

EXPLORING THE ESSENCE OF COW GHEE: A REVIEW ON ITS TYPE, ISOLATION OF CONSTITUENTS AND COSMETIC AND MEDICINAL USES

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1. ABSTRACT

Cow ghee, an ancient Indian staple food ingredient is a clarified lipid for its dietary, therapeutic, and cosmetic value. It's composed of ~99.5% lipids, including beneficial short-chain fatty acids like butyric acid and long chain fatty acids like conjugated linoleic acid (CLA), known for their anti-inflammatory and antioxidant properties. Ghee is also a vital source of fat-soluble vitamins A, D, E, and K. Traditional methods, like the Bilona process, yield ghee with superior quality and nutrient retention compared to industrial methods. Its complex lipid architecture includes triglycerides and an unsaponifiable fraction (with cholesterol, lutein, squalene) that benefits skin health. Medicinally, ghee enhances digestion, supports cardiovascular and neurological health, and acts as a carrier (Yogavahi) for Ayurvedic drugs. Its emollient and anti-aging properties also make it valuable in cosmetic

formulations. This review confirms cow ghee's role as a holistic, multifunctional bioactive substance.

KEYWORDS: Cow ghee, Conjugated linoleic acid (CLA), nutraceuticals, cosmetic formulations, therapeutic agent.

2. INTRODUCTION

Ghee is a type of clarified butter that originated in India and is widely used in South Asian

cuisine, traditional medicine (Ayurveda), and Hindu religious rituals. It is made by simmering regular butter until the water evaporates and the milk solids separate and brown, which gives it a distinct nutty, slightly sweet, and caramelized aroma and flavour.

2.1 Introduction and preparation of ghee (in general)

Ghee is a nutrient-rich clarified butter that provides about 469 KJ of energy per teaspoon and has an appealing aroma due to a flavonoid. Its composition is notable for containing various fatty acids, including high levels of CLA, which has been shown to inhibit bone cancer cell growth in studies.^[1] CLA also contributes to antioxidant homeostasis and possesses immunostimulatory properties. Furthermore, ghee is rich in butyric acid^[2], a short-chain fatty acid that supplies approximately 60% of the energy needed by colon cells and supports the potential anti-tumor effects of these components are of particular interest as an alternative to conventional cancer treatments like radiotherapy and chemotherapy, which are associated with significant adverse side effects, including fatigue and anemia.^[3]

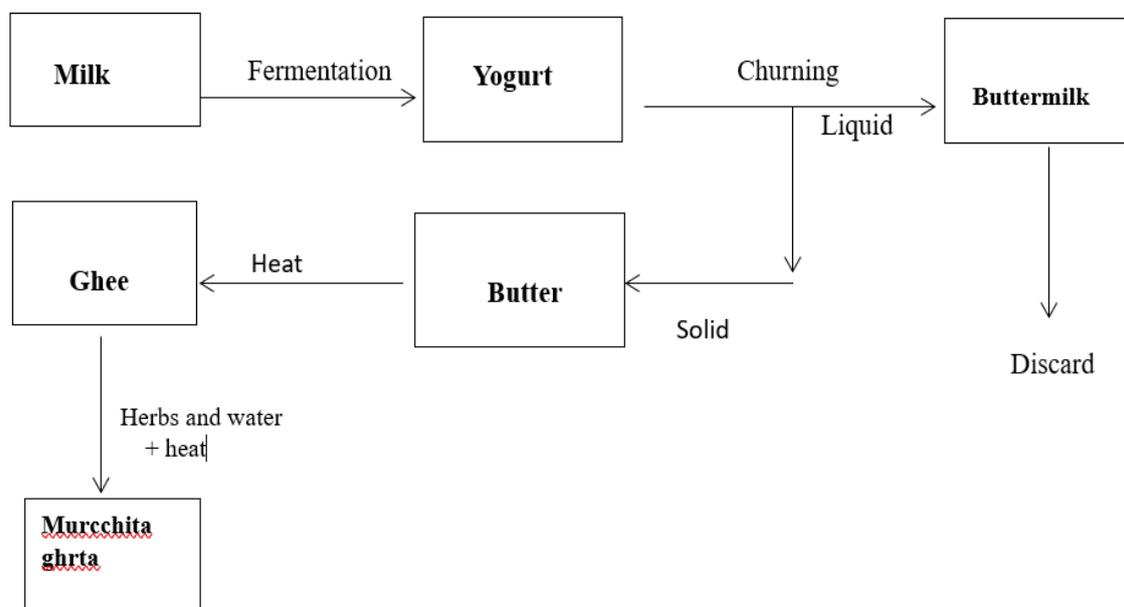


Fig. no. 1: Preparation of ghee.^[1]

Traditionally, ghee is made by a process involving

- Boiling milk (with cream)
- Curdling it with a *Lactobacillus*-containing curd
- Churning the resulting yogurt to separate from Buttermilk
- Coddling the butter to gain ghee.^[1,4,5]

2.2 Introduction on cow ghee

2.2.1 Cow ghee: Cow ghee is a type of clarified butter, consisting of approximately 99.5% lipid content, which is valued both as a culinary fat and a therapeutic agent in Ayurveda. Its nutritional profile includes a mixture of fatty acids, notably Butyric Acid (a short-chain fatty acid linked to gut health and anti-inflammatory effects), and CLA, along with being a significant source of fat-soluble vitamins such as A, D, E, and K. Furthermore, its high smoke point (around 200°C) makes it a stable and preferred fat for high-temperature cooking, and its role as a "yogavahi" (catalytic agent) allows it to carry the medicinal properties of herbs deep into body tissues.^[6]

2.2.2 Types of cows that produce ghee: Top Cow Breeds for Traditional Ghee (A2 Milk Producers) These native Indian breeds are highly valued for their A2 milk, which has a good fat content and is preferred for its traditional health benefits:

- **Gir:** Rich, grainy, and aromatic ghee.
- **Sahiwal:** Richness and creaminess of their milk.
- **Tharparkar:** Nutritious A2 milk.
- **Red Sindhi:** Originally from the Sindh province, this breed is also recognized for its milk's high fat.
- **Kankrej:** A dual-purpose breed from Gujarat, its milk is also used for making quality A2 ghee.
- **Rathi:** Nutritious A2 milk.^[7]

2.2.3 Types of Cow Ghee

Cow ghee can be categorized in several ways, primarily based on the source of the milk (specifically the cow breed or feed) and the method of preparation. The distinction often relates to nutritional profile, flavor, and traditional use.

1. Classification by Milk Source and Quality

This categorization often focuses on the type of cow milk used, which is thought to influence the final product's nutritional components.

- **A2 Cow Ghee:** Made from the milk of indigenous Indian cow breeds (like Gir, Sahiwal, or Badri) which produce A2 beta-casein protein.
- **Grass-fed Ghee:** Produced from the milk of cows that are primarily fed a grass diet and allowed to graze freely.^[8]

- Grain-fed Ghee: Made from the milk of cows whose diet consists largely of grains and non-grass-based feed.

