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Formulation and Quality Evaluation of Low-Fat Spread Based on Ghee Residue and *Sougri* Extract

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Abstract - The present study entitled "Formulation and Quality Evaluation of low-fat spread based on ghee residue and *Sougri* extract" was carried out with the objective to utilize ghee residue and *Sougri* extract for the preparation of low-fat spread. Low-fat spread was prepared using different proportions of butter and ghee residue, while *Sougri* extract was kept constant in all the samples. The low-fat spread prepared was compared with the market sample. Fat, protein, moisture, total solids, carbohydrate, ash, antioxidant activity, peroxide value, FFA and total phenolic content of the prepared sample was measured. Sensory evaluation was carried out using 9-point Hedonic scale. Data obtained was statistically analyzed using analysis of variance (ANOVA). On the basis of findings, low-fat spread which had 10% ghee residue and 50% butter scored the best with regard to color, flavor, texture, appearance and overall acceptability. It was found that addition of ghee residue increased the Total solids content, protein content, ash content, carbohydrate content, titratable acidity, FFA, antioxidant activity and total phenolic content. Whereas, moisture, fat and peroxide value decreased with the addition of ghee residue.

***Key Words*:** ghee residue, low-fat spread, *Sougri*, butter

1. INTRODUCTION

Low-fat spreads, contain a minimum of 40% fat and a maximum 60% fat. These can be spread easily due to its plastic nature into food products like bread. Nowadays, people have a tendency to shift to more healthier options in terms of any food they eat. As a result, low-fat spreads are gaining more acceptance. However, low-fat spread using ghee residue has not been prepared so far. According to NDDB statistics, India produces 209.96 million tons of milk annually, of which 30–35% is turned into ghee. The manufacturing of culinary products like chocolate burfi, samosa filling, chapatis, etc. uses ghee residue, a nutritive byproduct of ghee production that has been researched for its physicochemical qualities. Ghee residue has a significant deal of potential and is more suited to being utilized in the food business due to its chemical composition, extent of production, physical qualities, and long shelf life. Further, the flavor potential of ghee - residue is much greater than that of ghee. Hence it can be utilized for flavoring bland fats and also enhancing their keeping quality. Ghee-residue contains good quantities of milk fat, protein and minerals. Therefore, it can be used as a human dietary supplement. *Sougri* or Roselle is a flowering plant in the genus Hibiscus and has been studied for its medicinal and antioxidant properties. It is used to make sauces, wines, jellies, and jams. It soothes cramps and discomfort associated with menstruation and is nutrient-rich in ascorbic acid, which human beings need in order to strengthen and increase the function of our immune system.
Ghee residue is the least utilized by-product in the dairy industry as it is discarded to waste stream. It has large amount of excess free fat (32%-70%). Ghee residue having a number of nutritional properties that makes it a useful by-product. The replacement of portions of milk fat (cream, butter or butter oil) with processed ghee residue is a good way to make use of this wasted by-product. Different combinations of milk & processed ghee residue can be tried in the preparation of fat spread. Ghee residue is rich in natural sources of flavor compounds like free fatty acids, carbonyls & lactones thus will provide flavor to bland fats. Ghee residue is rich in phospholipids & nitrogenous compounds which makes it an excellent source of antioxidants. Phospholipid like cephalin shows the highest antioxidant property followed by α-tocopherol & vitamin A. Non lipids like amino acids, proline, lysine, cysteine, hydrochloride and tryptophan also shows antioxidant properties The proteins in the ghee residue is of great nutritional profile and thus can be used to prevent protein energy malnutrition in children. Such a by-product with excellent nutritional qualities, flavor profile, antioxidant properties along with its long shelf life should be incorporated in all the possible food products and thus reduce the waste of such a potential product into waste streams. *Sougri* is a natural coloring compound. The calyces of this shrub *Sougri* (Hibiscus sabdariffa) are rich in antioxidants like flavonoids, vitamin C and also minerals. These calyces are used to treat hypertension, pyrexia, liver damage and improves digestion. *Sougri* extract also imparts a light pink color to the spread & thus increases the acceptability.

