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# Nutrient composition of ghee residue

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**Abstract**
An experiment was conducted to analyze the chemical and nutritive value of the ghee residues and the complete analysis revealed the moisture, crude protein, crude fibre, ether extract, nitrogen free extract and total ash contents of ghee residue were 12.10, 19.86, 3.49, 47.12, 25.63 and 3.90 per cent, respectively. Fatty acid profile of ghee residue revealed that the palmitic acid registered the highest percentage (38.88) among saturated fatty acids and the oleic acid accounted for the highest percentage (25.15) among unsaturated fatty acids. Linoleic, linolenic, eicosapentaenoic and decosahexaenoic acid content of ghee residue were 2.02, 0.79, 0.36 and 0.25 per cent respectively. Amino acid profile of ghee residue revealed that the lysine and methionine, content were 0.99 and 0.61 per cent, respectively. Threonine and arginine levels are found to be at 1.44 and 0.76 per cent, respectively. The glutamic acid recorded the highest percentage (5.26), while cystine registered the lowest percentage (0.35) among amino acids in ghee residue. Thus, it could be concluded that ghee residue is a rich source of fat, protein, unsaturated fatty acids and amino acids. Further, experiments needed to find the inclusion level and digestibility in poultry/other monogastric animals.

**Keywords:** Ghee residue, proximate composition, nutrient composition

## Introduction
Generally, feed alone accounts for 60-70 per cent cost of production in any type of livestock and poultry rearing. There are many unconventional feed sources such as tamarind seed, azolla, acacia seed etc that have been included in the ration to minimize the cost of feed. Ghee residue is one such alternate feed ingredient which is a brownish solid mass obtained as a by-product of ghee industry. About 33 per cent of total milk produced in India is being utilized for ghee preparation and the average yield of ghee residue is calculated as one tenth of ghee produced (Gupta, 2007) [4]. Ghee residue proved to be a good source of protein, energy and minerals, especially calcium and phosphorus. Though the ghee residue has been used in food industry for making sweets, bakery products and as a flavour enhancer etc, most of the times, it is considered as a waste at the industry level as well as at the domestic level. As ghee residue contains 32–70 per cent of fat, it is used as a potential substrate for enzyme production of lipase (Sahasrabudhe *et al.* 2012) [10], used to improve the keeping quality of pet food in addition to lowering its cost (Rani *et al.* 2014) [7] and also used as an alternative feed ingredient to formulate low cost fish feed (Singh *et al.* 2015) [13]. Considering the above facts an attempt has been made to determine proximate composition and nutrient composition of ghee residue.

## Materials and methods
The ghee residue was procured from AAVIN, Viluppuram, Tamil Nadu where the ghee is being clarified from creamery butter. The ghee residue was mixed systematically and separated into four equal parts. The two opposite parts were removed and this procedure was repeated to obtain about 250 g of pooled sample of ghee residue. The collected ghee residue sample was subjected to complete analysis (moisture, crude protein, crude fiber, ether extract, total ash, calcium and phosphorus) as per A.O.A.C. (2003) [1]. The complete analysis of ghee residue was done at the laboratory of Animal Feed Analytical and Quality Assurance Laboratory (AFAQAL), Namakkal and it was expressed as per cent dry matter. The amino acid composition of ghee residue was analyzed by the Amino Lab., M/s. Evonic Industries, Evonic Degussa, Germany.
The fatty acid composition of ghee residue was analyzed at the laboratory of Animal Feed Analytical and Quality Assurance Laboratory, Namakkal. The technique of gas chromatography is applied for the estimation of fatty acid composition analysis. The ether extract from ghee residue was utilized for the analysis. The standardization of fatty acid profile was done as per Wang *et al.* (2000) [17]. The samples were subjected for direct methylation by using tricosanic acid as internal standard.

A fixed quantity (0.2 µl) of methylated sample was injected into gas chromatography equipped with fused silica capillary column. The temperature of oven was maintained at 180° C for five minutes and then increased to 220° C and held for five minutes. Temperature of 250° C was maintained at both inlet and detector. The flame ionization with air, hydrogen and nitrogen flow was 300, 30 and 4 ml per minutes, respectively. The methyl esters of fatty acids were separated in the column and quantified based on the retention time for fatty acid.

