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Effectiveness in Utilization of Ghee Residue in the Production of Cookies and Biscuit in an Industrial Level

Athulya Sojan[1], Athira Surendran[2], Smitha J Lukose[3]

[1]UG Student, Department of Dairy chemistry, College of Dairy Science and Technology, Mannuthy
[2]UG Student, Department of Dairy chemistry, College of Dairy Science and Technology, Pookode
[3]Assistant Professor of Department of Dairy Chemistry at College of Dairy Science and Technology, Mannuthy

Abstract: ***Ghee residue is a nutritional by product obtained during ghee production. Due to lack of awareness of its nutritional property and the methods of its effective utilization it was discarded to the waste stream by most of all the dairy industries. The project was done with an objective of finding the effectiveness in utilization of ghee residue in production of cookies and biscuit at an industrial level. Trials were done to incorporate the ghee residue in biscuit and cookies using different states (squeezed and washed) of ghee residues at different proportions.The sensory quality and shelf life of treatments were compared with that of control sample. Ghee residue cookies prepared with washed ghee residue (E samples) were rejected based on shelf life study and sensory evaluation due to the hydrolytic rancidity development. In samples prepared using squeezed ghee residue (C samples) with Batter: Ghee residue in the ratios, C1; 90:10, C2; 85:15, C3; 80:20and C4; 70; 30 where C1 scored high while C2, C3, C4 were rejected in sensory evaluation due to the poor body and texture profile. Based on the economic analysis and chemical analysis done on ghee residue utilization at an industrial level revealed that utilization of ghee residue will always bring economic benefit for the industries along with reducing environment pollution. The standardized ghee residue biscuit had 28.25% fat, 60.39% total carbohydrate, 5.73% protein and 506 Kcal/ 100g.***

Keywords: Ghee residue, cookies; biscuit, sensory evaluation, nutritional value, cost evaluation

1. Introduction

The annual production of milk in India is 165.4MT as per NDDB statistic 2016-17; out of the total milk produced 30-35% is converted to ghee (Gandhi *et al., 2013)*. Ghee is the supreme product used all over India for cooking and frying purpose. During the production of ghee, a nutritional byproduct is obtained; ghee residue. Amount of ghee residue obtained was about $1/10^{th}$ of the total ghee produced (Dairy India, 2007).

Due to the lack of awareness of proper utilization of ghee residue, most of the industrially produced ghee residue is often discarded to drainage. Ghee residue is rich in phospholipids, one of the major antioxidant (Santha & Narayanan 1976 b); thereby incorporating ghee residue in products can enhance the shelf life (Wadhwa et. al., 1991). Ghee residue has appreciable amino acid profile and fatty acid profile (Loganathan 2012). Higher concentration of free fatty acids, lactones and carbonyls results in enhanced flavor properties in ghee residue which benefits in producing products with enhanced flavor (Galhotra et.al., 1990).

Urge of people (all age group) towards bakery products are unavoidable. Cookies and biscuits are among the majorly consumed bakery products. While ghee residue is a nutritious by product obtained during the manufacturing of ghee, incorporating ghee residue in cookies and biscuit can definitely offer a good and stable future market along with economically benefiting the dairy industries.

2. Materials and Methods

Materials

Ingredients Required

The ghee residue was procured during the manufacturing of ghee at MILMA, Wayanad Dairy.Ghee is being prepared either by direct creamery method or creamery butter method or a combination of both is used. The other raw materials used for making of cookies are all purpose flour (provides high volume and soft texture), powdered sugar (sweetening agent), ghee, vanaspati (provides a puffier texture and tenderness), baking powder (chemical leavening agent), salt (for taste) and permitted preservatives. Where in biscuit vanaspati be excluded.