2. MATERIALS AND METHODS

Low-fat spreads based on ghee residue and *Sougri* extract was prepared using the ingredients ghee residue, butter, *Sougri* extracts, stabilizer-emulsifier mix, skim milk powder, salt and water. Ghee residue will be procured from the Dairy plant of Warner College of Dairy Science and Technology, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj and was immediately stored in the cold storage at a temperature of 5°C till further processing. Butter of renowned brand will be brought from the local market of Prayagraj. *Sougri* calyx was procured from Manipur. Skim milk powder of renowned brand was obtained from the local

market of Prayagraj. Salt will be brought from the local market. Stabilizer-Emulsifier blend used was supplied by Danisco Cremodan Sampoorna Pvt Ltd, Mumbai.

PREPARATION OF LOW-FAT SPREAD

Four samples of low-fat spread were prepared using different compositions of butter and ghee residue along with three replications and the control sample was market sample. Ghee residue and butter were used at different levels ranging from 5-20% and 40-55% respectively. The amount of *Sougri* extract added was kept at a constant value of 1%. Other ingredients utilized were stabilizer-emulsifier mix (1%), skim milk powder (2%), salt (2%) and water (35%). Details of treatments and ingredients are given in table 1. The procured ghee residue was grinded before actual preparation in order to maintain uniformity in the size of the particles. *Sougri* calyces were boiled in distilled water for the purpose of extraction. SMP, salt and stabilizer-emulsifier mix were added to distilled water that contains *Sougri* extract and thoroughly mixed. All these ingredients were prepared as needed and the final preparation of product was carried out using an electronic mixer. The ingredients were blended for 15 minutes. All the treatment samples were packed in airtight polypropylene tubs and stored at 5°C.

Table -1:

Treatments	Ghee residue (%)	Butter (%)	*Sougri* extract (%)	Stabilizers (%)	Emulsifiers (%)	Water (%)	SMP (%)	Salt (%)
T0	Market Sample							
T1	20	40	1	0.5	0.5	35	2	2
T2	15	45	1	0.5	0.5	35	2	2
T3	10	50	1	0.5	0.5	35	2	2
T4	5	55	1	0.5	0.5	35	2	2

PHYSICOCHEMICAL ANALYSIS OF LOW-FAT SPREAD

The prepared samples of low-fat spread were analyzed for moisture, fat, protein, carbohydrate and ash by the method prescribed by AOAC, 2005. The titratable acidity of the sample was analyzed by the method of titration (AOAC, 2005). Similarly, free fatty acid content and peroxide value of both treatments and replications were also determined. Free fatty acid content indicates the level of lipolysis and its value is important in a fat-rich product like low-fat spread. Rancidity of fat-rich product is mainly due to fatty acids. Peroxide value is one of the most commonly used quality assessment indicators in food and dairy industry, especially for fat-based products and is expressed as meq/kg oil. Peroxides are primary oxidation products and is formed during initial stages of lipid oxidation. The antioxidant activity of the prepared low-fat spread was prepared by using DPPH (2, 2-Diphenyl-1-picrylhydrazyl) reagent. The reaction involves reducing (DPPH) radical with antioxidant resulting in reduction of the absorbance. Absorbance was measured at a wavelength of 517 nm using spectrophotometer.

MICROBIOLOGICAL ANALYSIS

The prepared samples were analyzed for standard plate counts, coliform counts and yeast and mold. Plating technique was used for the evaluation of any sort of microorganisms in the sample. Standard plate counts were performed using nutrient agar, yeast and mold counts were performed using potato dextrose agar, and the number of coliforms in the sample was determined using McConkey broth.