As per the method of Sibbald (1976) [12], the metabolizable energy (ME) of ghee residue was estimated by metabolic bioassay. Birds from Poultry Research Station were selected (twelve adult single comb white leghorn cockerels) and divided into two groups (treatment and control groups) each consisted of six cockerels. Metabolic cages were used to house them individually and starved for 24 hours to eliminate the feed taken before the metabolic bioassay. The treatment group was force-fed with 30 gm of ghee residue and control group was starved throughout the period of metabolic bioassay to collect endogenous losses. Excreta from treatment group and endogenous losses from control group were collected individually after 24 hours. Gross energy of ghee residue, excreta and endogenous products were estimated in adiabatic bomb calorimeter.

The apparent and true metabolizable energy were calculated by following formulae:

$$\text{Apparent metabolizable energy (kcal/ g)} = \frac{(\text{Gef} \times X) - \text{Yef}}{X}$$

$$\text{True metabolizable energy (kcal/ g)} = \frac{(\text{Gef} \times X) - (\text{Yef} - \text{Yec})}{X}$$

Where,

Gef - Gross energy of ghee residue (kcal/ g)

X - Weight of ghee residue (per cent dry matter)

Yef - Gross energy voided in the excreta (kcal/ g) by treatment group

Yec - Gross energy voided in the excreta (kcal/ g) by control group

**Results and discussion**

Proximate composition of ghee residue is presented in table 1.The estimated moisture content (12.10 per cent) in this study is comparable with the value (13.4 per cent, 9. 81 per cent and 9.39 per cent) quoted by Verma and Narendar Raju (2008) [15], Loganathan (2012) [5] and Selvamani (2015) [11] respectively, but is lower than the value (23.8 per cent and 19.27 per cent) observed by Grewal (1979) [3] and Verma and Sukumar De (1978) [16]. Source of ghee residue may alter the composition in moisture content as evidenced by the findings of Santha and Narayanan (1978) [9], who reported considerable variations in moisture content of ghee residue (13.6 – 25.5 per cent) obtained from different sources. The crude protein content of ghee residue analyzed in this experiment (19.86 per cent) is comparable with the value (23.2 per cent, 18.0 per cent) quoted by Grewal (1979) [3] and Prahlad (1954) [6] respectively. However, the result of the study does not agree with Mani (1952), who reported higher crude protein content (36.5 per cent). The result of the study is also not in accordance with the values (25.8 per cent, 25.71 per cent, 24.32 per cent) quoted by Arumugam *et al.* (1989) [2], Loganathan (2012) [5], Selvamani (2015) [11] respectively. The considerable variation in crude protein reported by above authors may be due to the source of ghee residue as evidenced by the findings of Santha and Narayanan (1978) [9] and Verma and Narender Raju (2008) [15], who recorded a variation from 16.2 to 41.6 per cent from different sources.

**Table 1:** Proximate analysis of ghee residue (On dry matter basis) (Method adopted for ghee clarification - Creamery butter method)

| Proximate Principles | Composition |
|---|---|
| Moisture (%) | 12.10 ± 2.24 |
| Drymatter (%) | 87.90 ± 2.24 |
| Crude Protein (%) | 19.86 ± 1.34 |
| Crude Fibre (%) | 3.49 ± 1.74 |
| Ether Extract (%) | 47.12 ± 3.62 |
| Total Ash (%) | 3.90 ± 0.32 |
| NFE (%) | 25.63 ± 3.71 |
| Gross Energy (estimated) (Kcal/kg) | 6256.17 ± 266.36 |
| Calcium (%) | 0.62 ± 0.07 |
| Phosphorus (%) | 0.62 ± 0.04 |
| Salt (%) | 0.68 ± 0.09 |
| Sand & Silica (%) | 0.14 ± 0.03 |
| AME (Kcal/kg) | 5160 ± 72.10 |
| TME (Kcal/kg) | 5290 ± 76.06 |