2. Classification by Preparation Method: The method of preparation significantly impacts the flavor, texture, and nutritional value, with traditional methods being highly valued

- **Bilona Ghee (Traditional or Cultured Ghee):** This ancient Ayurvedic method is considered the gold standard. It involves:
 1. Converting the whole milk into curd (yogurt).
 2. Churning the curd (traditionally using a wooden churner called a *bilona*) to separate the butter (makkhan).
 3. Slowly simmering the resulting butter to make ghee. This process is more labor-intensive but results in a highly aromatic, granular ghee with a richer, often nuttier flavor and superior digestibility.^[9]
- **Direct Cream Ghee (Industrial Method)**
 1. Separating the cream directly from the milk.
 2. Heating the cream to make butter, or heating the cream directly.
 3. Clarifying the butter/cream to make ghee. This method is faster and yields more ghee but often results in a product with a milder flavor and less perceived nutritional benefit compared to the *Bilona* method.^[10]

2.2.4 Types of brands of cow ghee

Table no. I Brands of cow ghee.^[11]

Sr No.	Cow Ghees
1	Amul cow ghee
2	Mother Dairy Pure Ghee
3	Patanjali Cow Ghee
4	Aashirvaad Svasti Pure Cow Ghee (from ITC)
5	Nestle Everyday Shahi Ghee
6	Nandini Pure Cow Ghee
7	Gowardhan Pure Ghee
8	Britannia Ghee
9	GirOrganic

2.2.5 Analysis of cow ghee

For the differentiation and characterization of ghee prepared from cow's milk, physical and chemical properties were taken in the consideration. This differentiation is very important

necessary for the consumer.^[12]

Table no. II Physicochemical properties of cow ghee.^[12]

Constants	Cow Ghee
Butyro-refractometer (BR) reading	42.3
Sponification value	227.3
Reichert-Miessel (RM) value	26.7
Polenske value	1.76
Iodine value	33.7
Kirschner value	22.16
Solidifying Point (°C)	15-23.5
Melting point (°C)	28-41
Colour (yellow unit/g) (Tintometer)	8.8

2.2.6 GENERAL USES OF COW GHEE

- Skin & Healing: Exhibits skin healing, wound healing, and anti-inflammatory properties.
- Cosmetics: Ghee Residue shows enhanced moisturizing and antioxidant properties compared to cold creams, making it a promising cosmetic ingredient.
- Direct Application: Apply directly to lips and under the eyes to treat dryness and dark circles; can be used as a natural treatment for scars.
- Overnight Use: Applying ghee to the face overnight provides deep moisturization, nourishment, potential anti-aging effects, skin repair, and a glowing complexion.
- With Milk: Combining ghee and milk (in moderation) improves nutrient absorption, supports joint health, and calms the digestive system.^[13,14]

3. METHODS FOR SOLATION OF COW GHEE CONSTITUENTS

3.1 List of cow ghee constituents

- Fat
- Saturated Fat
- Cis-Monoene
- Trans-Monoene
- Diene
- Polyene
- Triglycerides (Triacylglycerols)
- Diglycerides

- Monoglycerides
- Unsaponifiable matter

3.1.1 FAT: The Gas Chromatography (GC) method for analyzing cow ghee's fat constituents is a two-step process essential for quality and authenticity assessment. The goal is to convert the non-volatile triglycerides into measurable Fatty Acid Methyl Esters (FAME).

Structure

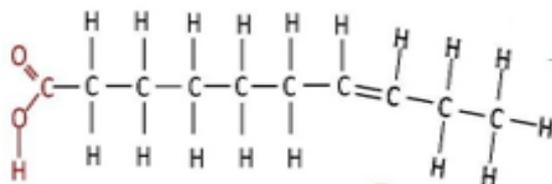


Fig. no. 2: Unsaturated Fat.

Characteristics: The core properties of pure cow ghee are: golden yellow colour from beta-carotene; a pleasant, nutty, and sweet aroma; a high boiling point (around 250°C-260°C) making it good for frying; a low melting point (around 28°C-44°C) meaning it melts easily; and a rich, buttery, slightly nutty, and sweet taste with a smooth mouthfeel.^[15]

Method

A. The process begins by preparing the ghee for GC analysis

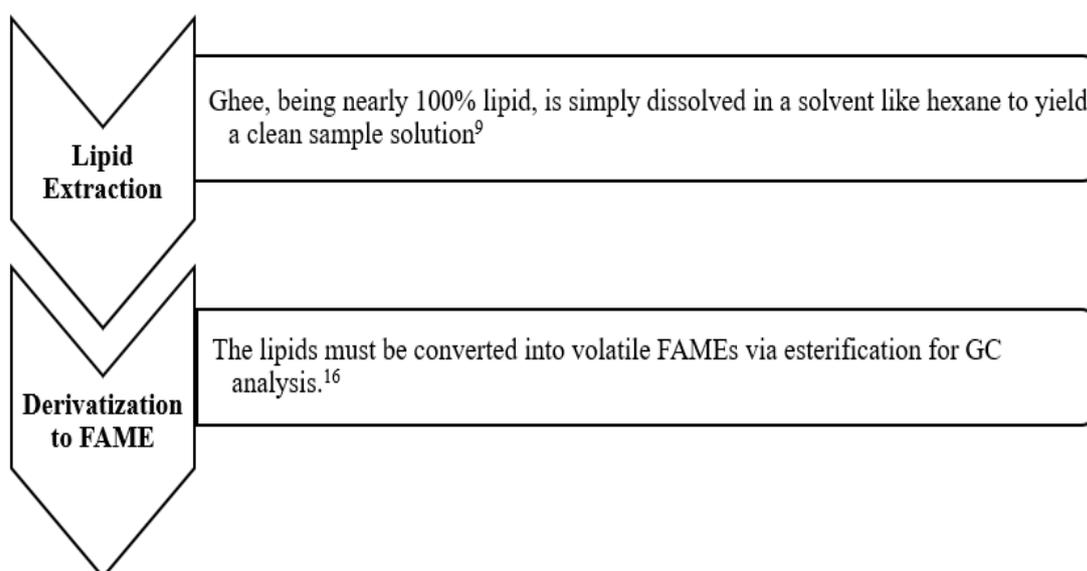


Fig. no. 3: The process begins by preparing the ghee for GC analysis.^[9,16]

for its high boiling point (BP), around 250°C-260°C, which makes it stable for high-heat cooking. Conversely, its melting point (MP) is low, typically 28°C-44°C, allowing it to melt easily at room or body temperature.^[19]

Method

A. Fractionation: Fractionation is the primary industrial method, relying on SFAs having higher melting points than UFAs.

