



# **GHEE RESIDUES**

**PROCESSING, PROPERTIES & UTILIZATION**



# 1. INTRODUCTION

- Ghee residue is a brownish solid mass obtained as a byproduct during ghee manufacture. It contains considerable amounts of milk fat, protein and minerals.
- Depending on the intensity of the heat treatment used during the ghee manufacture, colour of ghee-residue (GR) may vary **from light to dark brown**.
- It has **smooth to granular texture with glossy** exterior due to the presence of excessive free fat.
- About 33% of the TMP → ghee making (Dairy India, 2007)  
Ghee prod. → **(36.3 million tones) ...if TMP@110MT**  
GR Prod. → **3.63** million tonnes per annum

**TMP-121 Million Tonnes (NDDDB → Feb. 29, 2012)**

**Where**

average yield of GR @ **1/10<sup>th</sup>** the quantity of ghee produced,

## 2. CHEMICAL COMPOSITION

- The yield of GR varies with the variation in the serum solid content of the raw materials used for ghee manufacture.

**Table 1. Chemical composition and yield of ghee-residue (Hand pressed)**

Source of Ghee-residue	Chemical Composition (%)					Yield (Kg/100 Kg)
	Moisture	Fat	Protein	Lactose	Ash	
<i>Makkhan</i> (indigenous butter)	13.4	33.4	32.8	15.4	5.2	1.6
Creamery butter (unsalted)	5.7	65.0	25.5	Trace	3.8	1.2
Sweet cream	4.1	63.2	18.0	12.3	2.4	7.7
Sour cream	8.0	38.8	41.6	7.3	4.3	5.1
Washed sweet cream	1.7	80.8	16.2	Trace	1.3	3.5

### 3. TREATMENT AND PROCESSING OF GHEE-RESIDUE

- ❖ Ghee-residue has soft and smooth body but gets progressively hardened during storage.
- ❖ Much faster changes in textural characteristics occurs during the first 15 days and it becomes hard & gritty by the end of a month.
- ❖
- ❖ It is processed to eliminate these changes & to yield a soft and smooth texture, essential for edible preparations.
- ❖ Before subjecting it to any-treatment, lumps are broken & then pulverized by passing through 40 mesh sieve.

**Table 2. Comparison of chemical composition of ghee-residue subjected to various processing treatments.**

- T- I** Loosely tying the residue in the form of bundle & cooking in boiling water for 30 min.
- T- II** Cooking the residue in boiling 1.0% , NaHCO<sub>3</sub> /30 min.
- T- III** Washing the residue with 50% alcohol and then cooking in boiling water for 30 min.
- T- IV** Washing the residue with 50% alcohol followed by boiling in 1.0% NaHCO<sub>3</sub>
- T-V** Autoclaving the residue (15 PSI/10 min) obtained from III after incorporating 2% vinegar
- T-VI** Autoclaving the residue obtained from IV after incorporating 2% vinegar

Particulars	Treatment I		Treatment II		Treatment III		Treatment IV	Treatment V		Treatment VI
	Before	After	Before	After	Before	After	After	Before	After	After
Acidity (ml N/10 NaOH/g)	18.8	9.2	20.6	---	18.1	10.3	---	20.6	5.0	---
Moisture	13.3	49.7	13.8	65.0	15.3	61.5	70.7	13.8	49.0	68.0
Fat	52.2	26.7	49.8	18.5	46.8	18.2	15.0	49.8	22.0	15.4
Protein	19.7	17.6	19.9	10.8	19.9	16	10.1	19.9	23.6	12.0
Lactose	11.5	3.8	12.5	2.5	13.1	1.1	1.6	12.5	1.2	1.4
Ash	3.3	2.2	4.0	3.2	4.3	2.3	2.6	4.0	3.2	3.2

- ✓ Keeping quality of all types of GR clarified at 120°C is 3 months.
  - ✓ Its shelf life can further be extended to more than 4 months by
    - pressing it in cake form and
    - addition of ethanol extracts of browning compounds (1%)
- from defatted GR to cow and buffalo ghee clarified at 100°C and stored at 37°C extended the shelf life by about 1.5 and 2 months respectively.

### 3. Recovery of ghee from ghee residue

#### ↓ Recovery of ghee from GR

centrifugal process

- Heating GR in water (65°C) so as to transfer the occluded ghee of the residue to water.
- Ghee is subsequently recovered by centrifugation.
- yields 25% ghee (46% efficiency).

Pressure  
Technique

- Heated GR (65-70°C) is subjected to a limited pressure in hand screw or hydraulic press.
- This method gives an yield of about 45% (extraction efficiency of about 67%)

## 4. PHYSICO-CHEMICAL PROPERTIES

### 4.1 Particle size and density

- ↓ Ghee-residue is generally removed by bag filters or muslin cloth, but for the continuous ghee clarification process, centrifugal clarifiers have been designed.
- ↓ The average particle diameter of GR is **104.79 microns** and average density is **1.14 g/cm<sup>3</sup>** (Wadhwa, 1997).