Procurement of Ingredients

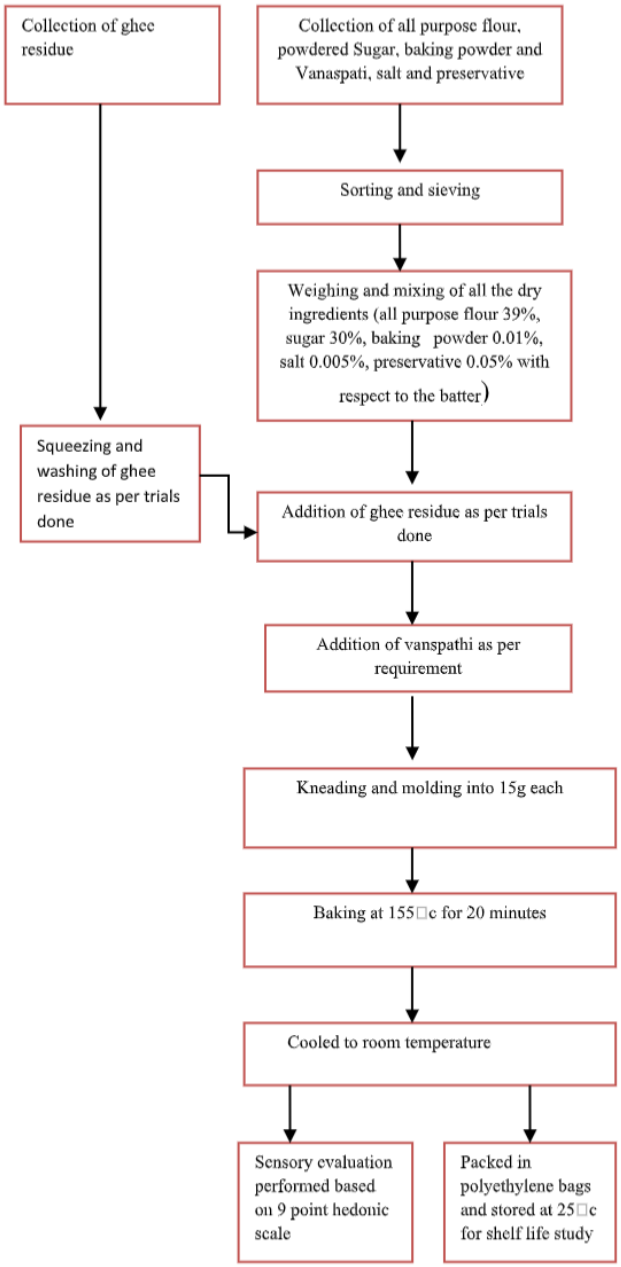
All the ingredients required for the preparation of ghee residue cookies and biscuits were procured from MILMA store.

Equipments Required

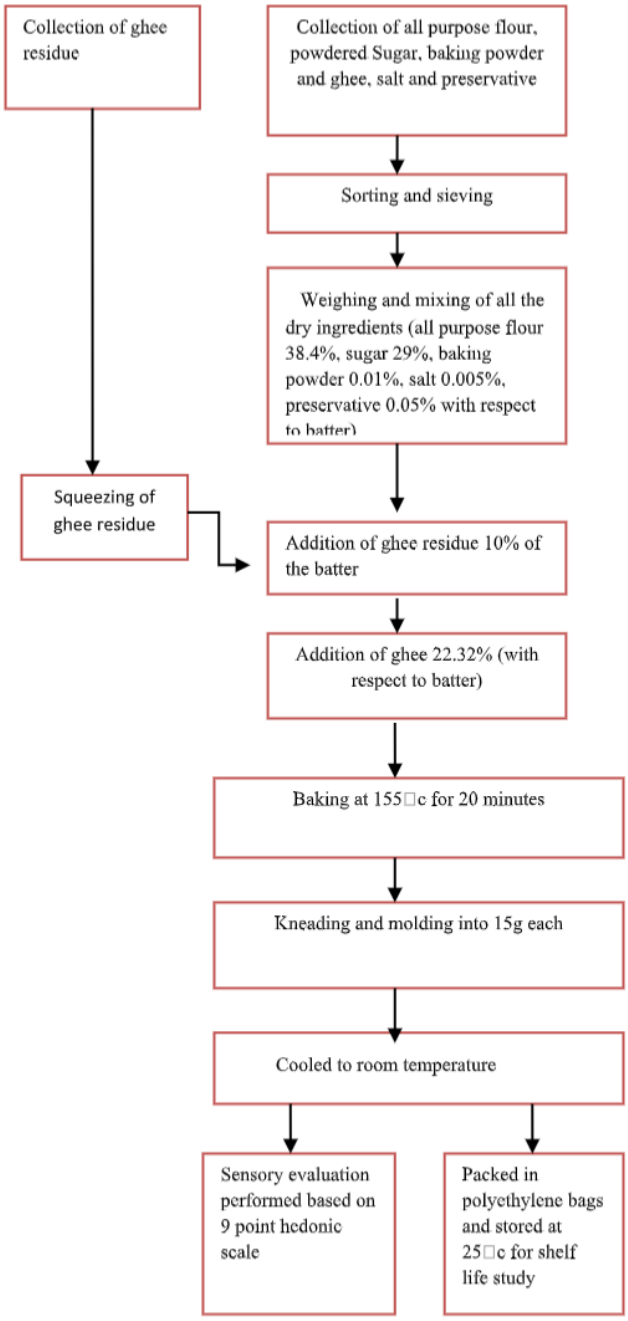
- Weighing balance
- Blender
- Molding device
- Oven
- Hand sealing machine