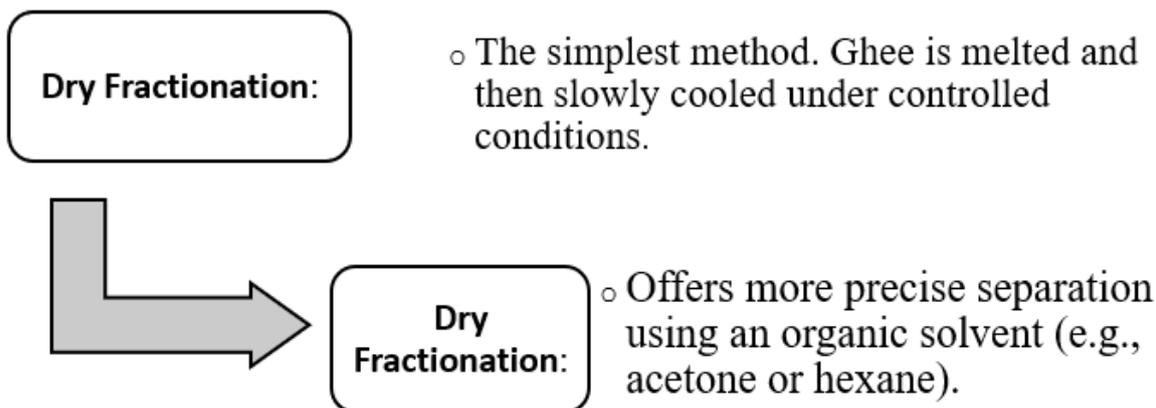


Fig. no. 6: Fractionation.^[20]

B. Urea Complexation: Urea complexation is a high-purity, laboratory-scale chemical separation method.

Principle: Urea forms stable, crystalline complexes with the straight-chain SFAs, but cannot complex with the bent-chain UFAs.

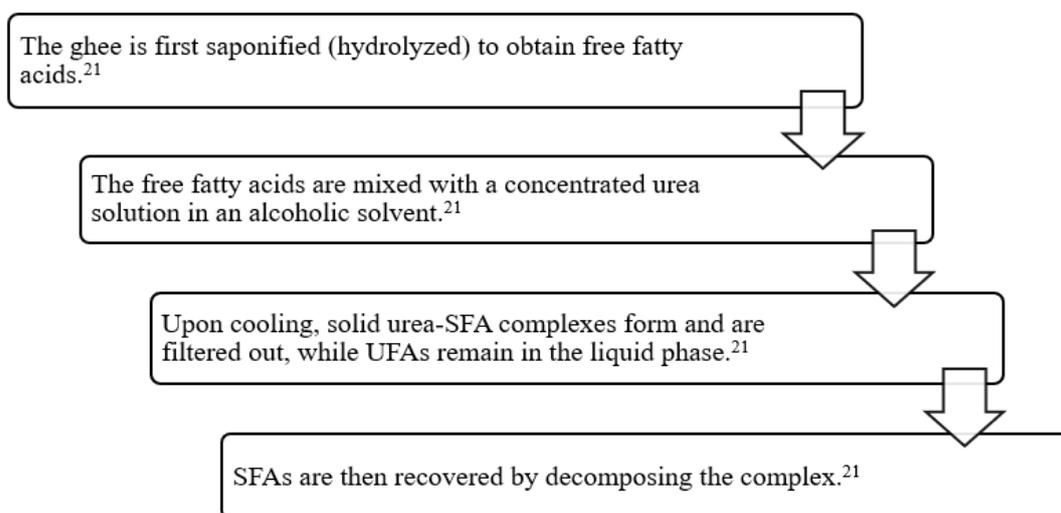


Fig. no. 7: Urea Complexation.^[21]

Uses

Table no. IV: Uses of Saturated Fats.

Uses Type	Benefits	Reference
Cosmetic	Moisturizer/Barrier: Palmitic and stearic acids create a protective, moisture-locking barrier. Hair: Deep conditioner to repair and add shine.	[Error! Bookmark not defined.,Error! Bookmark not defined.]
Medicinal	Gut Health: Natural source of acid (SCFAs) vital for colon cells, reduces gut inflammation. Metabolic: provide quick, digestible energy for the brain. Nutrient: Enhances absorption of fat-soluble vitamins (A,D,E,K).	[Error! Bookmark not defined.,Error! Bookmark not defined.]

3.1.3 CIS-MONOENE AND TRANS-MONOENE: On the number and geometry of their double bonds, using silver ions to form complexes with the cis isomers and isolating trans-monoene fatty acids from cow ghee is a specialized process that, like the isolation of cis-isomers, requires advanced chromatographic techniques to differentiate between fatty acid isomers. While standard gas chromatography can separate fatty acids by chain length and degree of unsaturation.

Structure

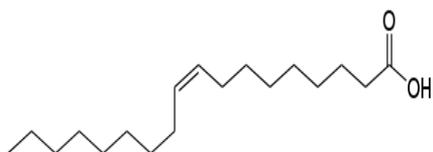


Fig. no 8 Trans (Elaidic-acid)

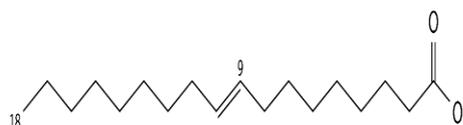


Fig. no. 9 cis (Oleic acid)

Characteristics: The fatty acid components of cow ghee, specifically Cis-Monoene Fat (like Oleic Acid) and Trans-Monoene Fat (like Vaccenic Acid), contribute distinct properties. Cis-Monoene Fat typically gives a pale yellow to golden colour and a mild, pleasant, buttery odour. It has a lower melting point (around 10°C-16°C) due to structural kinks but a high boiling point (around 230°C-250°C). Conversely, Trans-Monoene Fat is slightly paler in colour, has a stronger, more- fatty odour, and a significantly higher melting point (around 30°C-45°C) because its structure allows for tighter molecular packing. Its boiling point is also slightly higher (around 240°C-260°C), but it tends to impart a more waxy or slightly greasy taste.^[22]

Method

Argentation Chromatography (Isolation)	Cis-monoenes form stronger, more stable complexes with Ag ⁺ due to their kinked structure, causing them to elute slower, while trans-monoenes form weaker complexes and elute faster. ²³
High-Resolution Gas Chromatography (HRGC)	Modern HRGC systems utilize very long capillary columns with highly polar stationary phases. ²³
Fourier Transform Infrared (FTIR) Spectroscopy	The technique measures infrared light absorption at a characteristic frequency (around 966 cm ⁻¹) that is unique to the geometric configuration of the trans double bond. ²³

Fig. no. 10: Method of Isolation of Cis-Monoene and Trans-Monoene.^[23]

Uses of Cis-Monoene

Table no. V Uses of Cis-Monoene.

Use Type	Benefits	Reference
Cosmetic	Deeply moisturizes (acid) without greasiness, improves skin elasticity, acts as an excellent carrier for fat-soluble compounds.	[Error! Bookmark not defined.]
Medicinal	Cardiovascular: Helps lower "bad" and maintain "good" cholesterol. Anti-inflammatory: acid helps manage chronic inflammation, supports brain health.	[18]

Uses of Trans-Monoene

Table no. VI: Uses of Trans-Monoene.

Uses Type	Benefits	Reference
Cosmetic	Acts as an excellent carrier for fat-soluble compounds. effects are attributed to other fatty acids/vitamins.	[24]
Medicinal	Cardiovascular Risk: Known to increase and decrease cholesterol, raising the risk of heart disease.	[19,24]

3.1.4 DIENE: Conjugated Linoleic Acid (CLA): Dienes in cow ghee are notable for Conjugated Linoleic Acid (CLA), a polyunsaturated fatty acid with two double bonds separated by a single bond. Isolating CLA from ghee involves a multi-step chemical and chromatographic process.