SENSORY ANALYSIS

Sensory evaluation of the prepared fat spread was done using 9-point Hedonic scale by the panel of ten trained judges which included professors, PhD scholars and fellow students. The sample was evaluated for color, flavor, texture, appearance and overall acceptability. The judges' evaluation was based on a preference test using a nine-point hedonic scale. The optimal treatment was determined to be the sample that had the greatest mean score overall when compared to the control sample.

STATISTICAL ANALYSIS

The results were statistically analyzed using the analysis (ANOVA). Two-way ANOVA was used and effect of both treatments and replications on the analyzing parameter was checked.

3. RESULTS AND DISCUSSIONS

The mean values of all the physicochemical characteristics along with mean sensory scores are given in table 2.

MOISTURE CONTENT (%): The highest average value of moisture content (47.92) was observed in treatment T_4. **Ranjan *et. al* (2020)** observed similar results, where moisture increased with the level of ghee residue in the analysis of bakery product in which ghee residue was incorporated. From the result of ANOVA, it shows that there was significant effect of treatment on moisture content of the samples.

TOTAL SOLIDS (%): The highest average value of Total solid content is (56.78) was observed in treatment T_1 after T_0 which was the market sample. **Ranjan *et. al* (2020)** observed there was decrease in total solids with the increase in level of ghee residue in a bakery product incorporated with ghee residue. From the result of ANOVA, it shows that there was significant effect of treatment on total solids content of the samples.

FAT CONTENT (%): The highest average value of Total solid content is (47.35) was observed in treatment T_4 after T_0 which was the market sample. The fat portions of the product include butter and ghee residue, of which butter has higher fat content. As a result, T_4 had the highest fat percentage. From the result of ANOVA, it shows that there was significant effect of treatment on fat content of the samples.

PROTEIN CONTENT (%): The highest average value of Protein content is (5.35) was observed in treatment T4. **Ranjan *et. al* (2020)** observed there was a decrease in protein content with the decrease in level of ghee residue added. The simultaneous decrease from T1 to T4 may be due to decrease in the amount of ghee residue. From the result of ANOVA, it

shows that there was significant effect of treatment on protein content of the samples.

ASH CONTENT (%): Ash content is highest in T1, which contains the highest percentage of ghee-residue. The results were similar to that of **Ramesh *et. al* (2018**) who found that the ash content of ghee residue to be 3.90% and thus the increase in ash content as the amount of ghee residue added is increased. The simultaneous decrease of ash content from T_1 to T_4 is due to the decrease in the level of ghee residue added. From the result of ANOVA, it shows that there was significant effect of treatment on ash content of the samples.

CARBOHYDRATE CONTENT (%): The highest average value of carbohydrate content is (2.72) was observed in treatment T_1. **Hirpara *et. al* (2020)** observed there was an increase in carbohydrate content with the increase in level of ghee residue added while analyzing a traditional dairy product (*Thabdi* milk) in which ghee residue was added. The simultaneous decrease from T_1 to T_4 may be due to decrease in the amount of ghee residue added. From the result of ANOVA, it shows that there was significant effect of treatment on carbohydrate content of the samples.

TITRATABLE ACIDITY (%LA): The highest average value of acidity content is 0.36 was observed in treatment T1. **Hirpara *et. al* (2020)** observed there was an increase in titratable acidity with the increase in level of ghee residue added while analyzing a traditional dairy product (*Thabdi* milk) in which ghee residue was added. The simultaneous decrease from T1 to T4 may be due to decrease in the amount of ghee residue added. From the result of ANOVA, it shows that there was significant effect of treatment on titratable acidity of the samples.

PEROXIDE VALUE (meq/kg oil): The highest average value of Peroxide value is 0.16 was observed in treatment T4 after T0 which was the market sample. It is thus visible that there was a visible decrease in peroxide value when the amount of ghee residue added increases. Similar findings were cited by **Patange *et al.*, (2013)** in his literature. From the result of ANOVA, it shows that there was significant effect of treatment on peroxide value of the samples.