Methods

A) Cookies Incorporated with Ghee Residue



B) Ghee Biscuit Incorporated with Ghee Residue



Ghee Residue Cookies with Different Proportion of Squeezed Ghee Residue

Different proportions of ghee residue (squeezed) were incorporated in the production of ghee residue cookies. The batter: ghee residue proportions used were 100:0 **(C0)**, 90:10 **(C1)**, 85:15 **(C2)**, 80:20 **(C3)**, and 70:30 **(C4).** It was then hand molded into 15gram each after proper blending and kneading followed by baking. Sensory evaluation was performed based on 9 point hedonic scale. Control samples were kept for shelf life study after packing in polyethylene bags.

Ghee Residue Cookies from Washed Ghee Residue

Different proportions of washed ghee residue were incorporated in the production of ghee residue cookies.

The batter: ghee residue proportions used were 100:0 **(E0)**, 87:13 **(E1)**, 86:14 **(E2)**, 85:15 **(E3)** and 80:20 **(E4)**. It was then hand molded into 15gram each after proper blending and kneading and then baked. Sensory evaluation was performed based on 9 point hedonic scale. Control samples were kept for shelf life study after packing in polyethylene bags.

Standardization of Ghee Residue Cookies (C1)

Ghee residue cookies were standardized based on sensory evaluation finalized with 10% of ghee residue (squeezed) incorporation **(C1)**, in which percentage of replacement of ghee were analyzed. After proper blending and kneading it was then hand molded into 15gram each and baked. Sensory evaluation was performed based on 9 point hedonic scale. Control samples were kept for shelf life study after packing in polyethylene bags.

Ghee Residue Incorporation in the Production of Ghee Biscuit (F1)

In cookies production, based on sensory evaluation done 10% incorporation of ghee residue was found to be optimum. So optimized level was selected for ghee residue biscuit production. Amount of ghee replacement was estimated. All purpose flour, powdered sugar, ghee residue and ghee were used for production of ghee biscuit batter, it was then hand molded into 15gram each after proper blending and kneading and baked. Then it was packed in polyethylene bag, sensory evaluations were performed and control samples were kept for shelf life study.

Analysis Method

Both the products were analysed for proximate factors as per AOAC method.

Estimation of Fat %

Fat estimation of washed ghee residue and squeezed ghee residue was done by the standard Rose Gottlieb method (AOAC, 17th edn, 2000 official method 905.02 fat in milk). It was done to analyse the economic benefit of utilizing ghee residue for the production of cookies and biscuit at an industrial level.

Nutritional Facts Analysis

Ghee residue biscuit were chemically analyzed by the standardized procedure of AOAC (2005).The proximate components viz., total carbohydrate, fat, protein, energy were determined using standard procedure prescribed by AOAC (2005).