Structure

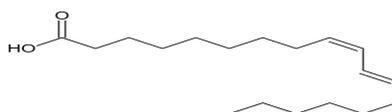


Fig. no. 11: Conjugated Linoleic acid (CLA).

Characteristics: Diene fats, such as linoleic acid, give ghee a light yellow to golden color. They have a mild, pleasant odour, though they are prone to oxidation, leading to a rancid or oily smell upon prolonged air exposure. Diene fats are less heat stable than saturated fats, possessing a slightly lower boiling point (around 220°C-230°C). Notably, they have a very low melting point (around -5°C to 5°C), meaning they stay liquid even in cool conditions. The taste is described as light, smooth, and slightly oily, lacking the rich buttery flavor of saturated fats.^[25]

Method

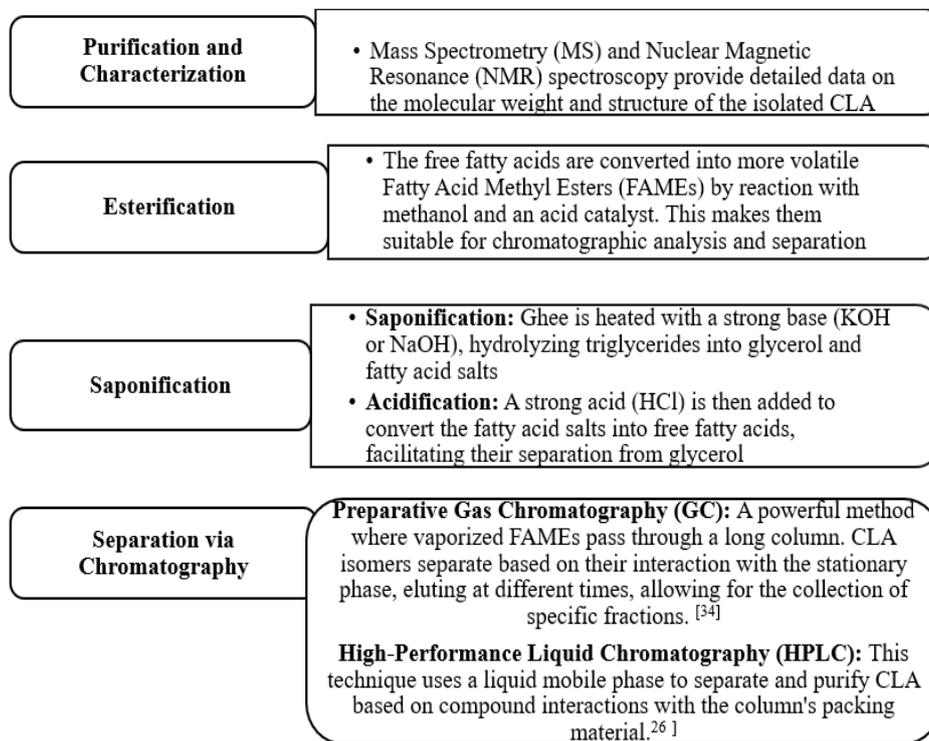


Fig.no.12 Method of Isolation of Diene (CLA).^[26]

Uses

Table no. VII Uses of Diene.

Uses Type	Benefits	Reference
Cosmetic	Anti-inflammatory properties; soothes irritated skin, protects from damage, supports minor wound healing.	[Error! Bookmark not defined.]
Medicinal	Anti-cancer: Suggested to inhibit certain cancer cells.	[Error! Bookmark not

	Metabolic: Reduces body fat, improves insulin sensitivity. Immune: effects, reduces chronic inflammation.	defined.,Error! Bookmark not defined.]
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3.1.5 POLYENE: Cow ghee contains polyenes, notably **Conjugated Linoleic Acid (CLA)**, a fatty acid, and **beta-carotene**, a pigment. Their isolation is a complex, multi-step laboratory process.

Structure

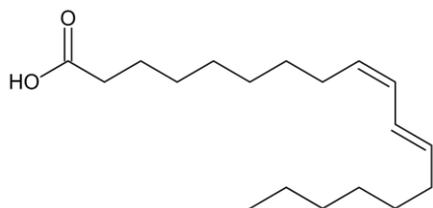


Fig. no. 13: Conjugated Linoleic Acid.

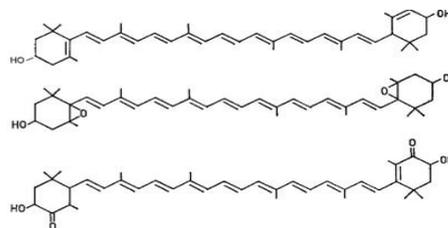


Fig. no. 14: Beta-carotene.

Characteristics: Polyene fats (like linoleic and linolenic acids) in ghee contribute a light yellow to pale golden colour and a mild, neutral odour when fresh, though they can easily become oily or rancid upon oxidation. They have a relatively low boiling point (around 220°C-230°C), making them less thermally stable. Crucially, they exhibit a very low melting point (around -10°C to 0°C), ensuring they remain liquid at room temperature. The taste of these fats is typically light, bland, and slightly oily, lacking the rich, nutty flavour of saturated fats.^[27]