The observed crude fibre content in this study (3.49 per cent) is higher than the value (0.24 per cent) found by Selvamani (2015) [11]. The ether extract content of ghee residue analyzed in this experiment (47.12 per cent) is comparable with the value (50.8 per cent and 51.35 per cent) reported by Arumugam *et al.* (1989) [2] and Loganathan (2012) [5] respectively. However, Verma and Sukumar De (1978) [16] reported higher fat content (55.04 per cent), whereas, Santha and Narayanan (1978) [9] and Grewal (1979) [3] observed a lower fat content (32.9-36.2 per cent). The variations may be due to different source of ghee residue. The nitrogen free extract of ghee residue (25.63 per cent) observed in this experiment is higher than the value (14.4 per cent and 18.11 per cent) reported by Arumugam *et al.* (1989) [2] and Loganathan (2012) [5] respectively and lower than the value (30.02 per cent) quoted by Selvamani (2015) [11]. The estimated total ash content (3.90 per cent) of this experiment is comparable with the value (4.83 per cent, 4.71 per cent, 5.2 per cent) observed by Loganathan (2012) [5], Selvamani (2015) [11] and Grewal (1979) [3] respectively but is lower than the value (8.98 per cent and 6.0 per cent) reported by Arumugam *et al.* (1989) [2] and Rao *et al.* (1997) [8] respectively.

The estimated gross energy of ghee residue was 6256 kcal/kg which is comparable with the value (6426 kcal/kg) mentioned by Rao *et al.* (1997) [8]. The estimated apparent metabolizable energy (5160 kcal/kg) and true metabolizable energy (5290 kcal/kg) value of ghee residue is comparable with the value (5570 kcal/kg and 5839 kcal/kg) found by Loganathan (2012) [5] and higher than the value reported by Arumugam *et al.* (1989) [2]. The estimated metabolizable energy value is considerably higher than the metabolizable energy value of maize, the predominant feed ingredient in any type of poultry feed. The ghee residue which is found to be energy rich feed ingredient, due to its higher level of ether extract content and may conveniently be considered as an alternative source for replacing the high energy poultry feed ingredient especially maize.

The estimated calcium (0.62 per cent) content of this study is higher than the findings of (0.1 per cent) Subbulakshmi *et al.* (1990) [14], comparable with the value (0.58 per cent) observed by Selvamani (2015) [11] and lower than the earlier reported value (0.74 per cent, 0.88 per cent, 0.78 per cent) of

Grewal (1979) [3], Arumugam *et al.* (1989) [2] and Loganathan (2012) [5] respectively. The estimated phosphorus content of ghee residue (0.62 per cent) is comparable with the value (0.58 per cent) reported by Selvamani (2015) [11] and higher than earlier findings of Grewal (1979) [3], Arumugam *et al.* (1989) [2] and Subbulakshmi *et al*. (1990) [14] who reported phosphorus content as 0.42, 0.5 and 0.5 per cent respectively. However, the phosphorus content of this study is lower than the value (0.72 per cent) quoted by Loganathan (2012) [5]. The study revealed that calcium and phosphorus ratio of 1:1 is narrower than the ideal level of 2 per cent. The ratio of calcium and phosphorus need to be taken care of while formulating rations.

Amino acid composition of ghee residue is presented in table 2. The estimated lysine content of ghee residue (0.99 per cent) is comparable with the earlier reported value (0.98 per cent) observed by Loganathan (2012) [5] and higher than the value (0.48 per cent) reported by Selvamani (2015) [11]. Many authors have also quoted poor availability of lysine in ghee residue (Arumugam *et al.*, 1989, Rao *et al.*, 1997) [2, 8]. The result obtained for methionine content of ghee residue (0.61 per cent) is higher than the earlier reported value (0.51 per cent and 0.46 per cent) found by Loganathan (2012) [5] and Selvamani (2015) [11]. Similarly the estimated arginine content of ghee residue (0.76 per cent) is comparable with the earlier reported value (0.79 per cent) observed by Loganathan (2012) [5] and lower than the value (1.95 per cent) reported by Selvamani (2015) [11]. The value for threonine content of ghee residue (1.44 per cent) is numerically higher than the earlier reported value (1.28 per cent and 1.11 per cent) quoted by Loganathan (2012) [5] and Selvamani (2015) [11] respectively.