Shelf Life Study

Shelf life study was done to analyse the keeping quality of the product by examining the control samples kept at 25ºc

Sensory Evaluation

The sensory evaluation was performed on 9-point hedonic scale for measuring the consumer acceptability of product.

Cost Evaluation

Cost evaluation of control sample and ghee residue biscuit were done using the preponderant prices of the ingredients used for production

3. Result and Discussion

Ghee Residue Cookies with Different Proportion of Ghee Residue

The basic formulation of cookies was optimized for different levels of ghee residue, other ingredients(Maida , vanaspati, baking powder, salt, ghee, preservatives).For this purpose different proportions of ghee residue(squeezed) viz 90:10 (C1), 85:15(C2), 80:20(C3), and 70:30(C4) were used for the preparation of ghee residue cookies keeping the other ingredients fixed as per standard. Normal cookies without ghee residue (ghee residue: batter in the ratio 0:100) served as contol. Product was judged based on various sensory attributes. Results showed that increase in overall acceptability in terms of flavor and texture was obtained on increasing ghee residue concentrations up to 10 %.Addition of more than 10% ghee residue resulted in decrease in overall acceptability. This could be due to brown color of ghee residue and the persistence of granule particle after consumption of ghee residue cookies above 10% replacement of batter with ghee residue. The flavor property increased with increasing the ghee residue concentrations, which might be due to the high concentrations of flavor components such as free fatty acids, lactones and carbonyls in ghee residue. (Galhotra et.al., 1990).

Figure 1 to 4. Illustrates that the cookies C1, C2, C3, C4 packed in polyethylene bags had good keeping quality for one month when stored at normal atmospheric temperature (at 25ºc)

Ghee Residue Cookies Using Washed Ghee Residue

The basic formulation of cookies was optimized for different levels of ghee residue and batter containing other ingredients (Maida, vanaspati, baking powder, salt, ghee, preservatives).For this purpose different proportions of ghee residue (washed) viz 87:13 (E1), 86:14 (E2), 85:15 (E3) and 80:20 (E4) were used for the preparation of ghee residue cookies keeping the level of other ingredients fixed as per standard. To optimize the level of ghee residue, the normal cookies C0 (batter: ghee residue in the ratio 0:100) served as control. Products were judged based on various sensory attributes. Results showed that overall acceptability in terms of flavor and texture was high for E1.On increasing ghee residue concentrations above 10% the overall acceptability decreased. This could be due to brown color of ghee residue and the persistence of granule particle after consumption of ghee residue cookies above 10% replacement of batter with ghee residue. The flavor

property increased with increasing the ghee residue concentration, which might be due to the high concentrations of flavor components such as free fatty acids, lactones and carbonyls in ghee residue (Galhotra et.al., 1990). Cookies obtained were with better body and texture.

Based on the shelf life study conducted, the control samples were found with rancid flavor after 10 days of storage in polyethylene bags at normal atmospheric conditions. The rancid flavor development is due to the usage of washed ghee residue. Contact of water with fat in ghee residue while washing could have resulted in the development of hydrolytic rancidity (Hamilton, 1994). Thus it is concluded that washed ghee residue is not suitable for production of ghee residue cookies.

Standardized Ghee Residue Cookies

Based on sensory evaluation and feasibility of commercial production, the proportion of ghee residue incorporation in cookies was finalized to 10% concentration. 100% replacement of ghee was achieved by replacing normal cookies batter with 10% ghee residue (squeezed) containing 60% of fat. From the chemical analysis done it is evident that washed ghee residue contains 37% fat, thus by effectively utilizing ghee residue for production of ghee residue cookies will be an economic benefit for the dairy by reducing the fat loss**.** The emulsifiers present in the fat portion of ghee residue imparted good body and texture to the product. High flavor components concentration in ghee residue might have resulted in enhanced flavor property for the product.