Module

A. Isolation of Conjugated Linoleic Acid (CLA)

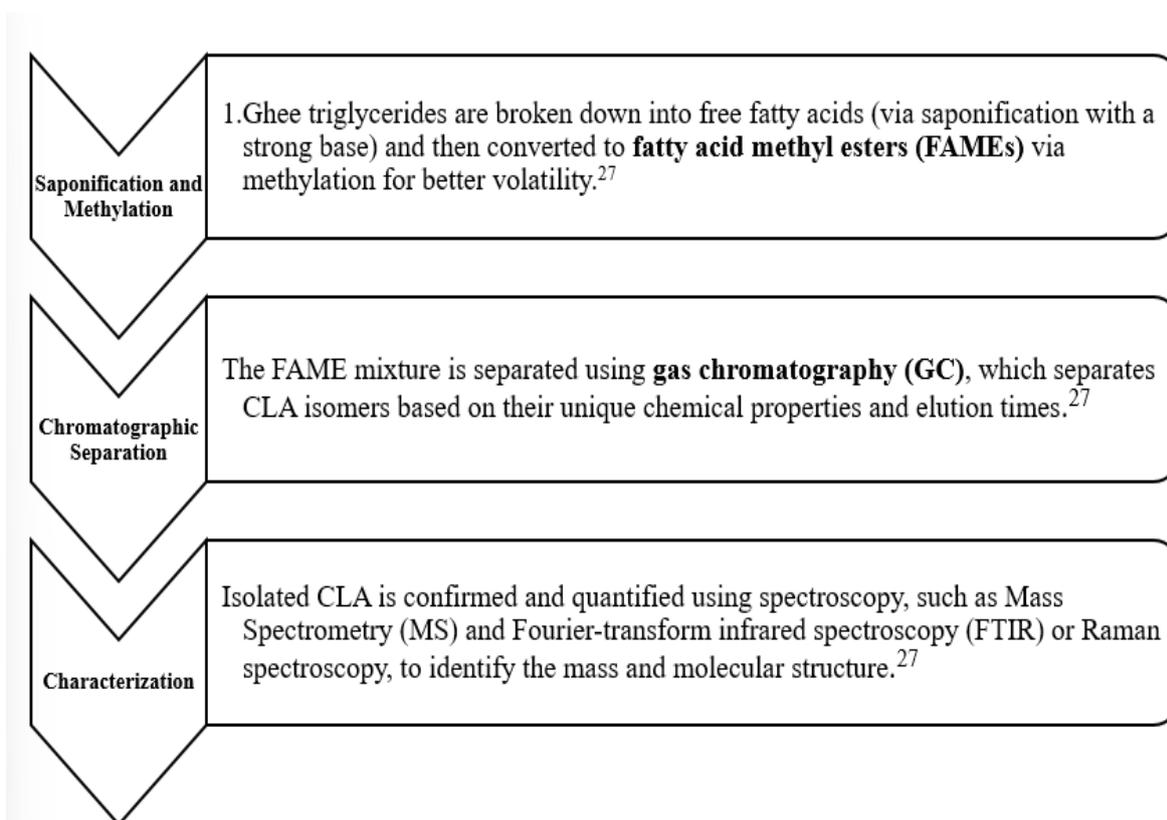


Fig.no.15 Isolation of Conjugated Linoleic Acid (CLA).^[27]

B. Isolation of Beta-Carotene

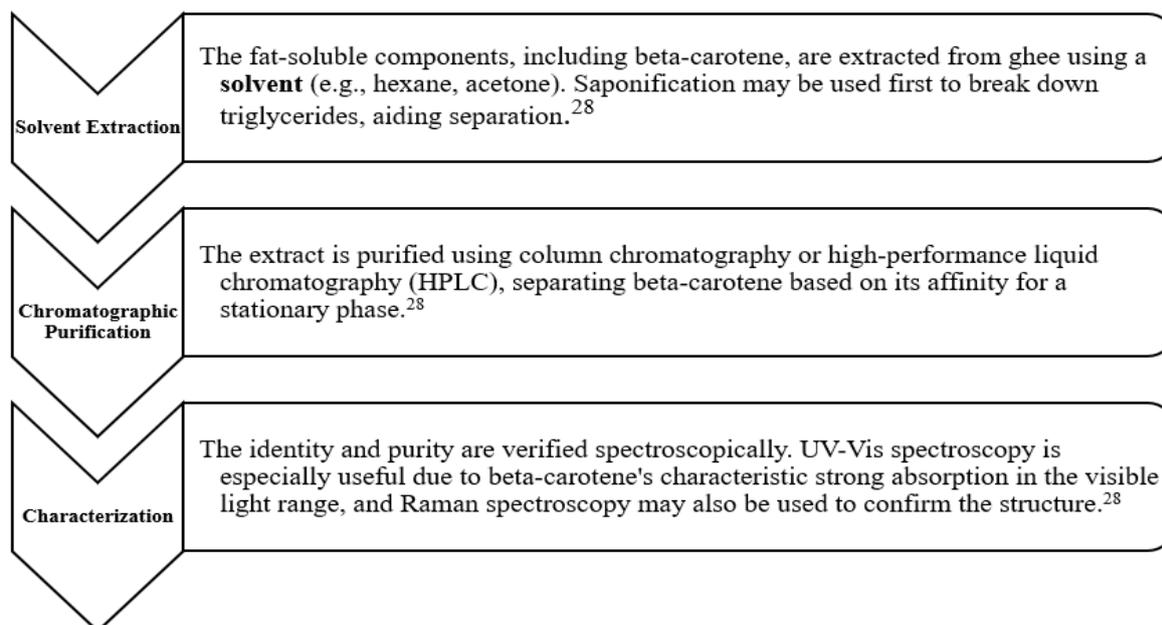


Fig. no. 16: Method of Isolation of Beta-Carotene.^[28]

Uses

Table no VIII Uses of Polyenes

Uses Type	Benefits	Reference
Cosmetic	Supports skin barrier (linoleic acid), preventing water loss. and provide anti-inflammatory effects, soothing conditions like acne/eczema.	[Error! Bookmark not defined.]
Medicinal	Essential Fatty Acids: Vital for health Omega-3 (ALA) Omega-6 and support brain and heart health, crucial for metabolic/hormonal regulation.	[Error! Bookmark not defined.]

3.1.6 TRIGLYCERIDES (TRIACYLGLYCEROLS)

Ghee is primarily composed of triglycerides (98-99%). The "isolation" is a purification and profiling process used in research and quality control to detect adulteration.

Structure

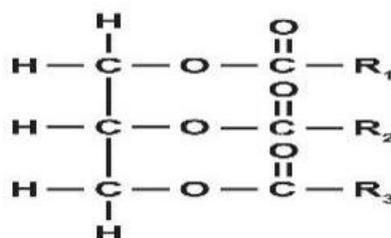


Fig. no. 17: Triglycerides.

Characteristics: Ghee is characterised by its golden yellow colour, attributed to β -carotene from cow's milk fat. It has a signature pleasant, sweet, and nutty aroma developed during preparation.^[1] Ghee is highly suitable for cooking due to its high boiling point (BP), ranging from 250°C to 260°C which is low, typically 28°C to 44°C, allowing it to melt easily at room or body temperature. The taste is rich, creamy, buttery, and slightly nutty, leaving a smooth texture with mild sweetness.^[29]

Method

Fig. no. 19: Diglycerides (DG).

Characteristics: Diglycerides, a component of cow ghee, are characterised by a light yellow to golden colour, similar to triglycerides, with the hue primarily coming from beta-carotene. They impart a mild, pleasant, and sweet buttery aroma, which is slightly less intense than that of triglycerides. Diglycerides have a high boiling point (BP), around 240°C-260°C, making them stable for cooking, though slightly lower than triglycerides. Their melting point (MP) is low, ranging from 25°C to 40°C, allowing them to melt easily. The taste is described as smooth, slightly oily, and mildly sweet, contributing to the overall rich texture of cow ghee.^[31]

Method: The separation relies on the difference in polarity and molecular size between DGs (more polar) and TGs.

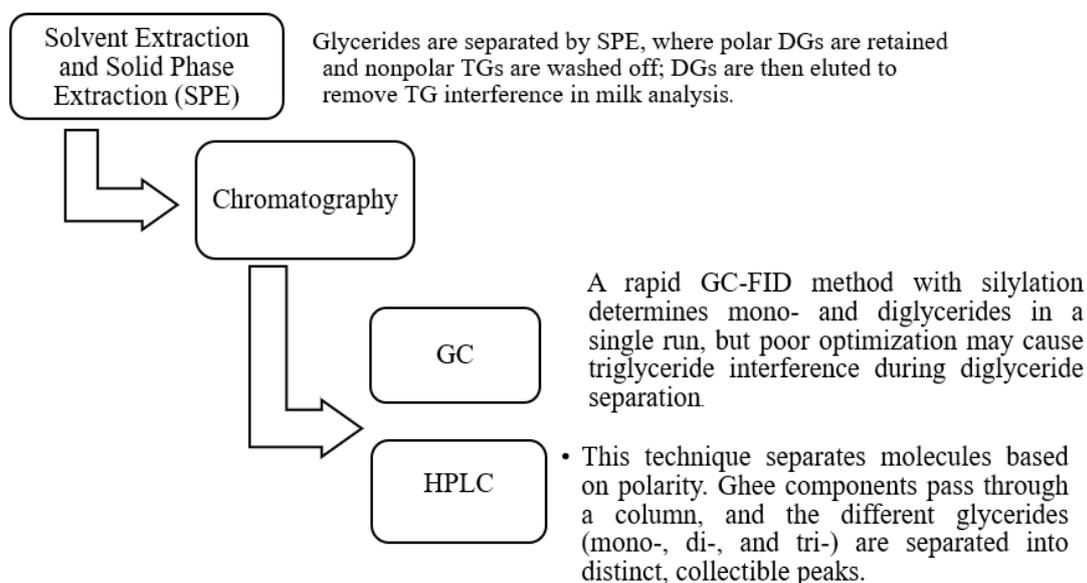


Fig. no. 20: Method of Isolation of Diglycerides.^[32]

Uses

Table no. X Uses of Diglycerides.

