

Fatty Acid (%)	Buffalo milk fat	Cow milk fat
Butyric	4.4	3.2
Caproic	1.5	2.1
Capric	1.3	2.6
Lauric	1.8	2.8
Myristic	10.8	11.9
Palmitic	33.1	30.6
Stearic	12.0	10.1
Oleic	27.2	27.4
Linoleic	1.5	1.5
Linolenic	0.5	0.6

Chemical composition of ghee

Constituents	Cow milk ghee	Buffalo milk ghee
Fat (%)	99 – 99.5	99 – 99.5
Moisture (%)	<0.5	<0.5
Carotene(mg/g)	3.2-7.4	-
Vitamin A(IU/g)	19-34	17-38
Cholesterol (mg/100g)	302 – 362	209 – 312
Tocopherol(mg/g)	26 – 48	18 – 31
Free fatty acid (%)	2.8	2.8

Principle involved in ghee preparation

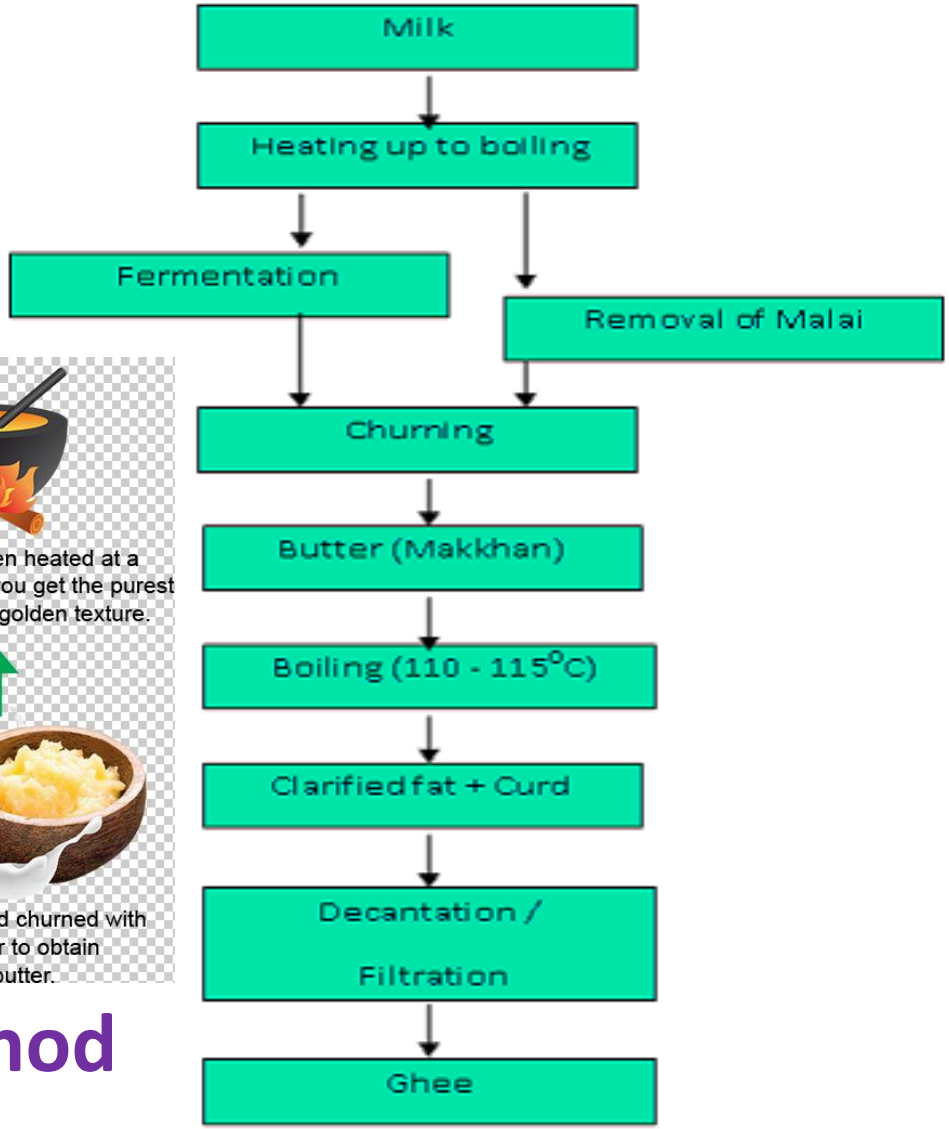
Concentration of milk fat in the form of cream or butter

Heat clarification of fat rich milk portion and thus reducing the amount of water to <0.5%.