Figure 9. Illustrates that F1 packed in polyethylene bags imparts keeping quality for one month at normal atmospheric conditions (at 25ºc). Enhanced shelf life property of ghee residue cookies were obtained due to the higher amount of natural antioxidant present in ghee residue such as phospholipids and free sulfhydryl components.

Ghee Residue Incorporation in the Production of Ghee Biscuit

Ghee residue biscuit were prepared with incorporation of 10% ghee residue. Standardization of product was achieved with maximum replacement of fat (ghee) with ghee residue. 17.63% of replacement of ghee was achieved by replacing normal ghee biscuit batter with 10% ghee residue (squeezed) containing 60% of fat. Based on sensory evaluation in comparison with the control sample ghee residue incorporated ghee biscuit scored high. Figure 10. Illustrates that H1 packed in polyethylene bags imparts keeping quality for one month at normal atmospheric conditions.

Chemical Evaluation

Rose Gottlieb method (AOAC, 17th edn, 2000 official method 905.02 fats in milk) was done for the analysis of fat in ghee residue.

Fat %	Trial 1	Trial 2	Trial 3	Average fat %
Washed ghee residue	40	38	33	37
Squeezed ghee residue	58	63	59	60

- Estimated fat % for washed ghee residue: 37%
- Estimated fat % for squeezed ghee residue: 60%
- Reduction in the fat loss for the dairy industries can be achieved by the proper utilization of ghee residue for the production of cookies and biscuit were it can contribute in the fat replacement.

Nutritional Facts Analysis

From the chemical analysis done it is being estimated that 100 g of ghee residue biscuit provides 506 KCal energy and contains 28.25% fat, 60.39% total carbohydrate and 5.73% protein.

Shelf Life Study

All products met the shelf life study parameters except the ghee residue cookies made using washed ghee residue.

1. Ghee Residue Cookies Using Squeezed Ghee Residue at Various Proportions

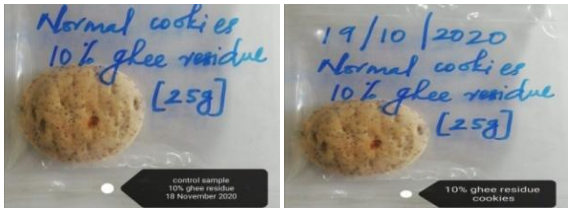


Figure 1: Pictures of C1stored at 25ºc for one month in polyethylene bags

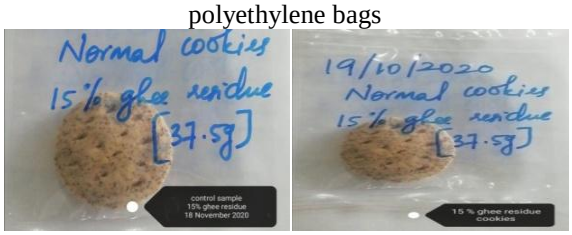


Figure 2: Pictures of C2 stored at 25ºc for one month in polyethylene bags

Figure 3: Pictures of C3 Cookies stored at 25ºc for one month in polyethylene bags

