

Ghee

Soma Maji

Introduction

- Ghee is almost anhydrous milk fat and because of its strong shelf life, it is most widely used milk product in the Indian sub-continent.
 - In India, it is prepared traditionally from buffalo milk which belong low in carotenoids produce a white ghee with greenish tinge
 - The characteristic colour of buffalo ghee has been attributed to tetrapyrozole pigments-biliverdin and bilirubin .
 - The presence of carotenoids in cow's milk produces a golden yellow coloured ghee.
 - Ghee has a pleasant, cooked and rich flavour. The taste is usually sweet, although a slight acidic flavour is preferred.
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- According to FSSR-2011, ghee means the pure heat clarified fat derived solely from milk or curd or from desi (cooking) butter or from cream to which no colouring matter or preservative has been added.

FSSR-2011 Standards for ghee state wise in India

Name of the State / Union Territory	Butyro Refractometer reading at 400C	Min. Reichert Value	FFA as oleic acid (max.)	Moisture (Max.)
Andhra Pradesh	40.0 to 43.0	24	3	0.5
Arunachal Pradesh	41.0 to 44.0	26	3	0.5
Assam	40.0 to 43.0	26	3	0.5
Bihar	40.0 to 43.0	28	3	0.5
Chattisgarh	40.0 to 44.0	26	3	0.5
Areas other than cotton tract areas	40.0 to 43.5	24	3	0.5
Cotton tract areas	41.5 to 45.0	21	3	0.5
Orissssa	40.0 to 43.0	26	3	0.5

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

AGMARK standards of ghee

Parameters	Special Grade	General Grade	Standard Grade
Baudouin Test	Negative	Negative	Negative
Butyro-refractometer reading at 40°C	40.0 - 43.0	40.0 - 43.0	40.0 - 43.0
Reichert Meissl value	Not less than 28.0	Not less than 28.0	Not less than 28.0
Polenske value	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0
Moisture content	Not more than 0.3%	Not more than 0.3%	Not more than 0.3%
Percentage of Free Fatty Acid (as oleic acid)	Not more than 1.4	Not more than 2.5	Not more than 3.0

METHODS OF GHEE PREPARATION

The principle involved in ghee preparation include;

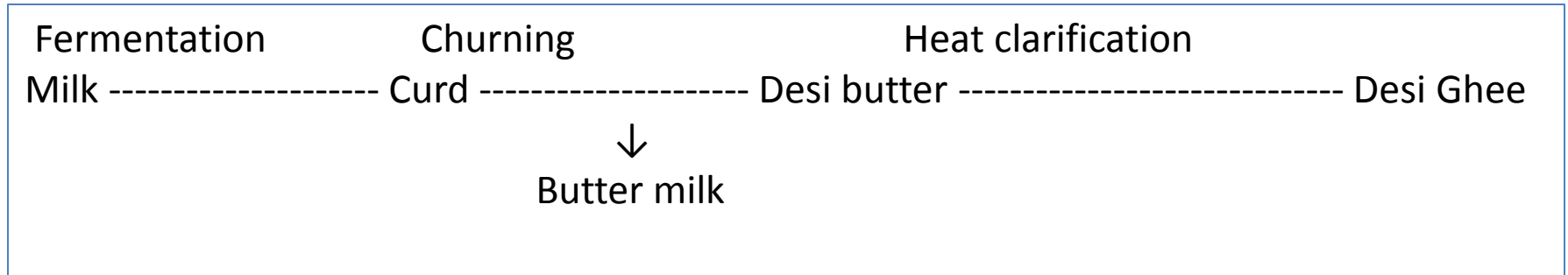
1. concentration of milk fat in the form of cream or butter.
2. Heat clarification of fat rich milk portion and thus reducing the amount of water to less than 0.5%.
3. Removal of the curd content in the form of ghee residue

There are four methods of ghee making:

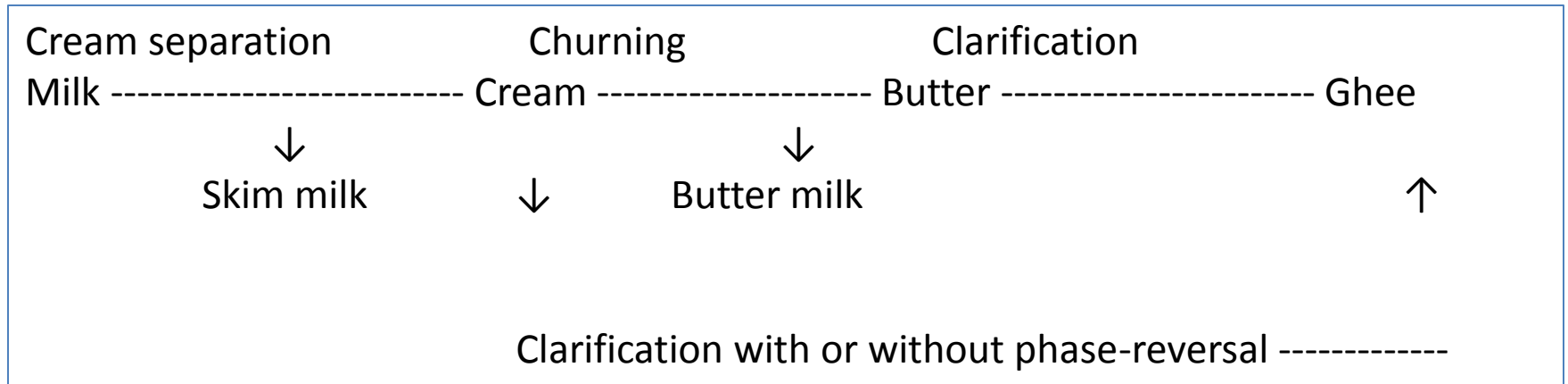
- i. Desi or Indigenous Method
- ii. Direct Cream Method
- iii. Creamery Butter Method
- iv. Prestratification Method

Method of preparation

Desi Method:



Creamery and creamery butter Method:



Pre-Stratification:

In the pre-stratification method, butter is melted at 80 – 85⁰C and held for 30 minutes. The top layer being of scum, middle layer of fat and bottom layer of butter milk serum. The bottom layer of butter milk is drained out and the remainder of curd particle and fat layer heated to a final temperature of 110 – 120⁰C

Desi method and Creamery Method

➤ **Advantages**

1. No need for butter production prior to manufacturing of ghee.

➤ **Disadvantages**

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

Advantages of pre-stratification method over desi method and creamery method

- Removal of buttermilk (bottom layer) eliminates prolonged heating for evaporation of the 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



Antioxidants in Ghee

- Ghee is expected to have a storage life of 6-12 months when stored under sealed condition at 21⁰C .
- The keeping quality of ghee is adversely affected by increase in acidity and development of off-flavour viz. rancidity, oxidation, tallowiness, etc.
- The antioxidant butylated hydroxyl anisole (BHA) is generally added to control the oxidation of ghee. In addition to BHA, it is found that butylated hydroxyl toluene (BHT) and tertiary butyl hydroquinone (TBHQ) imparted excellent oxidative storage stability of ghee .
- There are certain naturally occurring compounds such as betel leaves, curry leaves, moringa leave, safflower, amla, lime juice, etc have been found to be effective in checking oxidation of ghee during storage .
- Several components of ghee such as phospholipids, carotenoids, α – tocopherol and browning compounds which are formed during ghee manufacture, retard deterioration of ghee during storage and act as innate antioxidant.

Physico-chemical changes during manufacture of ghee

The quality of ghee depends on milk, cream, dahi or butter, methods of preparation, temperature of clarification, storage conditions, and type of animal feed. These factors in turn will determine the physicochemical characteristics of ghee. The principal measurements of ghee quality are: peroxide value, acidity, and flavour.

Flavour: (Carbonyles, lactones)

The most important factor controlling the intensity of flavour in ghee is the **temperature of clarification**.

- **Ghee prepared at 120°C** or above has an intense flavour which is usually referred to as **cooked or burnt flavour**.
- **Ghee prepared at around 110°C** has a somewhat mild flavour, often referred to as **curdy**.
- **Ghee prepared from desi method** generally produces the **most desirable flavour**.
- Flavour in ghee is retained longer when butter contains 1% NaCl.
- The acidity of the cream or butter affects the flavour of ghee. **Sweet cream-butter** yields ghee with a **fiat flavour** whereas **ripened cream or butter** having an acidity of 0.15 to 0.25% (lactic acid) produces ghee with a **more acceptable flavour**.
- Cow ghee contains more volatile carbonyls. The total carbonyls of buffalo ghee is higher than that of cow ghee irrespective of the method of preparation and temperature of clarification.