Uses Type	Benefits	Reference
Cosmetic	Emulsifier: Helps blend oil and water for stable creams. Emollient: Supports skin barrier, preventing water loss for soft, supple skin.	[Error! Bookmark not defined..Error! Bookmark not defined.]
Medicinal	Absorption: More easily absorbed than triglycerides, enhancing of fat-soluble vitamins (A,D,E,K).	[Error! Bookmark not

	Energy/ Signaling: Quick, digestible energy source and act as cellular signaling molecules.	defined.]
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3.1.8 MONOGLYCERIDES: Monoglycerides (MG) are a minor but valuable component of cow ghee, comprising less than 1% of its composition, with triglycerides (TG) being the majority. Due to their emulsifying properties, MGs are highly sought after in the food, cosmetic, and pharmaceutical industries. Their isolation from Ghee is a specialized, multi-step laboratory procedure.

Structure

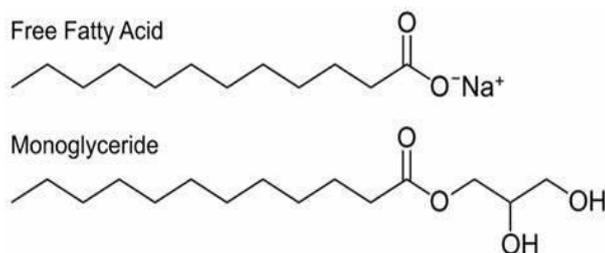


Fig. no. 21: Monoglycerides (MG).

Characteristics: Monoglycerides in cow ghee contribute to its light yellow to pale golden colour (derived from beta-carotene) and a mild, sweet, buttery odour that is less intense than other fat components. As simpler molecules, they have a slightly lower boiling point (BP), typically around 230°C-240°C. Their low melting point (MP), ranging from 20°C-35°C, is key to making ghee soft and smooth at room temperature. The taste they impart is smooth, mildly oily, and slightly sweet, enhancing the ghee's creamy mouthfeel and rich texture.^[33]

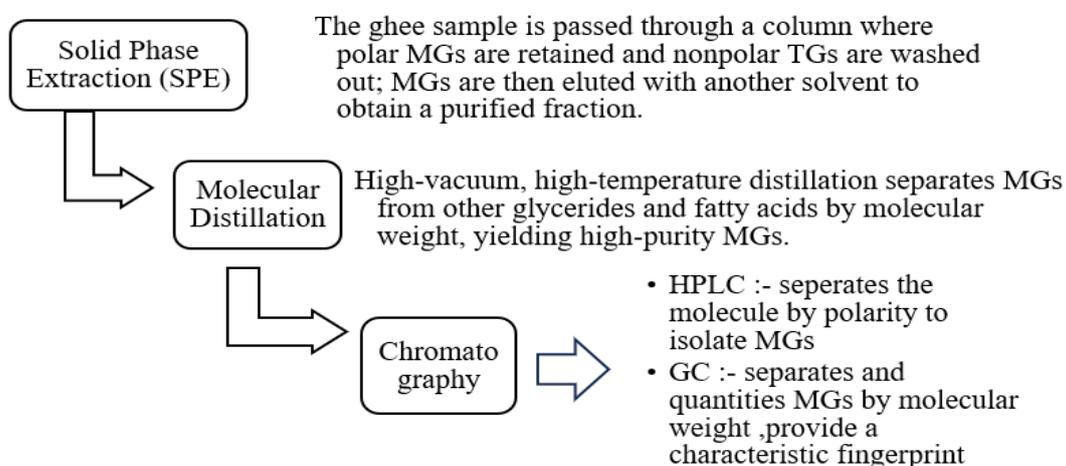


Fig. no. 22: Method of Isolation of Monoglyceride. [Error! Bookmark not defined.,34]

Uses

Table no. XI: Uses of Monoglycerides.

Uses Type	Benefits	Reference
Cosmetic	Supports skin barrier (linoleic acid), preventing water loss. and provide anti-inflammatory effects, soothing conditions like acne/eczema. Emulsifier: Helps blend oil and water for stable creams. Emollient: Supports skin barrier, preventing.	[Error! Bookmark not defined.,Error! Bookmark not defined.]
Medicinal	Essential Fatty Acids: Vital for health. Omega -3 (ALA) Omega-6 and support brain and heart health, crucial for metabolic/hormonal regulation.	[Error! Bookmark not defined.]

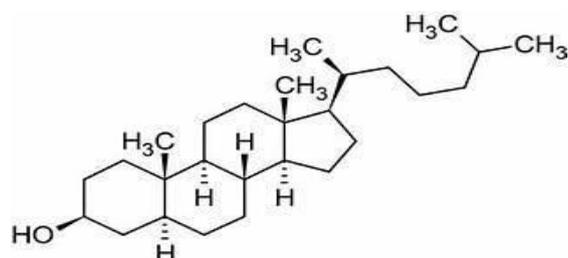
3.1.9 UNSAPONIFIABLE MATTER: Unsaponifiable matter is the fraction of cow ghee that does not convert into soap when treated with an alkali, serving as a key purity indicator against adulteration.

This includes: Cholesterol, Lanosterol, Lutein, Squalene, Vitamin A, Vitamin E, and Ubiquinone.