Removal of curd content in the form of ghee residue.

Methods of Ghee Making:

- ❑ Desi or Indigenous Method
- ❑ Direct Cream Method
- ❑ Creamery Butter Method
- ❑ Pre-stratification Method
- ❑ Continuous Method



Desi or Indigenous Method

- Age-old days practice where excessive milk will be cultured and kept overnight for fermentation. Resultant curd was churned using hand driven wooden beaters to separate milk fat in form of desi butter.
- Another method, milk is heated continuously to about 80 C, malai (creamy layer) that forms over the surface was collected manually and then churned to get desi butter. After collection of desi butter over period of time, butter is melted in metal pan or earthenware vessel on an open fire.
- Extent of frothing is an index to judge when to terminate heating. Heating is stopped when sudden foaming appears and leave the contents undisturbed after heating.
- Curd particles starts settling down over period of time and decant the clear fat carefully.
- **75– 85% fat recovery.**

✓Involves separation of cream of 60-70% fat from milk by centrifugation process, fresh cream or cultured cream is heated to 114±2 C in a stainless steel, jacketed ghee kettle.

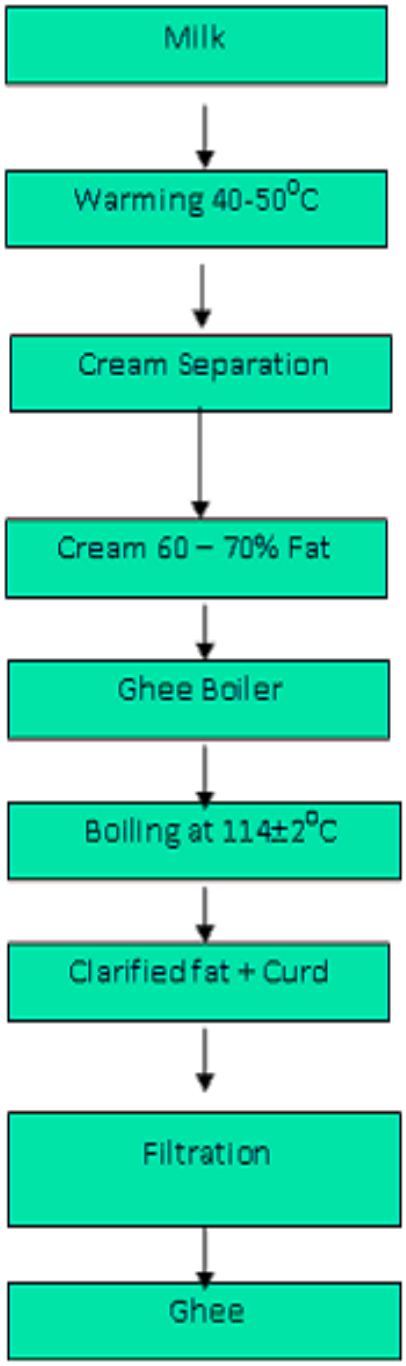
✓Kettle is fitted with an agitator, steam control valve, pressure and temperature gauges. A movable hollow stainless tube centrally bored for emptying out contents to decant the product.

✓Heating is discontinued as soon as colour of ghee residue turns to golden yellow or light brown.

✓First plenty of effervescence accompanied by crackling sound in preliminary stages of boiling but both gradually subsides when the moisture content decreases.

✓After evaporation of moisture, temperature of liquid medium suddenly spurts up and care taken to control heating.

✓End point is indicated by appearance of second effervescence, accompanied by browning of curd particles. Typical ghee flavour emanates and indicates the final prepared ghee.