### 4.2 Lipids in ghee-residue

- ↓ The lipids of GR have lower Reichert and Polenske values (24.4., 1.3) but have higher iodine value (43.4) in comparison to those of the corresponding ghee.
- ↓ The lipids of GR contain 53% lower chain fatty acids (C4.0 to C12.0), 58.7% total saturated fatty acids and 41.3% unsaturated fatty acids.
- ↓ Irrespective of the method of preparation, polyunsaturated fatty acids (PUFA) content of GR lipids (4.4%) is higher than those of corresponding ghee (2.8%).



# Cont...

- Ghee-residue is rich in phospholipids (1-9%) → acts synergistically with reducing substances → protects it from oxidative defect.
- Higher phospholipids (a good emulsifier) content of GR is beneficial in developing certain products where emulsification of fat & aqueous phase is desired.
- The phospholipid content of GR is dependent upon the method of preparation.

## 4.3 Proteins in ghee-residue

- ❖ Due to the denaturation of the proteins, Soluble nitrogen content of GR prepared from cream or creamery butter decreases with heating time.
- ❖ By paper chromatographic technique, 11 free amino acids, 2 amines and 8 unidentified spots were detected in GR .
- ❖ These substances are liberated from protein during heat treatment and because of their polar nature they are mostly retained in the GR.
- ❖ Whey proteins, especially  $\beta$ -lactoglobulin are the main source for the sulphhydryl compounds

## 4.4 Milk sugars in ghee residue

- Ghee-residue prepared at 120°C contains sugars (wt %) such as lactose (76.6), galactose (14.1), glucose (5.3), and two unidentified sugars.
- As the period of heating is increased, the lactose content of GR decreases with a corresponding increase in galactose and glucose content.
- The unidentified sugars are also found to increase as the period of heating is increased.
- The unidentified sugars might be due to some of the breakdown products or sugar fragments formed during browning or caramelization reactions

## 5. ANTIOXIDANT PROPERTIES

Lipid  
constituents

Non-lipid  
constituents

### Antioxidant activity

- Phospholipids > Tocopherol > Vit. A
- Phospholipid fractions-**cephalin** (Max)
- Heating GR with ghee(1:4) at 130°C  
→ Max transfer of phospholipids to ghee

- Amino acid proline, **lysine**, cysteine hydrochloride and tryptophane
- At 0.02% level ,Proline have max. antioxidant property though less than BHA

→ Addition of lactose, glucose, galactose and their interaction products with protein and P. lipids and reducing substances including free sulphhydryls, increases oxidative stability of ghee

→ Antioxidant efficiency of GR decreases with increase in the temperature of clarification of ghee i.e. Less peroxides will develop.

→ GR antioxidant strength: **creamery** > **desi butter** > **direct creamery**



→ GR can be used as a source of

✓ Natural antioxidants

✓ To improve the shelf-life of dairy & food products as the use of synthetic antioxidants is generally not preferred due to their toxic effects

✓ Its oxidative stability for flavoured butter oil is parallel to BHA & BHT

## 6. FLAVOURING PROPERTIES

- Ghee-residue is a rich source of natural flavouring compounds viz. free fatty acids (FFA), carbonyls and lactones

	Ghee	Ghee Residue
FFA ( $\mu\text{m/g}$ )	53.6	627.5
Carbonyls ( $\mu\text{m/g}$ )	4.3	43.7
Lactones ( $\mu\text{g/g}$ )	30.3	3992.9

## 7. NUTRITIVE VALUE OF GHEE RESIDUE

- Ghee residue has poor quality of protein because of its lower lysine content.
- Supplementation of GR with some good quality protein such as SMP, sharply increased its protein efficiency ratio (PER) from 0.66 to 2.4.
- Supplementation with 8% lysine, 2.5% methionine and 1.4% tryptophan strikingly improved its nutritive value which is even slightly higher than SMP
- Supplementation of GR with other proteins and/or amino acids can be taken up for developing value added edible products from it.

**Table 4. Nutritive value of ghee-residue**

<b>Diet</b>	<b>Protein Efficiency Ratio (PER)</b>	<b>Digestibility Coefficient</b>	<b>Biological Value (%)</b>	<b>NPU (%)</b>
Skim Milk Powder	3.92	93.61	91.99	86.12
Ghee-residue	0.75	92.65	65.07	40.77
Ghee-residue + 8%lysine	3.24	82.48	77.87	64.23
Ghee-residue + 8% lysine + 2.5% Methionine + 1.4% Tryptophane	4.11	86.24	93.84	80.64

$$PER = \frac{\text{Gain in body mass}(g)}{\text{Protein intake}(g)}$$

**Digestibility Coefficient:**

The proportion of food digested and not excreted, shown as a percentage of the total food eaten



- **Biological Value** : BV of a Protein is a value that measures how well the body can absorb and utilize a protein. As a result, proteins with the highest BV promote the most lean muscle gains.