Characteristics: The unsaponifiable matter in cow ghee, though mostly colourless itself, contributes to the overall yellow to golden colour via natural pigments like beta-carotene. Its overall high boiling point (BP), around 250°C to 260°C, indicates that its components (like sterols and hydrocarbons) are largely heat-stable. The melting point (MP) varies between 28°C to 44°C, aligning with the fat portion of ghee. Lastly, it imparts a mild, smooth, and slightly nutty taste, contributing significantly to the typical rich flavour of cow ghee.^[35]

A. Cholesterol: Cholesterol isolation hinges on its property as an unsaponifiable sterol.

Structure

**Fig. no. 23: Cholesterol.**

Method

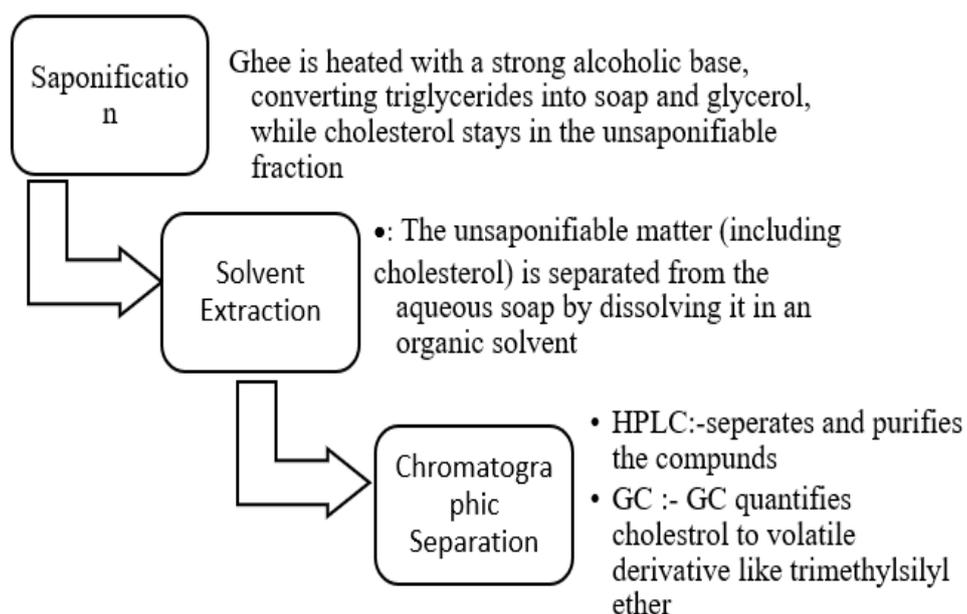


Fig. no. 24: Method of Isolation of Cholesterol.^[36]

B. Lanosterol: Lanosterol isolation is complex due to its low concentration relative to cholesterol.

Structure

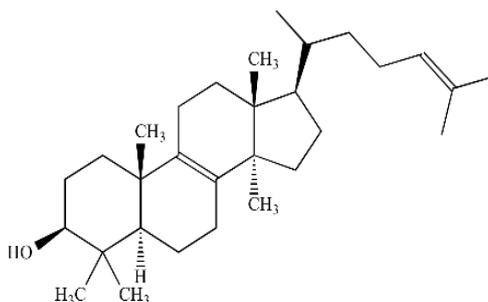


Fig. no. 25: Lanosterol.

Method

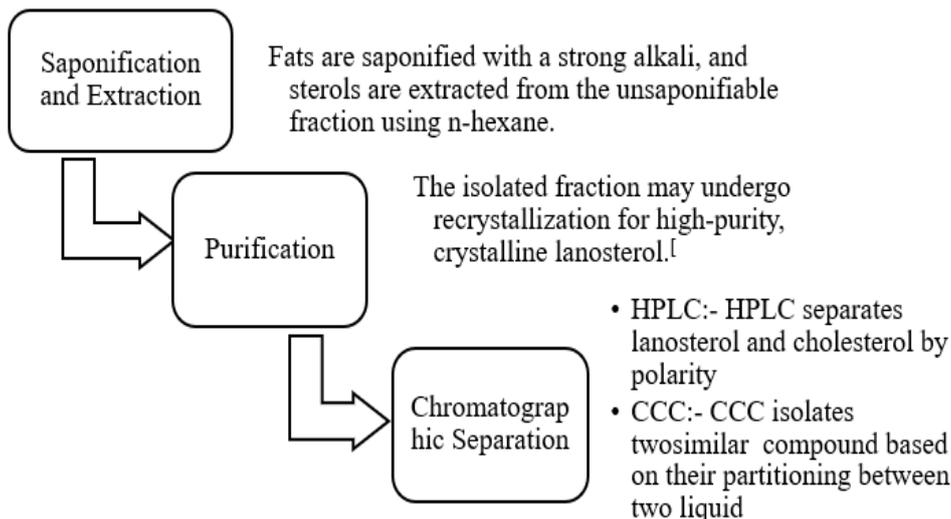


Fig. no. 26: Method of Isolation of Lanosterol.^[37]

C. Lutein: Lutein isolation is challenging due to its low concentration as one of the carotenoids responsible for ghee's color.

Structure

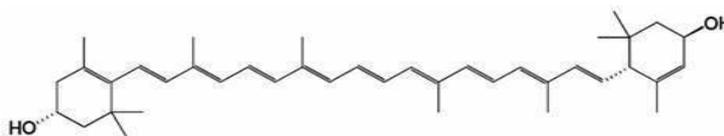


Fig. no. 27: Lutein.

Method

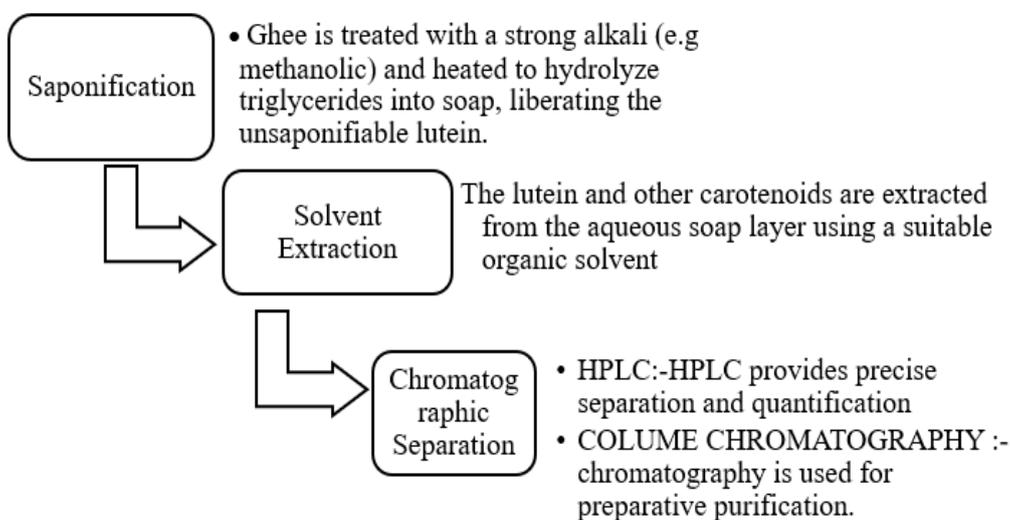


Fig. no. 16: Method of Isolation of Lutein.^[38]

D. Squalene: Squalene isolation is difficult because it is a very minor, unsaponifiable

hydrocarbon component.

Structure

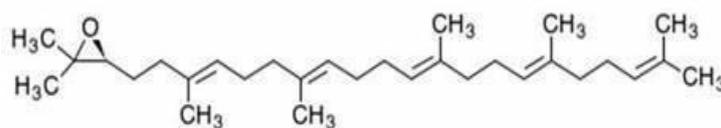


Fig. no. 28: Squalene.