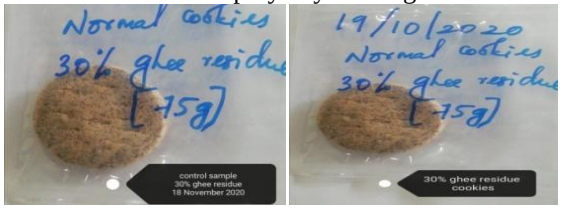


Figure 4: Pictures of C4 stored at 25ºc for one month in polyethylene bags

2. Ghee Residue Cookies Using Washed Ghee Residue

Figure 5: Pictures of E1 stored at 25ºc for one month in polyethylene bags

Figure 6: Pictures of E2 stored at 25ºc for one month in polyethylene bags

Figure 7: Pictures of E3 stored at 25ºc for 24 days in polyethylene bags

Figure 8: Pictures of E4 stored at 25ºc for one month in polyethylene bags

3. Standardized Ghee Residue Cookies

Figure 9: Pictures of C1 stored at 25ºc for 24 days in polyethylene bags

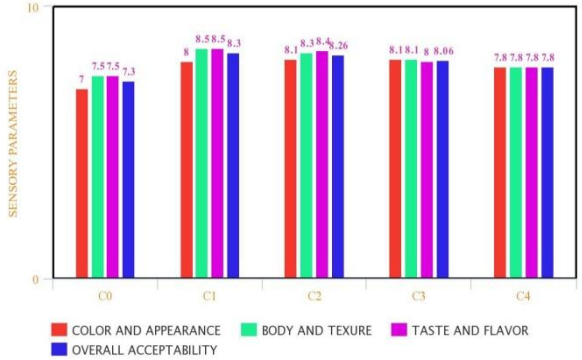
4. Ghee Biscuit

Figure 10: Pictures of F1 stored at 25ºc for 24 days in polyethylene bags

Sensory Evaluation

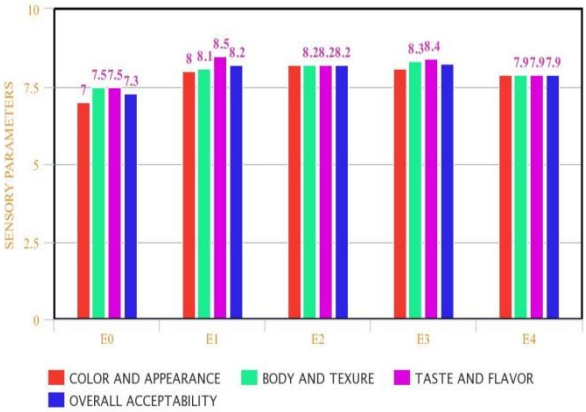
Sensory evaluation done based on 9-point hedonic scale.

1. Sensory Evaluation of Ghee Residue Cookies (Using Squeezed Ghee Residue at Different Proportions)



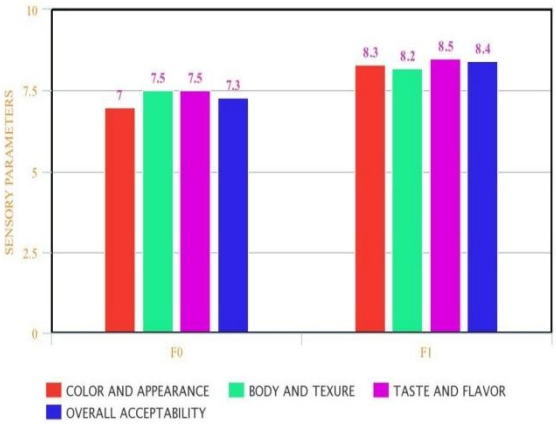
C0 = normal cookies batter: ghee residue in 100: 0 ratio, C1=normal cookies batter: ghee residue in 90: 10 ratio, C2 =normal cookies batter: ghee residue in 85: 15, C3= normal cookies batter: ghee residue in 80:20 ratio, C4= normal cookies batter: ghee residue in 70:30 ratio.

2. Sensory Evaluation of Ghee Residue Cookies (Using Washed Ghee Residue at Different Proportions)



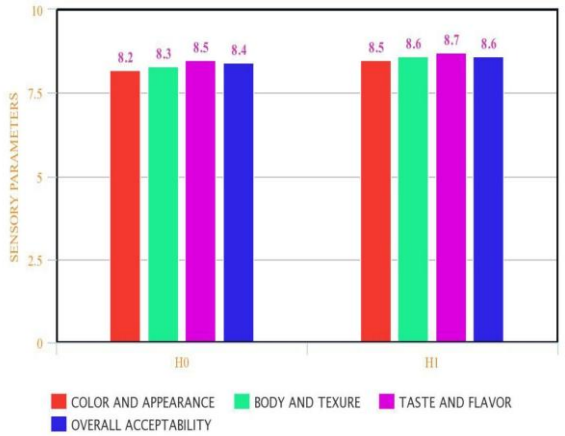
E0= normal cookies batter: ghee residue in 100: 0 ratio, E1=normal cookies batter: ghee residue in 87:13 ratio, E2 =normal cookies batter: ghee residue in 86:14, E3= normal cookies batter: ghee residue in 85:15 ratio, E4= normal cookies batter: ghee residue in 80:20 ratio.