Whey protein → 104, Egg protein → 100 , milk proteins → 91

Beef protein → 80 , soy proteins → 74, Bean proteins → 49

- The **net protein utilization (NPU)** is the ratio of amino acid converted to proteins to the ratio of amino acids supplied.
- Experimentally, this value can be determined by determining dietary protein intake and then measuring nitrogen excretion.
- $$\text{NPU} = \frac{((0.16 \times (24 \text{ hour protein intake in grams})) - ((24 \text{ hour urinary urea nitrogen}) + 2) - (0.1 \times (\text{ideal body weight in kilograms})))}{(0.16 \times (24 \text{ hour protein intake in grams}))}$$
- As a value, NPU can range from 1 to 0.

## 8. APPLICATIONS OF GHEE-RESIDUE

### 1. Preparation of candy

The ingredients required for candy preparation include processed GR (1 kg), sugar (500- 625g), and coconut powder (125-250g).



The candy making process involves thorough mixing of processed GR with 50% sugar syrup with the help of suitable ladle followed by evaporation to remove moisture by heating on low fire with continuous stirring.



When the mass becomes sufficiently sticky, coconut powder is added. The candy is evenly spread on a plate and cooled (5-10°C) for about an hour and cut into small cubes and wrapped in parchment paper.

## 2.Preparation of chocolate



Ingredients: processed GR 1 kg, sugar 500 to 625 g, cocoa powder 60 to 90 g and skim milk powder 250 g.



Processed GR is added to 50% sugar syrup, and thoroughly mixed with a ladle. The contents are desiccated on a low flame till dough is formed.



At this stage cocoa and skim milk powder are added and stirred vigorously till pat is formed.



Finished product is spread on a plate and cooled overnight and cut into slabs or cubes and wrapped in parchment paper.

The product has a shelf life of more than 3 months



### 3.Preparation of *burfi-type confection*

Processed GR was mixed with khoa in the proportion of 1:1 (total solids basis). Sugar was added @75% of the total solids (*khoa + ghee residue*).



*The whole mass was heated and worked vigorously for 10-15 minutes so as to dissolve the added sugar completely. At this stage about two-third of the mixture was taken out and spread as a thick layer on a well greased tray.*



In the remaining one-third of the sweetened mass, chocolate powder @ 8% of the total solids (*khoa + ghee residue*) was *thoroughly worked*.



*This portion containing the chocolate was applied as a thin layer over the two-third portion of the mixture in the tray taken out earlier.*



The mass was cooled and when set cut into pieces of uniform size and shape.

The product got a sensory score of 7.5 (like moderately to very much)

on 9-point Hedonic scale.

# 4.Preparation of confections

- ❖ It contains the major constituents in suitable proportion and possesses fine texture that impart requisite body to such products.
- ❖ Further the treatment during processing of these confections involves heating to such an extent that it completely arrests enzymic activity and flavour deterioration in the final product.
- ❖ The higher fat content in the residue quite often obviate the need for addition of oils and fats in its preparation

## 5. Preparation of edible pastes

- ✦ For preparation of edible paste for sandwich, processed GR is first mixed with salt @ 2.5-3% and then with marmite (a yeast product) @ 0.1-0.5%.
- ✦ The whole mass is heated on a low fire for about 5 min till a paste is formed. An edible paste for *dosa and samoosa* can be prepared if chutney powder @ 2-4% is used instead of marmite.
- ✦ *Both these preparations, if properly* packaged, can remain marketable for 2 months

## 6. Preparation of bakery products

- *Borawake*, prepared *nankatai* type cookies and sponge cake from processed GR obtained from ripened cream.
- In this study a part of vanaspati fat used in preparation of these products was replaced by ghee-residue fat.
- Replacement of vegetable fat up to a level of 30 and 20% for cookies and sponge cake respectively resulted in acceptable quality of products.

## 7. Enhancing flavour of ghee

- Ghee, especially one prepared from fresh creamery-butter (without ripening) has mild flavour.
- GR can be used to enhance flavour in such ghee.
- Unripened creamery butter mixed thoroughly with ghee-residue (10%) and clarified at 120°C, filtered through 4-fold of muslin cloth and subsequently centrifuged to get residue free ghee enhances flavour



# Conclusions

- **Ghee Residue is**
  - **Potent source of nutritive value**
  - **Flavour potential**
  - **Anti oxidant potential**
  
- **Ghee residue, thus, by virtue of its chemical composition, bulk of production, physical characteristics, long shelf life permitting its collection and centralized handling has great potential and is more amenable to exploit its utilization in food industry.**