Direct Cream Method

Advantages:

- ✓No need for butter production prior to manufacturing of ghee

Disadvantages:

- ✓Long heating time to remove moisture.
- ✓High content of serum solids in cream may also produce a highly caramelized flavour in the ghee.
- ✓4-6% loss of butter fat in ghee residue & during the handling operations. So, 70-80% fat cream is recommended to minimize both fat loss and steam consumption.

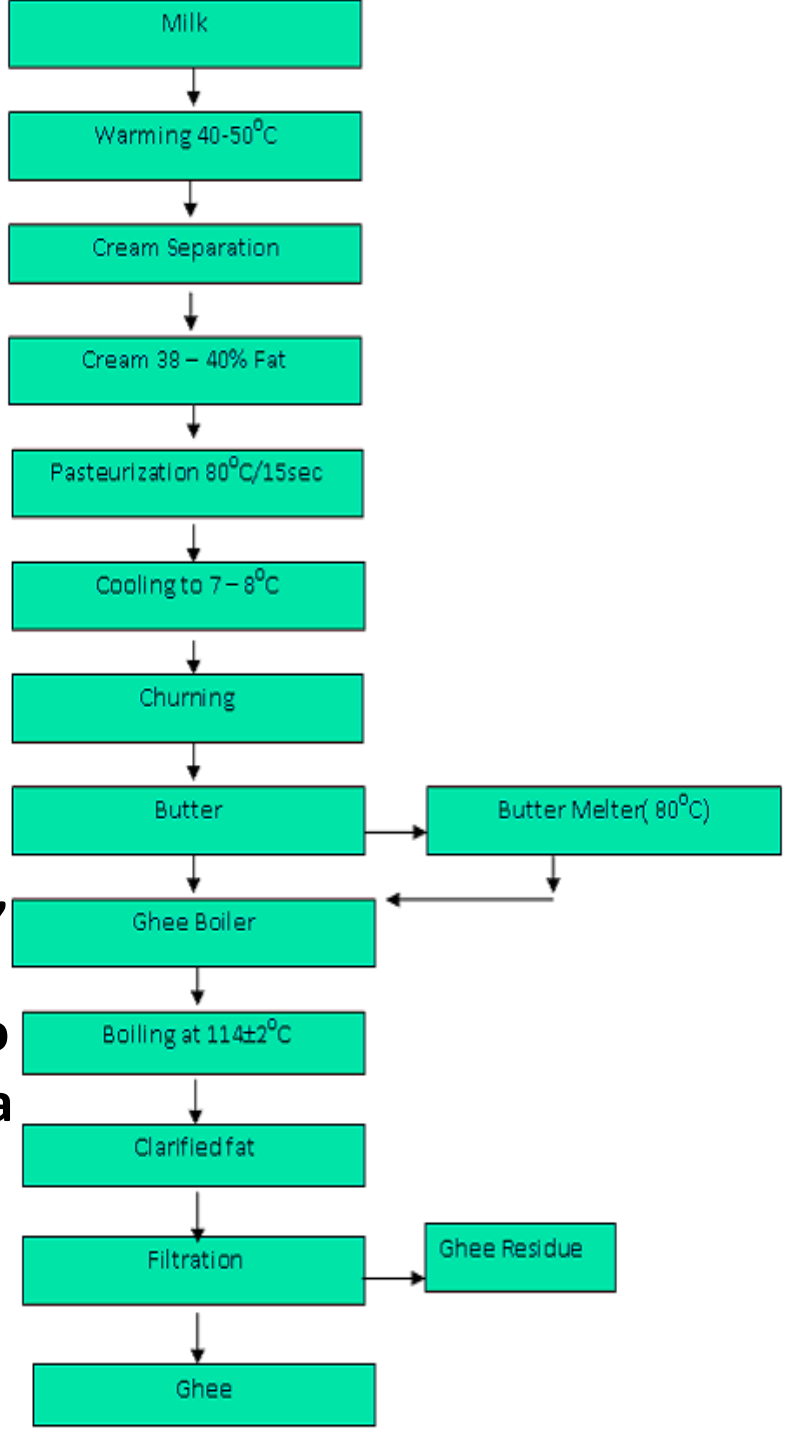
✓**Standard method adopted in organized dairies.**