Physico- chemical changes of Ghee during Storage

Physical changes :

- Dependent primarily on the temperature of storage.
- Crystallization occurs with the formation of solid, semi-solid and liquid layers.
- Ghee prepared from cow and buffalo milk, kept either in a metal or glass container at 20°C or below, solidifies uniformly with fine crystal.
- Above 20°C and below 30°C, solidification is a loose structure.
- To avoid layer formation it would be preferable to store ghee below 20°C .



Chemical changes:

- The liquid portion of ghee had a significantly higher RM value and iodine number than the granular solid or hard flaky portion of the same ghee.
- Ghee stored at high temperature is susceptible to oxidative deterioration, rancidity, and off flavour. Shelf life of ghee is also dependent on the method of preparation.
- The keeping quality of desi ghee is better than that of direct cream or creamery butter ghee.
- Peroxide value, TBA value and acidity increases with storage
- Milk phospholipids in ghee improves its shelf life. Ghee having more residue, which is a source of phospholipids, has a longer storage life.

Oxidation of Fat

- Edible fats containing unsaturated molecules are susceptible to attack by molecular oxygen.
- Process is referred to as lipid oxidation and can give rise to undesirable volatile flavour compounds, potentially toxic oxidation products, and a general deterioration in the quality of the fat
- **Factors affecting the fat oxidation in ghee:**
 - ✓ light exposure,
 - ✓ Storage temperature,
 - ✓ presence of pro-oxidant metals,
 - ✓ presence of antioxidant compounds (Tocopherols, Ascorbic acid, Carotenoids, Thiols, Proteins and enzymes)
 - ✓ the degree of unsaturation of the fat
 - ✓ Milk fat globule membrane
 - ✓ Moisture
 - ✓ Fatty acid composition

Type of Rancidity

Oxidative rancidity:

Also known as autoxidation, occurs when oxygen is absorbed from the environment. In the presence of oxygen and/or ultraviolet (UV) radiation, most lipids breaks down and degrade, forming several other compounds. Oxygen is eight times more soluble in fats than it is in water; it is the main cause of the autoxidation process, increasing the saturation of the oil.

Hydrolytic rancidity:

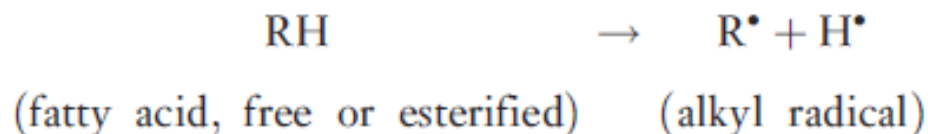
Also called hydrolysis or enzymatic oxidation, occurs in the absence of air, but with the presence of moisture. This normally is accomplished through enzymatic peroxidation, where enzymes found naturally in fats (i.e., lipoxygenase, cyclooxygenase) which can catalyze reactions between water and fat.

The volatile flavour products of lipid oxidation include

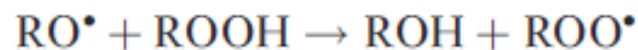
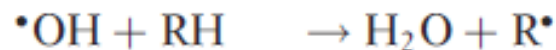
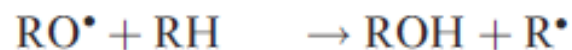
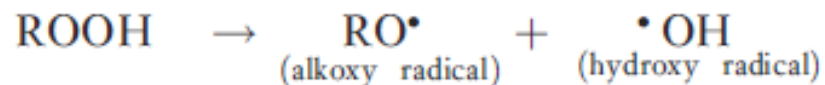
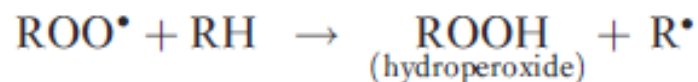
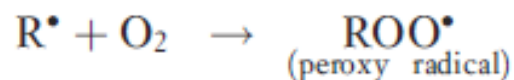
- ✓ aldehydes,
- ✓ ketones,
- ✓ alcohols,
- ✓ esters,
- ✓ lactones, and
- ✓ hydrocarbons,
- ✓ of which the **unsaturated aldehydes and ketones** are primarily responsible for undesirable oxidized (rancid) flavours.