The estimated content of other amino acids i.e. cysteine, phenyl alanine, leucine, isoleucine and valine in ghee residue are (0.35, 1.54, 2.85, 1.50, and 1.74 per cent respectively) comparatively higher than the value reported (0.31, 1.24, 2.38, 1, 26, and 1.49 per cent) by Loganathan (2012) [5] and lower than the estimated result found by Selvamani (2015) [11]. The lesser content of amino acids in ghee residue may probably be due to denaturation of protein during ghee preparation. As the estimated crude protein value of the ghee residue is 19.86 per cent, it may be considered as one of the good source of protein when the limiting amino acids are supplemented as per the standard requirement.

**Table 2:** Amino acid profile of ghee residue (On dry matter basis)

| Amino acid | Composition* (per cent) |
|---|---|
| Alanine | 1.11 |
| Arginine | 0.76 |
| Aspartic acid | 2.48 |
| Cysteine | 0.35 |
| Glutamic acid | 5.26 |
| Glycine | 0.80 |
| Histidine | 0.55 |
| Isoleucine | 1.5 |
| Leucine | 2.85 |
| Lysine | 0.99 |
| Methionine | 0.61 |
| Methionine + cysteine | 0.96 |
| Phenylalanine | 1.54 |
| Proline | 2.36 |
| Serine | 1.66 |
| Threonine | 1.44 |
| Valine | 1.74 |

* The amino acid composition of ghee residue was analyzed by the Amino Lab., M/s. Evonic Industries, Evonic, Degussa, Germany.

Fatty acid composition of ghee residue is presented in table 3. The observed linoleic acid (2.02 per cent of fat) content of ghee residue of this study is very much comparable with the value (2.22 per cent of fat) observed by Loganathan (2012) [5] and linolenic acid (0.79 per cent of fat) content of ghee residue of this study is higher than the value (0.33 per cent of fat) reported by same author. However, linoleic and linolenic acid content value (3.81 and 0.83 per cent of fat) found by Selvamani (2015) [11] is higher than the value observed in the present study. The fatty acid profile as evidenced in the study indicates that the ghee residue is very rich source of oleic acid (25.15 per cent) which is higher than the values reported for oleic acid in ghee (20.50) and sunflower oil (18.70). The observed ratio on saturated and unsaturated fatty acid of ghee residue (65.5:34.5) is very much comparable with the worked out value (64.5: 35.5 and 64.2: 35.8) of Loganathan (2012) [5] and Selvamani (2015) [11] respectively.

**Table 3:** Fatty acid composition of ghee residue (%) (On dry matter basis)

| Carbon number | Name of the Fatty acids | Composition |
|---|---|---|
| 14:0 | Myristic acid | 13.38 ±1.01 |
| 16:0 | Palmitic acid | 38.88±1.18 |
| 18:0 | Stearic acid | 12.72 ± 0.68 |
| 22:0 | Behenic Acid | 0.32± 0.05 |
| 20:0 | Arachidic Acid | 0.25 ± 0.03 |
| 18:1 | Oleic acid | 25.15 ± 1.37 |
| 16:1 | Palmitoleic acid | 2.20 ± 0.17 |
| 18:2 | Linoleic acid | 2.02 ± 0.28 |
| 18:3 | Linolenic acid | 0.79± 0.10 |
| 20:5 | Eicosapentaenoic Acid | 0.36± 0.08 |
| 22:6 | Docosahexaenoic Acid | 0.25 ± 0.08 |
| Other isomers of long chain fatty acid | | 3.68 ± 0.40 |

Saturated Fatty Acid (%) (SFA): 65.5
Unsaturated Fatty Acid (%) (USFA): 34.5
SFA: USFA: 1.9:1

## Conclusion

Study revealed that ghee residue can be used an unconventional feed resource for poultry since it contains considerable amount of crude protein and gross energy. It can be incorporated in the poultry feed to partially replace maize and soya and thereby reduce the feed cost in poultry.

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