✓**Unsalted or white butter is used as raw material.**

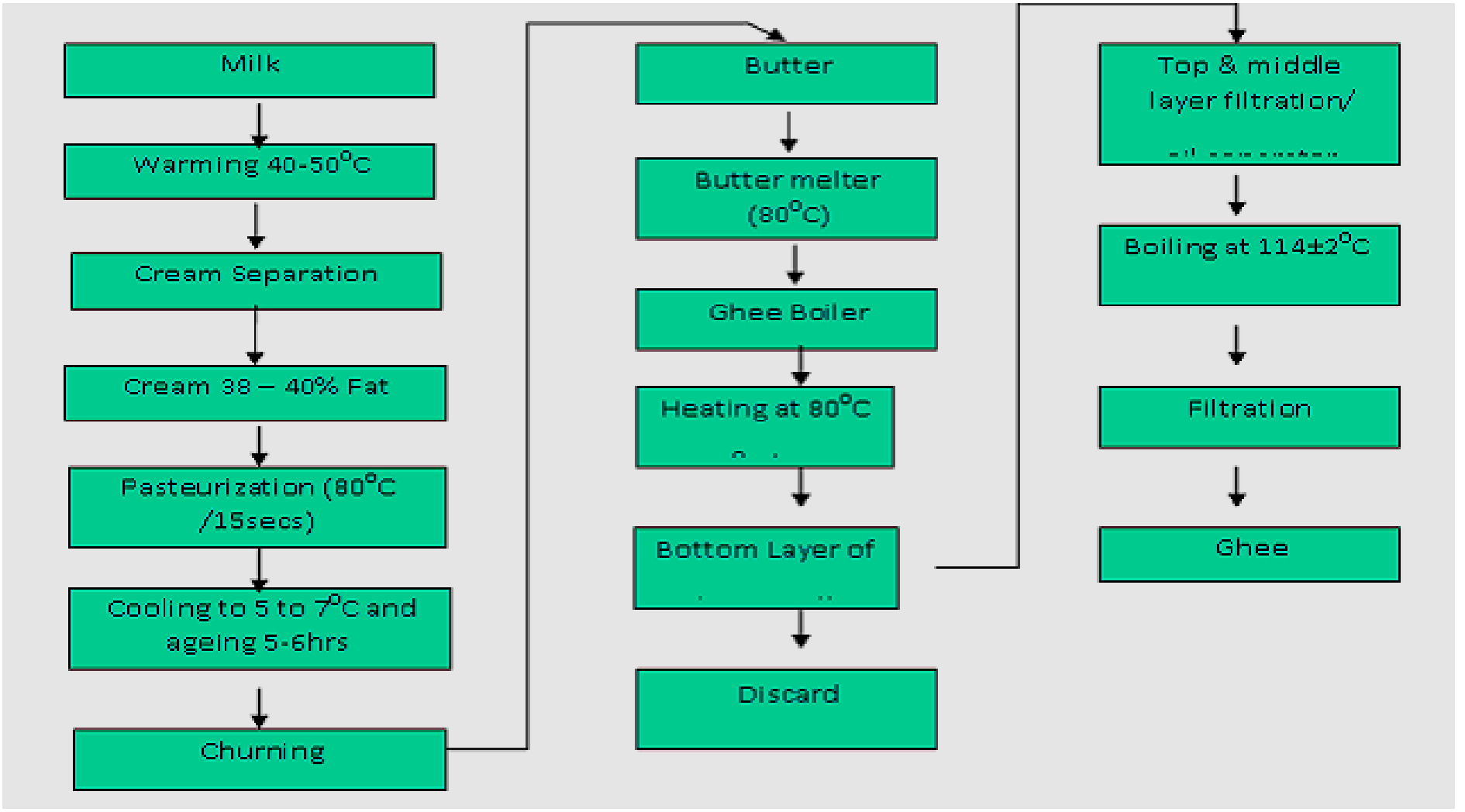
✓**Butter mass or butter blocks are melted at 60-80 C in butter melter. Molten butter is pumped into ghee boiler where final heating done using steam. Increase the steam pressure to raise the temperature.**