Mechanism of Lipid oxidation

Initiation

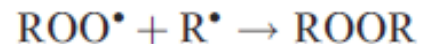
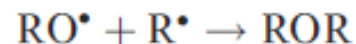
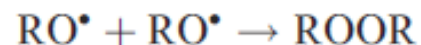


Propagation

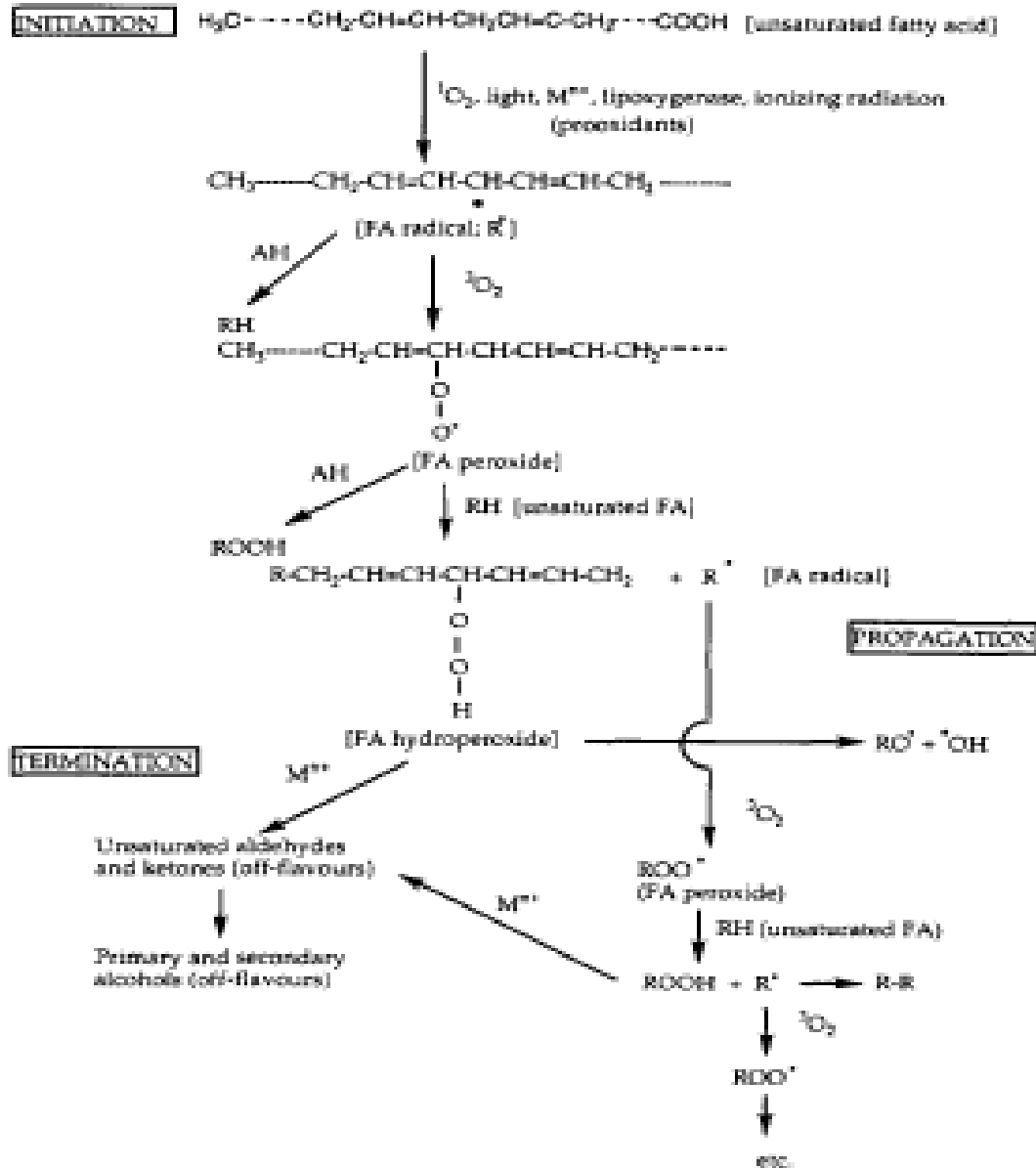


ROOH → Nonradical end products, for example, aldehydes

Termination



Lipid oxidation and role of antioxidant



Rancidity

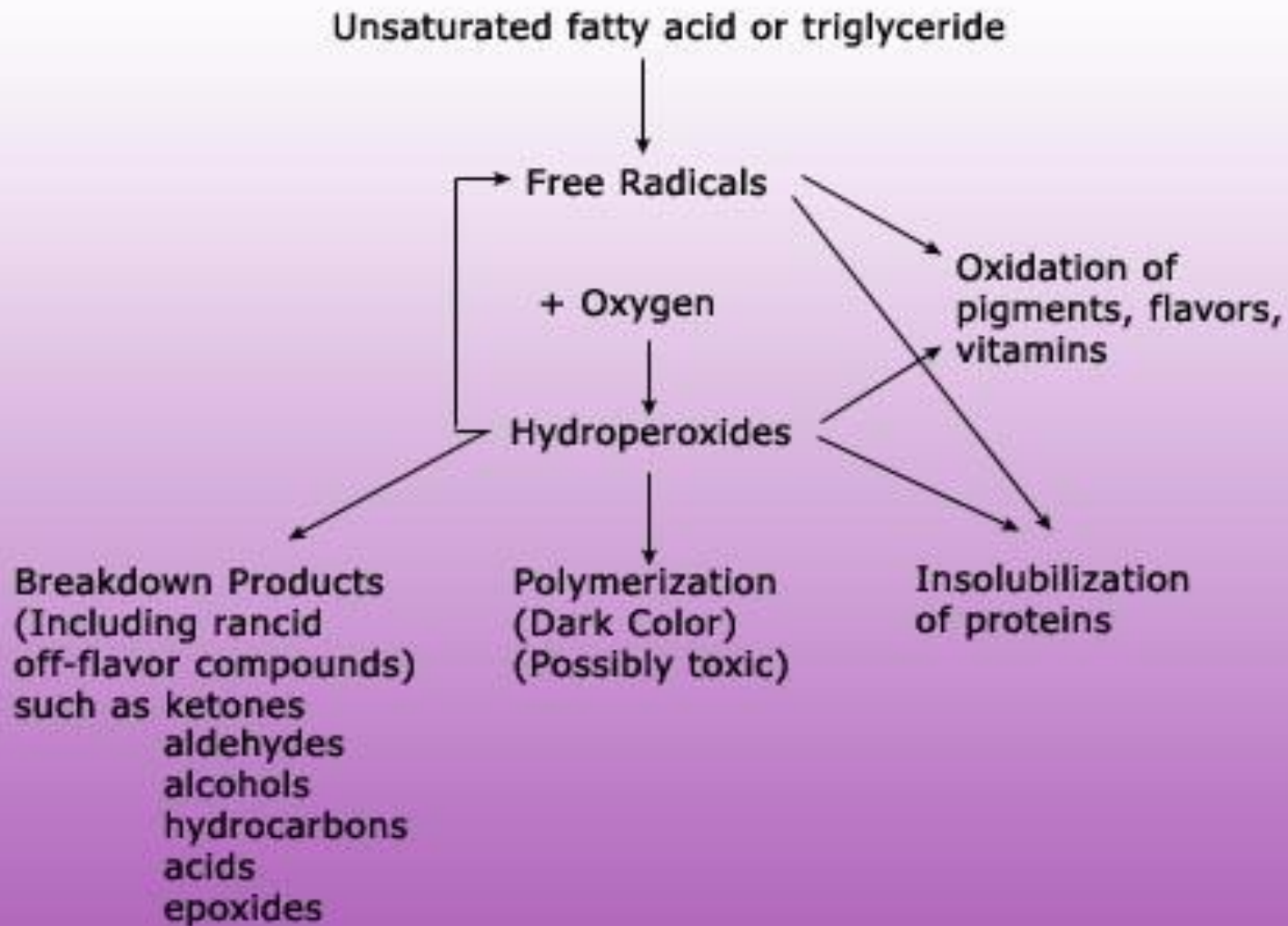


Fig. 1 Lipid Oxidation Mechanism

Prevention of oxidation

1. Elimination of oxygen:

- Packaging under nitrogen
- packaging in vacuum
- packaging with an oxygen scavenger

2. Elimination of the sensitive substrate:

- Replacement of polyunsaturated oils with less unsaturated oils, such as olive oil or palm oil, that are more stable

3. Decreasing the rate of oxidation:

- Storage at low temperatures
- storage in the dark
- use of fats and oils that contain low levels of oxidation promoters (eg. oxidized products and heavy metals)

4. Hydrogenation:

- Treatment of an oil with hydrogen and a suitable catalyst to decrease the number of double bonds and increase the degree of saturation

5. Use of antioxidant :

- use of ingredients that are naturally rich in antioxidants
- Use of synthetic antioxidant (eg. BHA)