3. Sensory Evaluation of Standardized Ghee Residue Cookies



F0= normal cookies batter: ghee residue in 100: 0 ratio, F1=normal cookies batter: ghee residue in 90:10 ratio

4. Sensory Evaluation of Ghee Residue Biscuit



H0= normal cookies batter: ghee residue in 100: 0 ratio, H1=normal cookies batter: ghee residue in 90:10 ratio.

Cost Evaluation

Based on the cost evaluation done it is being estimated that by incorporating ghee residue in ghee biscuit cost of production can be decreased by 16.16% per 100 g. Table 1 & 2 illustrates the cost evaluation of ghee biscuit and ghee residue biscuit batter respectively.

Table 1: Cost Evaluation of Normal Ghee Biscuit Batter Per 100 g

Name of ingredients	Quantity used(in grams)	Unit cost (in rupees)	Total cost(in rupees)	Total cost of production per 100 g of ghee biscuit batter
All purpose flour	43.6g	30/100g	1.308	**18.712 rupees**
Sugar	29g	38/100g	1.102	
Ghee	27.1g	60/100g	16.26	
Permitted preservative	0.3g	14/100g	0.042	

Table 2: Cost Evaluation of Ghee Residue Biscuit Batter Per 100 g

name of ingredients	quantity used(in grams)	unit cost (in rupees)	total cost (in rupees)	total cost of production per 100 g of ghee biscuit batter
All purpose flour	38.4g	30/100g	1.152	**15.688 rupees**
Sugar	29g	38/100g	1.102	
Ghee	22.32g	60/100g	13.392	
Permitted preservative	0.3g	14/100g	0.042	
Ghee residue	10g	-	-	

4. Conclusion

Cookies and biscuits are generally agreeable snacks for all age groups. It gives a sense of satisfaction and feeling of fullness in addition to supply of proteins, minerals, vitamins and carbohydrates.

By conducting various studies on the production of ghee residue cookies with different parameters, it is being concluded that ghee residue can be a good and better fat replacer in confectionery products to an extent. The benefits of using ghee residue (squeezed) as a fat replacer were its good fatty acid profile, amino acid profile (containing essential amino acids with exceptions), rich flavor profile (provided by the flavor compounds such as free fatty acids, lactones and carbonyls), and good antioxidant property (provided by the antioxidants such as phospholipids and free sulfhydryl compounds). Enhancement of body and texture property of ghee residue cookies were achieved (imparted by the emulsifiers in ghee residue).

Based on sensory evaluation and feasibility of commercial production, the proportion of ghee residue incorporation in cookies and biscuit were finalized to 10% concentration. most of all the dairy industries practices to disperse the ghee residue in hot water for maximum recovery of fat even then based on the chemical analysis done it is being found that the ghee residue discarded to waste stream contains 37% of fat, thereby it is being ensured that utilizing ghee residue for producing various products will always bring economic benefit for the dairy industries.

Incorporation of ghee residue in ghee biscuit can replace up to 17.63% ghee thereby cost of production can be decreased by 16.16%.Nutritional analysis revealed that ghee residue biscuit is a good source of energy, fat, protein and carbohydrate. Washed ghee residue is not suitable for the production of ghee residue cookies due to the possibility of hydrolytic rancidity development on storage. Washed ghee residue may be subjected to some drying treatment for their effective use in some products and to avoid rancidity. It is evident from the shelf life study and sensory evaluation that ghee residue biscuit have better sensory scores and keeping quality, which makes them marketable. Along with bringing economic benefit to the dairy industry it contributes to the environment by reducing pollution. Based on the studies conducted it is being concluded that effectiveness in utilization of ghee residue for production of biscuit and cookies are overwhelming.

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