✓**Scum which is forming on top of surface of the product is removed from time to time with the help of perforated ladle.**

✓**Moment of disappearance of effervescence, appearance of finer air bubbles on surface of fat and browning of curd particles indicates to stop heating. At this stage, typical ghee aroma is produced.**



Creamery Butter Method

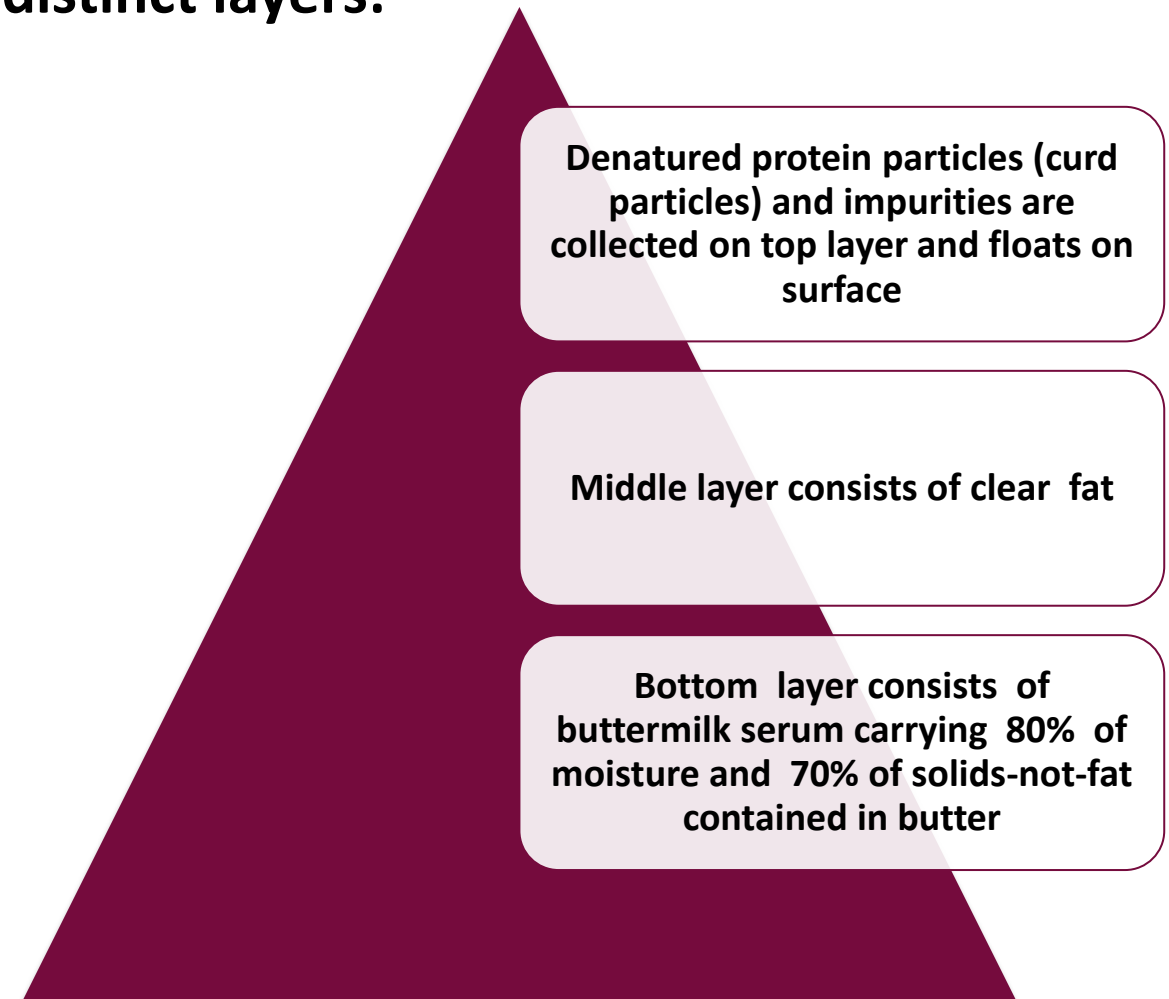


Pre-stratification Method

✓**Butter is produced from aged cream of 38-40% fat using continuous butter making machine or batch churn.**