FREE FAATY ACID (%OA): The highest average value of FFA content is (1.57) was observed in treatment T1, which contains the highest percentage of ghee-residue. The results were similar to that of **Ramesh *et. al* (2018)** who found that ghee residue is a rich source of oleic acid and thus with the increase in ghee residue in the treatments FFA is also increased. The simultaneous decrease of FFA from T1 to T4 is due to the decrease in the level of ghee residue added. From the result of ANOVA, it shows that there was significant effect of treatment on FFA of the samples.

ANTIOXIDANT ACTIVITY (%): The highest average value of antioxidant content is (28.40) was observed in treatment T1. **Pandhare (2022)** cited in his literature that the antioxidant activity of ghee residue is high. Thus, the simultaneous increase of the radical scavenging activity can be explained. **Wani *et. al* (2022)** also had similar findings. **Mohd-Esa *et. al* (2009)** also recognized the calyces of *Sougri* as a rich source of antioxidant. From the result of ANOVA, it shows that there was significant effect of treatment on antioxidant activity of the samples.

MICROBIOLOGICAL ANALYSIS: Standard plate count was highest in T_1. As the amount of ghee residue added increased, the SPC count is also appreciably increased. This might be due to the poor sanitary measures adopted during the preparation of ghee. The findings were similar to that cited by **Sourabh *et. al* (2018)** in his literature. The control and experimental samples of low-fat spread were tested for yeast and mold and coliform counts. It was found that these counts were nil in the samples.

SENSORY ANALYSIS: On comparison with the market sample T0, it was found that the mean scores for color (8.33), flavor (9.67), texture (8.33), appearance (8.67) and overall acceptability (8.67) was the highest for T3 (10% ghee residue and 40% butter). From the result of ANOVA, it shows that there was significant effect of treatment on sensory attributes of the samples.

Table-2:

Parameter	Scores/values based on mean value of different parameters of treatments					C.D.
Treatment	T_0	T_1	T_2	T_3	T_4	
Fat content (%)	56.02	45.22	45.72	46.35	47.35	0.02
Ash content (%)	1.05	1.87	1.50	1.18	0.74	0.01
Moisture content (%)	36.03	43.24	45.11	46.89	47.92	0.01
Protein content (%)	5.20	6.95	5.39	4.13	2.45	0.01
Carbohydrate Content (%)	1.70	2.72	2.28	1.75	1.54	0.01
Total Solids content (%)	63.97	56.76	54.89	53.73	52.08	0.01
Titratable Acidity (%LA)	0.24	0.36	0.31	0.28	0.25	0.01
Peroxide Value (meq/kg oil)	0.17	0.10	0.12	0.15	0.16	0.01
Free Fatty Acid (%)	0.91	1.57	1.39	1.30	1.07	0.01
Antioxidant activity (%)	7.40	28.4	20.92	13.21	8.21	0.01
Standard Plate Count(cfu/ml)	3.22	4.79	4.47	4.41	4.12	0.23
Yeast and Mold(/g)	0	0	0	0	0	
Coliform(/g)	0	0	0	0	0	
Colour	8.67	6.33	7.33	8.33	8	0.78
Flavour	9.33	7.67	7.33	9.67	6.67	0.82
Texture	8.67	6.33	7.33	8.33	7.67	0.75
Appearance	9.33	6.33	7.33	8.67	7.67	0.87
Overall acceptability	9.67	6.33	7.33	8.67	7.67	0.87

4. CONCLUSIONS

It is concluded from the present study that ghee residue can be effectively utilizes as a fat source in low-fat spreads. The product was acceptable with regard to sensory attributes. Also, the nutritional composition was found to be higher in the sample (T1) in which the content of ghee residue was higher. The antioxidant activity and FFA of the prepared low-fat spread increased as the level of incorporation of ghee residue increased. Even though, the product does not contain any sort of preservatives the shelf-life was 7 weeks and this is due to the antioxidant activity of ghee residue and *Sougri*. The *Sougri* calyces is also known to have preservative effect.

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