Method

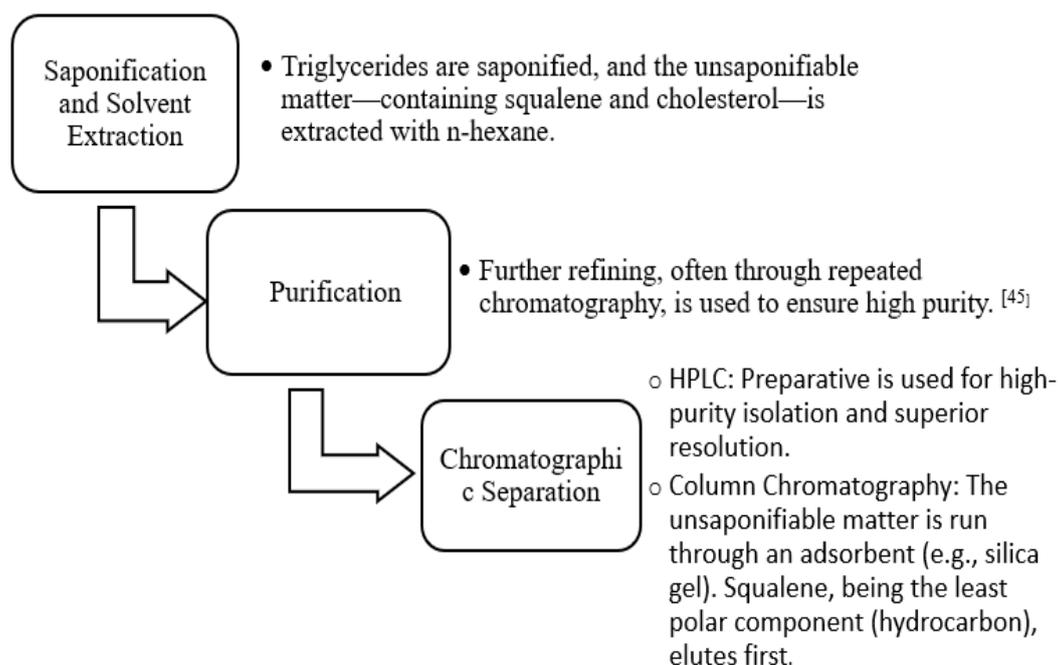


Fig. no. 28: Method of Isolation of Squalene.^[39]

E. Ubiquinone: Ubiquinone (eg. Coenzyme) isolation is challenging due to their low, fat-soluble concentration in ghee.

Structure

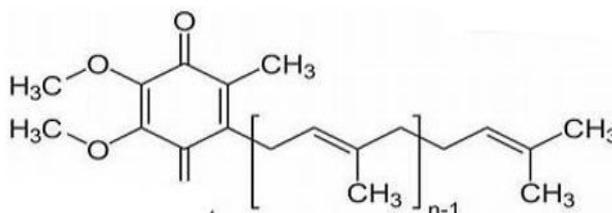


Fig. no. 29: Ubiquinone.

Method

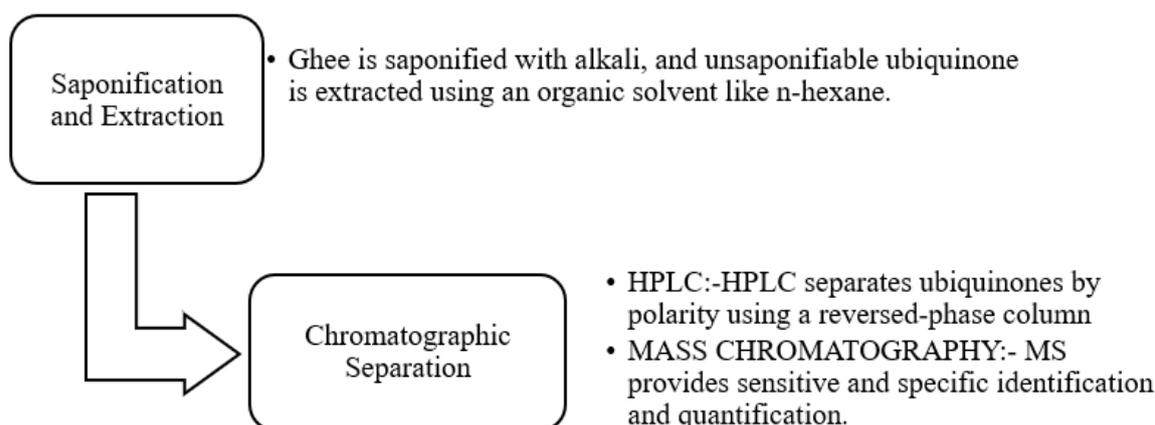


Fig. no. 30: Method of Isolation of Ubiquinone.^[40]

Uses

Table no. XII Uses of Unsaponifiable matter.

Constituents	Cosmetic uses	Medicinal	References
a. Cholesterol	Maintains skin barrier, prevents water loss, acts as a natural emulsifier, supports minor healing.	Critical component of cell membranes/nervous system. Precursor for hormone and Vitamin synthesis. Facilitates (herb transport) property.	[Error! Bookmark not defined.,Error! Bookmark not defined.]
b. Lanosterol	Supports skin barrier/moisture retention, acts as an emulsifier, potential anti-aging benefits.	Potential for cataract reversal (dissolves protein aggregates in the lens). Contributes to overall lipid metabolism.	[Error! Bookmark not defined.]
c. lutein	Powerful antioxidant protecting from damage/free radicals; improves skin hydration and elasticity.	Eye Health: Protects retina from blue light, reduces risk of and cataracts. properties.	[Error! Bookmark not defined.,Error! Bookmark not defined.]
d. Squalene	Excellent moisturizer/emollient (natural sebum component). Antioxidant protects from /stressors. Enhances absorption of other ingredients.	Potent antioxidant protecting cells from oxidative damage. effects. Potential to support cardiovascular health.	[Error! Bookmark not defined.]
e. ubiquinone	Powerful antioxidant (reducing aging signs). Energizes skin cells, supporting regeneration, and may boost.	Essential for cellular energy production (in mitochondria). Highly beneficial for cardiovascular health and has neuroprotective effect.	[Error! Bookmark not defined.,Error! Bookmark not defined.]

5. CONCLUSION

This review highlights cow ghee as a multifaceted natural product that bridges traditional Ayurvedic wisdom and modern scientific understanding. The results demonstrate that cow ghee's therapeutic potential arises from its diverse bioactive constituents, including butyric

acid, conjugated linoleic acid (CLA), β -carotene, and sterols such as cholesterol, lanosterol, and squalene. These compounds collectively contribute to antioxidant protection, improved digestion, enhanced immunity, and cellular rejuvenation. Traditional Bilona ghee derived from A2 milk of indigenous breeds such as Gir and Sahiwal shows superior nutritional quality and digestibility.

From a cosmetic perspective, cow ghee and its derivatives act as natural emollients and anti-aging agents that promote hydration, elasticity, and skin barrier repair. Medicinally, ghee supports cardiovascular and neural functions, assists in wound healing, and enhances nutrient absorption, validating its Ayurvedic Rasayana (rejuvenating) properties. Future studies should focus on controlled clinical evaluations, development of standardized extraction and purification methods, and potential integration into nutraceutical and dermatological formulations.

In summary, cow ghee, when sourced and prepared authentically, remains a valuable functional food and therapeutic agent with strong potential for applications in health, nutrition, and cosmetic industries.

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