✓**Butter is then transferred to butter melter and melt at 80 C.**

✓**Molten butter is kept undisturbed in ghee kettle or boiler at 80-85 C for 30 min. In ghee kettle, stratification of mass takes place, product stratifies into 3 distinct layers:**



✓**Bottom layer is then carefully removed without disturbing the both top and middle layers.**

✓**Middle layer largely consists of fat is heated to 114±2 C along with top layer of floating curd particles and denatured protein. This step is necessary to develop characteristic ghee aroma.**

✓**Milder flavour ghee can be produced, since most of curd content is removed before final clarification temperature of ghee.**

Advantages:

- ✓Removal of buttermilk (bottom layer) eliminates prolonged heating for evaporation of moisture
- ✓Formation of significantly low quantity ghee residue
- ✓Low quantity of ghee absorbed into ghee residue; so, less fat loss along with ghee residue
- ✓Production of ghee with lower FFA and acidity.

Continuous Method: **This method was developed to meet the requirement of high volume production and to overcome the limitation of batch method.**

- Requires high energy
- Cleaning and sanitation of equipments, not satisfactory
- Equipments and process unsuitable for large volume of production
- Floor becomes slippery due to ghee spillage
- Handling losses are more

Advantages of Continuous Method

- ✓Better control on quality of product
- ✓Only small hold-up of raw material in the plant at any time and hence, no chance for whole batch getting spoiled
- ✓Contamination by handlers can be eliminated
- ✓CIP can be possible
- ✓No foaming of product during production

1. Butter is heated in butter melter to molten state and then transfer into balance tank, and pumped further to scraped surface heat exchanger(SSHE), followed by flashing in vapour separator.
2. Heating in SSHE and flashing are repeated in next two stages to reduce the moisture level.
3. Ghee is then pass through centrifugal clarifier where residue will be removed. Clarified ghee is stored for filling and packing.

Granulation and Cooling of Ghee: Granulation is important criterion of quality; higher temperature of clarification gives better grain size due to high phospholipids content.

Phenomenon:

- Completely melted ghee on cooling under Indian temperature, can assume the form of large, coarse grains suspended discretely or in clusters in a liquid phase.
- Process of crystallization is initiated with formation suitable nuclei.
- Rate of cooling strongly influences the rate nucleus formation.
- Stirring/agitation and seeding (1-3%) encourage nucleus formation.
- For better granulation, ghee to be slowly cooled to 28 C in 2-3 h time and agitation is required during granulation to form smaller granules.

Causes of granulation:

- Partly granular form assumed by ghee is due to certain content of glycerides of higher melting saturated fatty acids (palmitic and stearic).
- Buffalo milk ghee show predominant granulation than cow milk ghee.

Yield:

Factors influence the yield of ghee:

1. Method of production: Fat recovery in indigenous method is lowest in range of 80-85%, in creamery butter method it ranges from 88-92% and highest in direct cream method ranging from 90-95%.

2. Fat content of raw material used: Higher the fat content higher will be the yield and vice versa.

3. Quality of milk/cream: If acidity of milk or cream intended to use in ghee production is higher, then fat losses in ghee residue will be higher, thus reducing yield.

4. Fat recovery from ghee residue: Extraction as much as fat from ghee residue by dissolving ghee residue in hot water followed by filtration and centrifugation can be done. It is possible to extract fat from ghee residue and that fat can be added back to cream or butter melter.

Substandard milk for ghee production:

- In commercial dairy plants, acidic milk is diverted and collected separately based on platform tests.
- This sourced milk is collected in balance tank and circulated using high speed pump, causing breakdown of fat globule membrane and release fat.
- After circulation of 30 min, milk is kept undisturbed thus, separating cream base which is used for ghee production directly or collected over -a-period of time and neutralized to produce butter from this cream. This butter will be used for ghee making.

Quality difference between fresh milk ghee and acid milk ghee

Parameter	Fresh milk ghee	High acid milk ghee
Liquid portion	Less	More
Colour units	High	Less